Review of WIC Food Packages: Proposed Framework for Revisions: Interim Report

DETAILS

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Committee to Review WIC Food Packages

Food and Nutrition Board

Institute of Medicine

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This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their review of this report:

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Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations nor did they see the final draft of the report before its release. The review of this report was overseen by **Diane F. Birt,** Iowa State University, and **Elaine L. Larson,** Columbia University Mailman School of Public Health. They were responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the institution.

Contents

Preface

The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) began 40 years ago as a pilot program and has since grown to serve more than 8 million pregnant women, and mothers and their infants and young children. Today, the program serves more than one-quarter of the pregnant women and half of the infants in the United States, at an annual cost of about $6.2 billion. Through its contribution to the nutritional needs of pregnant, breastfeeding, and postpartum women; infants; and children under 5 years of age; this federally supported nutrition assistance program is integral to meeting national nutrition policy goals for a significant portion of the U.S. population.

To assure the continued success of WIC, Congress mandated that the Food and Nutrition Service of the U.S. Department of Agriculture (USDA) re-evaluate the program's food packages every 10 years to assure that they remain aligned with the goals of the *Dietary Guidelines for Americans*. In 2014, the USDA asked the Institute of Medicine (IOM) to undertake this reevaluation. This complex task included consideration of whether or not WIC participants should be permitted to purchase white potatoes with the cash value voucher (CVV), a part of the benefit package that provides access to fresh fruits and vegetables. In its first of three reports, published early in 2015, the Committee to Review WIC Food Packages (the committee) recommended that white potatoes be allowed as a WIC-eligible vegetable for purchase with the CVV. This, the second report of this series, provides a summary of the work of phase I of the study, and serves as the analytical underpinning for phase II in which the committee will report its final conclusions and recommendations (the third and final report).

In this report, the committee provides the findings and conclusions from its evidence gathering and data analyses. Finally, the report presents the committee's criteria that lay the groundwork for phase II of the study, and offers a framework to guide development of the committee's recommendations.

The work of the committee was greatly enhanced by the contributions of many individuals who participated in the study's public activities. The committee is grateful to the speakers in its data-gathering workshops who gave valuable insights as well as their time to assist the committee with its task. The committee also thanks the members of the public who provided comments in open sessions or through the committee's website. Lastly, the committee is indebted to the many WIC staff members who gave their time and expertise to help committee members better understand administration and participation in the WIC program.

The size of this report is testimony to the magnitude of the committee's task. It exists thanks to the hard work of many individuals. Committee members volunteered many hours of their time to this work. Their collaborative spirit as well as careful thinking and writing are to be commended. The committee was supported in its work by two consultants. Suzanne Murphy provided critical insights based on her experience in leading the committee that produced the first major reevaluation of the WIC food packages, published in 2006. Her sage advice is much appreciated. Mei Chung led the development and execution of all of the committee's literature reviews.

The committee would like to thank the staff of the Center for Agricultural and Rural Development (CARD) and the Department of Statistics at Iowa State University for their analysis of the data from the National Health and Nutrition Examination Survey (NHANES) and the National Household Food Acquisition and Purchase Survey. Committee members Alicia Carriquiry and Helen Jensen guided CARD's work, which was carried out by Hocheol Jeon and David Osthus. John Kirlin of USDA-Economic Research Service reviewed the committee's application of the Food Acquisition and Purchase Survey dataset to the study, and Kevin Dodd of the National Cancer Institute provided helpful guidance on analyses of NHANES.

To accomplish this task, numerous staff members at the National Academies of Sciences, Engineering, and Medicine supported the work of the committee. Marie Latulippe served as the project's study director and provided leadership, creative ideas, and a calm spirit against tight deadlines. She was assisted by Meghan Quirk after March 2015. Bernice Chu assisted with literature reviews and data management, and Ambar Saeed dealt with administrative logistics. Leslie Pray assisted with report organization and editing, and Rebecca Morgan of the National Academies Library/Research

Center with fact-checking. Alice Vorosmarti assisted with literature reviews and other data-oriented tasks. Ann Yaktine, director of the Food and Nutrition Board, supervised the work of the staff and provided useful insights at many points in the committee's deliberation. The committee owes them all a debt of gratitude for their hard work and professionalism.

Kathleen M. Rasmussen, *Chair*
Committee to Review WIC Food Packages

This volume is dedicated to Gail G. Harrison, Ph.D. (1943–2015) in recognition of her substantial contributions to the field of maternal and child nutrition and to the WIC program in particular. Gail's vision and leadership led to substantive positive impacts on mothers and children in the United States and around the world.

Summary

The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) was launched in 1974. Its goal was to provide supplemental foods that would supply nutrients lacking in the diets of low-income pregnant, breastfeeding, or postpartum women, infants, and children less than 5 years of age, who had at least one nutritional risk factor. The WIC program also provides nutrition education and referrals to health and social services. The U.S. Department of Agriculture's Food and Nutrition Service (USDA-FNS) requested that the Institute of Medicine (IOM) undertake a review of the WIC food packages to align the program with dietary guidance in the 2015 *Dietary Guidelines for Americans*. In response, the IOM convened the Committee to Review WIC Food Packages (the committee) to address this task. This, the phase I interim report, is the second of three reports. The first report, *Review of WIC Food Packages: An Evaluation of White Potatoes in the Cash Value Voucher: Letter Report*, recommended allowing white potatoes for purchase with the cash value voucher. This second report presents the evidence, analyses, and framework that will be applied to develop the final report (phase II), which will include recommendations.

In the final report, recommendations for revisions to the WIC food packages will build on the revisions recommended in the 2006 IOM WIC report (implemented in 2009) and the evidence presented here, including an update and additional analyses. This interim (phase I) report contains an evidence-based review of relevant scientific literature, analyses of dietary intakes as well as food expenditure data and data on breastfeeding trends. The dietary intake evaluation included comparison of WIC participants

to WIC-eligible nonparticipants. A comparison of intakes before the 2009 food package changes to after these changes will be presented in the final report (phase II). The committee identified possible priority nutrients and food groups that could be used to address nutritional inadequacies (see Chapter 1 for the complete statement of task).

To design the phase I approach, the committee reviewed the key objectives of the WIC program and relevant changes to the WIC population, food packages, and dietary guidance and eating patterns among U.S. populations that occurred since the last IOM review of WIC food packages. Based on its preliminary review of evidence, the committee developed the approach to the task outlined below.

THE COMMITTEE'S APPROACH

The committee's information-gathering activities included convening two workshops, conducting a comprehensive literature and report review, analyzing data, considering comments from the public and information obtained from committee member visits to WIC clinics and shopping with WIC vouchers. Data analyses were conducted with two national datasets. First, an independent evaluation of National Health and Nutrition Examination Survey (NHANES) data was conducted to examine intakes of nutrients and food groups of WIC participants and WIC-eligible nonparticipants (low-income and pregnant, breastfeeding, or postpartum women; infants; and children ages 1 to less than 5 years). Second, the Food Acquisition and Purchase Survey (FoodAPS) data were evaluated to determine the contribution of WIC foods to household food expenditures. Approaches to a sensitivity analysis and a regulatory impact analysis were developed, to be completed in phase II. The sensitivity analysis will evaluate the effect of major food package changes on nutrient and food group intakes and package cost. The regulatory impact analysis will assess the impact of WIC food package changes on program participation, the value of food packages, and program cost and administration. To serve as the baseline for the sensitivity and regulatory impact analyses evaluations, the committee developed an approach to generating baseline food package nutrient profiles and determining costs of the food packages.

Application of Current Dietary Guidance to the Task

The recommendations of the *Scientific Report of the 2015 Dietary Guidelines Advisory Committee* (2015 DGAC report), along with the Dietary Reference Intakes (DRIs), served as the basis for evaluation of nutrient and food intake adequacy in this report. The USDA's Healthy U.S.

Food Pattern served as the basis for comparison of food group intakes by WIC participants and WIC-eligible nonparticipants. Other key recommendations in the 2015 DGAC report included identification of shortfall nutrients and nutrients of public health concern, and limits for sodium, solid fat, and added sugars intakes.

Nine shortfall nutrients were identified in the 2015 DGAC report (vitamin A, vitamin D, vitamin E, vitamin C, folate, calcium, magnesium, fiber, potassium, as well as iron for premenopausal females). Among these shortfall nutrients, calcium, vitamin D, fiber, and potassium were classified as nutrients of public health concern because their under-consumption has been linked to adverse health outcomes. Iron was a shortfall nutrient of public health concern for adolescent females and premenopausal adult females. A specific limit for cholesterol intake was not indicated, and the recommended sodium intake limit for the general population was set at 2,300 mg per day.

The *Dietary Guidelines for Americans* and 2015 DGAC report apply only to individuals ages 2 years and older. Therefore, the committee compiled current published dietary guidance for individuals younger than 2 years of age issued by the American Academy of Pediatrics and other authoritative groups to evaluate adequacy of the diets of WIC participants of these ages.

Analyses of NHANES

Analyses to determine estimated nutrient and food group intakes used relevant NHANES data. Subgroups of interest include WIC participants as well as low-income, potentially eligible (pregnant, postpartum, or breastfeeding women; infants; and children less than 5 years of age) WIC nonparticipants. At the time of this report, the indicator to identify WIC participants was not available for the most recent NHANES release, 2011–2012. Therefore, a comparison of nutrient or food intakes among WIC participants before the 2009 food package changes to those after the changes could not be conducted. Moreover, although the 2009–2010 NHANES data allowed comparison of WIC participants to WIC-eligible nonparticipants, this period covered the change in food packages and was not considered appropriate for the evaluation of pre- or post-food package change intakes. All low-income WIC-eligible individuals in the NHANES 2011–2012 dataset were analyzed as a proxy for WIC participants. In phase II, the WIC indicator will be applied to the NHANES 2011–2012 dataset if the sample sizes are sufficient. Finally, the committee developed a nutrient-based diet quality index for evaluation of the overall nutrient adequacy and applied the Healthy Eating Index-2010 (HEI-2010) for evaluation of food group intakes.

KEY CONCLUSIONS

Preliminary Nutrient and Food Group Priorities

The committee's reviews of the scientific literature, analyses described in Chapters 4 and 5, as well as nutrition-related health risks reviewed in Chapter 6, led to the identification of potential target nutrients and food groups for WIC participants of specific ages. These findings are organized in the tables that follow, by age group. Indicated in the tables with a "✓" are: (1) nutrients for which inadequacy is apparent in more than 5 percent of the indicated age subgroup, or nutrients that are prioritized based on other information (see Table S-1a), (2) nutrients for which mean usual intakes fall below the adequate intake (AI) value (see Table S-1b), (3) nutrients for which more than 5 percent of the population exceeds the Tolerable Upper Intake Level (UL) (see Table S-2), and (4) food groups for which intakes of at least 50 percent of the population fall below or above recommendations (see Table S-3).

Conclusions Based on Phase I Findings

In addition to the nutrients and food groups identified above, the committee's approach to information gathering led to the key findings contained in Chapter 11. Here, the committee presents the overall conclusions, based on the phase I review and resulting findings. The findings, conclusions, and supporting evidence will be used in conjunction with additional planned analyses to develop the committee's recommendations in phase II.

1. Participation in WIC has declined recently. The reasons for this are likely multifaceted and cannot be attributed to the initial rollout of the food package changes. Paper vouchers are being replaced by electronic benefits transfers (EBTs), which may improve program participation as well as redemption of issued benefits.
2. There are some racial and ethnic differences in satisfaction with specific items in the food packages, but, aside from the limited availability of Kosher and Halal food options, the packages appear to be broadly culturally suitable.
3. Both women and children (ages 2 to less than 5 years) WIC participants had low or inadequate intakes of several nutrients that could potentially be addressed with food package changes (see Tables S-1a and S-1b). These inadequacies may be linked to food intakes that fell below recommendations for specific food groups (see Table S-3).

TABLE S-1a Nutrients with Evidence of Inadequate Intake[a] in the Diets of WIC Participant Subgroups

Nutrient	Pregnant, BF, or PP Women, 19 to 50 Years	FF Infants 6 to Less Than 12 Months	Breastfed Infants 6 to Less Than 12 Months	Children 1 to Less Than 2 Years	Children 2 to Less Than 5 Years
Calcium	✓				✓
Copper	✓				
Iron	✓	✓	✓[b]		
Magnesium	✓				
Zinc	✓				
Vitamin A	✓				
Vitamin D[c]	✓				
Vitamin E	✓			✓	✓
Vitamin C	✓				
Thiamin	✓				
Riboflavin	✓				
Niacin	✓				
Vitamin B6	✓				
Folate	✓				
Protein	✓[d]				

NOTES: BF = breastfeeding; FF = formula fed; PP = postpartum. Table is based on results for WIC participating individuals in NHANES 2005–2008. The committee found no evidence of inadequate intake in the diets of formula-fed infants 0 to 6 months of age.

[a] Nutrients listed represent those for which 5 percent or more of each population subgroup had intakes below the Estimated Average Requirement (EAR), unless otherwise noted.

[b] Based on the committee's literature review findings of a high risk of low iron intakes in breastfeeding infants.

[c] Based on serum 25(OH)D below 40 nmol/L. Serum levels were not available for infants.

[d] More than 5 percent of this subgroup had intakes below the Acceptable Macronutrient Distribution Range (AMDR).

SOURCES: As indicated in Table 11-1a of this report. See Chapter 3 for details on determination of nutrient adequacy.

4. Women, infants, and children had excessive intakes of several nutrients (see Table S-2). In some cases, these excessive intakes may be addressed with changes to the food packages; in other cases, they may be addressed with nutrition education.
5. Inasmuch as the sample size of low-income women in the 2011–2012 analysis was small, it was not possible to estimate the proportion of the population with food group intakes that were inadequate or excessive compared to recommended intakes. Small sample sizes for some of the population subgroups are likely to limit further disaggregation into WIC participants and WIC-eligible nonparticipating individuals. Therefore, in phase II, mean intakes can be compared among groups and to recommendations, but a population-level comparison to recommended intakes for women before and after the 2009 food package changes is unlikely to be possible.
6. The committee notes that the NHANES 2005–2008 nutrient and food intake data do not capture the impact of the 2009 food package changes. Results from these survey years are therefore not suitable to serve as the sole basis for final determination of nutrient and food group priorities in phase I. The nutrient and food group gaps identified in this report will be re-evaluated in phase II as the NHANES 2011–2012 "WIC" identifier is incorporated into the analysis.
7. Breastfeeding promotion and support appear to play a role in the improvement of breastfeeding initiation, duration, and exclusivity among WIC participants. The 2009 changes to the food package to improve support for breastfeeding women were associated with

TABLE S-1b Nutrients for Which Mean Usual Intake Falls Below the Adequate Intake (AI) in the Diets of WIC Participant Subgroups*

Nutrient	P, BF, or PP Women, 19 to 50 Years	FF Infants 0 to 6 Months	Children 1 to Less Than 2 Years	Children 2 to Less Than 5 Years
Potassium	✓		✓	✓
Choline	✓	✓		
Fiber	✓		✓	✓

NOTES: BF = breastfeeding; FF = formula fed; P = pregnant; PP = postpartum. Table is based on results for WIC participating individuals in NHANES 2005–2008. Mean intakes of infants 6 to less than 12 months of age fell above the AI.

* Because breastmilk intakes were not quantified, nutrient intake of breastfeeding infants in NHANES were not analyzed.

SOURCES: As indicated in Table 11-1b of this report. See Chapter 3 for details on determination of nutrient adequacy.

only limited positive changes in breastfeeding behavior. There may be additional possibilities for aligning the food packages with support for breastfeeding women.

8. The current WIC food packages provide adequate options for participants with most major food allergies, celiac disease, and food intolerances, but inclusion of substitutions for eggs and fish may be warranted.
9. Vendors and manufacturers were able to adapt to the 2009 food package changes with some challenges. It is important to consider the feasibility of potential future food package changes from the perspectives of vendors and food manufacturers.

The committee's phase II activities will include an update to the comprehensive scientific literature review that was conducted for this interim report, an evaluation of nationwide costs and distribution of foods to ensure that the recommended new food packages are efficient for nationwide distribution, and sensitivity and regulatory impact analyses. The committee will conduct a sensitivity analysis that will consider the effect of major recommended alternative food items and changes in quantity relevant to priority nutrient intakes, intakes of food groups and subgroups, and cost. Then the committee will conduct a regulatory impact analysis that

TABLE S-2 Micronutrients with Evidence of Intakes Exceeding the Tolerable Upper Intake Level (UL)* in the Diets of WIC Participant Subgroups

Nutrient	P, BF, or PP Women, 19 to 50 Years	FF Infants 6 to Less Than 12 Months	Children 1 to Less Than 2 Years	Children 2 to Less Than 5 Years
Copper				✓
Iron	✓			
Selenium		✓	✓	✓
Sodium	✓		✓	✓

NOTES: BF = breastfeeding; FF = formula fed; P = pregnant; PP = postpartum. Table is based on results for WIC participating individuals in NHANES 2005–2008. Only nutrients with intakes above recommended levels in more than 5 percent of the population for at least one population subgroup are presented. The committee's literature review found no evidence of excess nutrient intake for breastfeeding infants or formula-fed infants 0 to 6 months of age.

* Nutrients represent those for which 5 percent or more of the population subgroup exceeded the UL.

SOURCES: As indicated in Table 11-2 of this report. See Chapter 3 for details on determination of excessive intake.

TABLE S-3 Food Groups with Evidence of Intakes Below and Above Amounts Recommended in the DGAC 2015 Report in the Diets of WIC Participant Subgroups

Food Group	P, BF, or PP Women, 19 to 50 Years[a]	Children 2 to Less Than 5 Years[b]
Intakes Below Recommended Amounts		
Total fruit	✓	
Total vegetables	✓	✓
Dark green	✓[c]	✓
Total red and orange	✓	✓
Beans and peas	✓	✓
Total starchy	✓	✓
Other vegetables	✓	✓
Total grains	✓	
Whole grains	✓	✓
Total protein foods	✓	✓
Seafood	✓	✓
Nuts, seeds, and soy	✓	✓
Total dairy	✓	✓
Oils	✓	✓
Intakes Above Recommended Amounts[d]		
Solid fat	✓	✓
Added sugars	✓	✓

NOTES: BF = breastfeeding; DGAC 2015 = *Scientific Report of the 2015 Dietary Guidelines Advisory Committee*; P = pregnant; PP = postpartum. Food groups and subgroups listed are those for which 50% or more of the population subgroup had intakes falling below levels recommended in the 2015 DGAC report, or in the case of food groups to limit, above levels recommended in the 20155 DGAC report. The table is based on results for WIC participating women and children in NHANES 2005–2008. The USDA food patterns do not apply to infants and children less than 2 years of age; thus, these age groups were omitted from the table. The committee's literature review found no evidence to support that specific food group intakes are low among breastfeeding infants, although low intake of iron-containing foods may be of concern.

TABLE S-3 Continued

[a] Based on the 2015 DGAC report food pattern for a 2,200 kcal diet, which was the EER calculated for women in this report.

[b] Recommended intakes were generated by weighting the 1,000 and 1,300 (averaged from 1,200 and 1,400 kcal patterns) kcal food patterns in a 1:3 ratio. This results in a food pattern equivalent to approximately 1,225 kcals, slightly under the EER calculated for children 2 to 5 years of age of approximately 1,300 kcals; therefore, intakes for this age group in comparison to recommendations may be slightly overestimated.

[c] Too few individuals in NHANES 2005–2008 for this age group reported consumption to produce population-level estimates of intake, suggesting that intakes may be low.

[d] Indicates usual mean intake levels above the upper limit defined by the 2015 DGAC report food pattern comparisons for each age group.

SOURCES: As indicated in Table 11-3 of this report. See Chapter 3 for details on methods applied.

will assess the impact of proposed WIC food package changes on program participation, the value of the food packages, and program cost and administration. Additional details of the approaches to be used for the different activities are discussed in Chapter 3.

GUIDING PRINCIPLES AND FRAMEWORK FOR REVISION OF THE WIC FOOD PACKAGES

The criteria that the committee established to underpin the phase II analyses and evaluation and to guide development of its recommendations are presented in Box S-1 and incorporated into Figure S-1. The final criteria were only slightly modified from those applied by the IOM (2006) Committee to Review WIC Food Packages because, after a thorough review of the evidence, the committee concluded that these criteria were comprehensive and remained relevant. These criteria reflect the committee's priorities to first, meet the goals of the WIC program; second, respond to the requirement that the WIC food packages be aligned with the 2015 DGA; and third, provide a package that is acceptable to participants and feasible to implement at every level.

The criteria outlined above will be further explored (and possibly revised) in phase II after an update of the phase I review as well as consideration of the results of the analysis of nutrient and food consumption by WIC participants in NHANES 2011–2012 and limitations related to cost. The committee's proposed process for revising the WIC food packages in phase II is illustrated in Figure S-1. The objective is to ensure that the revisions fall within the criteria outlined in the previous section, with attention to cost constraints. First, the current food packages will be evaluated for

BOX S-1

Proposed Criteria for Inclusion of Foods in the WIC Food Packages

1. The package contributes to reduction of the prevalence of inadequate nutrient intakes and of excessive nutrient intakes.
2. The package contributes to an overall dietary pattern that is consistent with the *Dietary Guidelines for Americans* for individuals 2 years of age and older.
3. The package contributes to an overall diet that is consistent with established dietary recommendations for infants and children less than 2 years of age, including encouragement of and support for breastfeeding.
4. The foods in the package are available in forms and amounts suitable for low-income persons who may have limited transportation options, storage, and cooking facilities.
5. The foods in the package are readily acceptable, commonly consumed, are widely available, take into account cultural food preferences, and provide incentives for families to participate in the WIC program.
6. The foods will be proposed giving consideration to the impact of changes in the package on vendors and WIC agencies.

the nutrients and food groups provided and alignment with dietary guidance, as well as the challenges faced during implementation. After reviewing this information, the committee will identify priority changes in the food packages and test possible changes in an iterative fashion to align with the criteria and ensure overall program cost neutrality (the sensitivity analysis). During this process, the criteria or framework may be modified if deemed necessary. The committee anticipates that this process will involve trade-offs, with final recommendations guided by the criteria and cost constraints. Once the iterations result in changes that meet the final criteria, recommendations will be finalized. A regulatory impact analysis will then be conducted to assess the impact of changes in WIC food packages on program participation, the value of the food packages as selected,[1] and program costs and administration.

[1] The value that individuals place on the change resulting from a particular regulatory alternative.

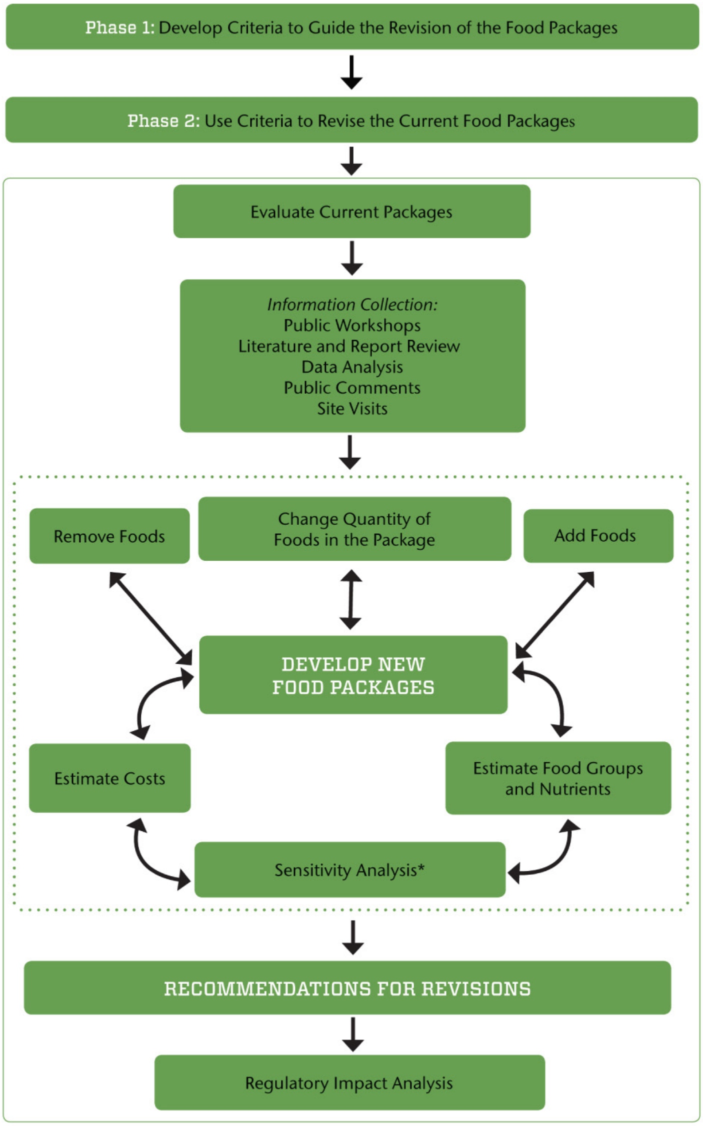

FIGURE S-1 Process for revising the WIC food packages.
NOTE: The dotted line indicates components of the process that iterate until the criteria for food package revisions are met (see Box S-1).
* The sensitivity analysis includes considerations for maintaining the cost neutrality of the overall WIC food packages.

1

Introduction and Background

The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) was piloted by the U.S. Department of Agriculture's Food and Nutrition Service (USDA-FNS) in 1972 and enacted into legislation in 1975 (USDA/ERS, 2009). The WIC program is designed to provide specific nutrients determined by nutritional research to be lacking in the diets of the WIC target population (7 CFR § 246). To qualify for participation, applicants must meet eligibility criteria for life stage, income, and nutritional risk.[1] Participants can receive benefits through vouchers or, more recently in some states, an electronic benefit transfer (EBT) card. WIC is administered as a federal grant to the 50 states and the District of Columbia, Puerto Rico, Guam, American Samoa, the American Virgin Islands, the Northern Mariana Islands, and 34 Indian Tribal Organizations (USDA/FNS, 2013a). The program is currently funded by appropriations set aside as part of the Healthy, Hunger-Free Kids Act of 2010, which is scheduled for reauthorization in late 2015. In 2014, the WIC program served approximately 8.2 million women, infants, and children through 1,900 local agencies in 10,000 clinic sites (USDA/FNS, 2015a). Approximately 50 percent of infants and 40 percent of pregnant women in the U.S.

[1] Specifically, participants must be the following: (1) either women who are pregnant and up to 6 months, or, if breastfeeding, 1 year postpartum; infants; or children up to 5 years of age; (2) at or below 185 percent of federal poverty guidelines or enrolled in Temporary Assistance for Needy Families, Supplemental Nutrition Assistance Program, or Medicaid; and (3) at nutritional risk (e.g., anemia, obesity, underweight, high-risk pregnancy).

benefit from WIC services (USDA/FNS, 2015b; Personal communication, J. Hirschman, USDA-FNS, October 15, 2014).

Although the mission of WIC remains the same, that is, to "safeguard the health of low-income women, infants, and children up to age 5 who are at nutritional risk" (USDA/FNS, 2012), the goals of the WIC program have evolved since its introduction. Today they include promoting and supporting successful long-term breastfeeding; providing WIC participants with a wider variety of foods, including fruits, vegetables, and whole grains; and providing WIC state agencies greater flexibility in prescribing food packages to accommodate cultural food preferences of WIC participants (USDA/FNS, 2014a). WIC supports the national health goals of Healthy People 2020, specifically those related to birth weight, childhood and adult weight, and breastfeeding prevalence (NWA, 2013; HHS, 2014).

In 2006, an Institute of Medicine (IOM) committee proposed the first significant revisions to the WIC food packages since inception of the program (IOM, 2006). Table C-1 in Appendix C shows major changes proposed in 2006 compared to corresponding federal regulations and available state options for implementation as outlined in the March 2014 final rule (USDA/FNS, 2014a). The revisions, which were initially implemented in 2009 (USDA/FNS, 2007b) and finalized in 2014 (USDA/FNS, 2014a), resulted in dramatic changes to the food packages (see Appendix D, Tables D1 and D2 for information on the current food packages). Most, but not all, of the 2006 IOM report recommendations were fully implemented. For example, recommendations to add a cash value voucher (CVV) for the purchase of fruits and vegetables and to reduce the quantities of milk, cheese, and eggs in the food packages were implemented fully. Other recommendations, however, underwent modification before implementation. As an example, the recommendation to allow only whole grain breakfast cereals was modified to require that at least one-half of all breakfast cereal on each state agency's authorized food list have whole grain as the primary ingredient by weight, thereby providing participants with a choice to continue to purchase breakfast cereals that are not whole grain. Finally, some recommendations were not implemented at all. For example, the proposed addition of a higher-value CVV for breastfeeding mothers was not implemented, with the 2014 final rule specifying that breastfeeding women would receive the same value CVV as all other women participants (USDA/FNS, 2014a). Table 1-1 illustrates that while most changes were implemented by fall of 2009 in accordance with the interim rule (USDA/FNS, 2007a), changes have been implemented over a period of 6 years. The final change (i.e., allowing a yogurt substitution for milk) was still underway at the time of this writing.

A number of research activities have been undertaken to evaluate the impact of WIC generally and the food package changes specifically. As

TABLE 1-1 Timeline for Implementation of the Most Recent WIC Food Package Changes

Deadline for Implementation	Action of State Agencies	Source
1992	FP VII was created to encourage breastfeeding, added two new items: carrots and canned tuna, along with increased amounts of juice, cheese, beans/peas, and peanut butter for women who exclusively breastfeed their infants	WIC Program: Background, Trends, and Economic Issues (USDA/ERS, 2009)
October 1, 2009	New WIC food packages effective February 4, 2008 (CVV for fruits and vegetables, added whole grains, reduced amount of juice, milk, cheese and eggs, allowed greater substitution of foods), must be implemented by August 5, 2009, according to the Interim Rule, later changed to October 1, 2009, to align with the federal fiscal year	WIC Interim Rule (December 6, 2007); WIC Program: Background, Trends, and Economic Issues (USDA/ERS, 2009)
June 2, 2014	CVV must increase for children from $6 to $8	WIC Final Rule (March 4, 2014)
October 1, 2014	State agencies may issue authorized soy-based beverages or tofu to children who receive FP IV based on the determination of a competent professional authority	WIC Final Rule (March 4, 2014)
October 1, 2014	States must require only low-fat (1%) or nonfat milks for children more than age 2 and women in FP IV–VII	WIC Policy Memorandum 2014-6 (USDA/FNS, 2014b)
January 15, 2015	States are required to include white potatoes to be eligible for purchase with CVV 15 days after the date of enactment (December 31, 2014), all implementations including education and new product lists completed by July 1, 2015	WIC Policy Memorandum 2015-3 (USDA/FNS, 2015c)
April 1, 2015	Split tender CVV must be implemented	WIC Final Rule (March 4, 2014)
April 1, 2015	States may authorize yogurt for children and women in FP III and VII	WIC Final Rule (March 4, 2014)
October 1, 2015	CVV for women must increase from $10 to $11	WIC Policy Memorandum 2015-4 (USDA/FNS, 2015d)

NOTES: CVV = cash value voucher; FP = food package. See Appendix D for detail on composition of the WIC food packages.

shown in Appendix E, Table E-1, USDA-sponsored investigators have studied changes in the behavior of vendors, the availability of vegetables and fruits for purchase with the CVV, the availability of foods in new package sizes, and the pattern of household-level food purchases.

More recently, in response to a request from Congress, the USDA-FNS charged the IOM's current Committee to Review the WIC Food Packages to conduct a two-phase evaluation of the WIC food packages and develop recommendations for revising the packages to be consistent with the 2015 *Dietary Guidelines for Americans* (DGA) and to consider the health and cultural needs of a diverse WIC population while remaining cost neutral, efficient for nationwide distribution, and nonburdensome to administration in national, state, and local agencies. The statement of task for this study is presented in Box 1-1.

This report is the second of three reports aimed at fulfilling the USDA-FNS request. The first report in the series, *Review of WIC Food Packages: An Evaluation of White Potatoes in the Cash Value Voucher: Letter Report*

BOX 1-1

Statement of Task

An ad hoc committee will undertake a two-phase comprehensive examination of the U.S. Department of Agriculture's Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) food packages (i.e., the foods provided to supplement the diet of participants, tailored to their age and health status). The committee will first review and assess the nutritional status and food and nutritional needs of the WIC-eligible population and the impact of the 2009 regulation, finalized in 2014, to exclude white potatoes from WIC food packages against key recommendations of the 2010 *Dietary Guidelines for Americans*, on nutrient intake and indicators of diet quality; and changes in nutrient and food intake values and indices of diet quality if fresh white potatoes are included in the WIC benefit.

The committee will then review and assess the WIC food packages and make specific evidence-based recommendations, based on its evidence review and grounded in the most recently available science. Recommendations for changes to the WIC food packages will build on the revisions recommended in the 2005 Institute of Medicine report *WIC Food Packages: Time for a Change* and implemented in 2009. Recommended revisions to WIC food packages will be consistent with the 2015 *Dietary Guidelines for Americans*, the Dietary Reference Intakes, and advice from the American Academy of Pediatrics. The recommendations will take into account the health and cultural needs of the WIC participant population, support efficient program operations, and allow effective administration across the geographic scope (national plus some U.S. territories) of the pro-

(IOM, 2015), assessed the impact on food and nutrient intakes of the WIC population of the 2009 regulation to allow the purchase of vegetables and fruits, excluding white potatoes, with a CVV and recommended that white potatoes be allowed as a WIC-eligible vegetable (IOM, 2015). For this second (interim) report, the committee was tasked with a more comprehensive review of evidence to support the development of recommendations that will appear in the final (phase II) report. This review of evidence supported the development of the proposed criteria and framework to be used for possible food package revisions in phase II.

The evidence and analyses summarized in this report are limited by the statement of task. Although the committee's review of evidence took into account that food selection and preparation affects the nutrient composition of the diet, some aspects of food preparation were beyond the scope of its task. Specifically, the addition of fat from butter, other fats, or toppings to vegetables, bread, rice, or other foods by the consumer may be likely, but the committee was not asked to consider how WIC participants

gram. The goal is to recommend changes in the food packages, as appropriate, while ensuring that the recommendations are practical, economical, reflect current nutritional science, and allow the program to effectively meet the nutritional and cultural needs of the WIC population.

The study will be carried out in two phases and produce three reports. An initial phase I letter report will include dietary and energy intake analyses, food intake analyses relative to the *Dietary Guidelines for Americans*, diet quality indices, and a sensitivity analysis to determine the impact of exclusion of white potatoes in WIC food packages on consumption of other foods and the ability of WIC participants to meet key recommendations of the *Dietary Guidelines for Americans*. The letter report will contain findings and recommendations for white potatoes that are consistent with the current *Dietary Guidelines for Americans*, consider the health and cultural needs of the WIC population, and can be administered effectively and efficiently nationwide and in a cost-effective manner. A phase I (interim) report will contain a description of the evidence-based review strategy, dietary and energy intake analyses, data on breastfeeding trends and variability, and food expenditure analysis and will recommend general food groups that could be used to address specific nutritional deficits. The phase II (final) report will be based on the findings in phase I, evidence gathered from the literature review, evaluation of costs, and assessment of sensitivity and regulatory impact analyses, and will recommend revisions for WIC packages that are culturally suitable,[a] cost neutral, efficient for nationwide distribution, and non-burdensome to administration.

[a] The term "culturally suitable" was not clearly defined. The committee's interpretation is that foods in the package should align with food preferences and feeding practices based on a participant's ethnic group and religion.

modified WIC foods for consumption. Additionally, because the committee was charged to consider foods that are readily available in the marketplace, this review will not consider foods under development, nor recommend the development of new foods. Finally, changes to USDA-FNS programs that are linked to the WIC food package but are fiscally independent (e.g., farmers' markets) are considered for context, but no changes to the functions of such programs will be suggested in phase II.

This report contains only findings and conclusions, which are summarized in Chapter 11. It does not make recommendations. However, the committee was tasked with developing a preliminary list of priority nutrients and food groups that could be used to address nutritional deficits in the WIC population (Tables 11-1a, 11-1b, 11-2, and 11-3). To help with subsequent phase II activities and based on evidence reviewed in this report, the committee developed criteria and a proposed process to use during its phase II evaluation of the current WIC food packages, also described in Chapter 11.

Organization of This Report

In addition to introducing the charge to the committee and the rationale for this report, this first chapter considers demographic, administrative, and food system and dietary changes, including changes in national dietary guidance, that have occurred since the previous IOM committee proposed revisions to the WIC food packages (IOM, 2006).

Chapter 2 illustrates the diversity of the WIC population and complexity of behavioral and environmental factors that influence participation in WIC and consumption of items in the WIC food packages. The chapter also considers how challenges to administering WIC food packages at both state and local levels can affect the WIC participant experience.

Chapter 3 describes the committee's approach to collecting and evaluating the range of evidence available to address its task. In addition to searching and reviewing published literature, conducting data analyses, and reviewing public comments collected through an online submission system and in open sessions over the course of the study, the committee gathered evidence from the IOM and government reports on other nutrition assistance programs, childhood obesity, weight gain during pregnancy, food security, and Dietary Reference Intakes. Also included in Chapter 3 is a discussion of challenges the committee faced when evaluating WIC-specific data. This chapter describes that the *Scientific Report of the 2015 Dietary Guidelines Advisory Committee* (2015 DGAC report) serves as the basis for evaluation of food intakes in phase I. In phase II, the basis for comparison will be the 2015 DGA.

As part of its phase I task, the committee was charged with assessing both nutrient intakes and food group and subgroup intakes of the WIC and WIC-eligible populations (low-income children and pregnant, breastfeeding, or postpartum women). USDA-FNS also requested an evaluation of intakes before and after the 2009 food package changes.[2] These analyses, described in Chapter 3 with results presented in Chapters 4 and 5, will support the committee's preliminary list of nutrient and food group priorities (described in Chapter 11) for consideration during the phase II evaluation of the food packages.

Also as part of its phase I task, the committee evaluated nutrition-related health risks of particular concern for the WIC population, including inappropriate weight status, low hematocrit or hemoglobin, inappropriate growth or weight gain pattern, inappropriate nutritional practices, and general obstetrical risks. This evaluation is summarized in Chapter 6. Additionally, Chapter 6 summarizes the committee's evaluation of food safety considerations.

As part of its phase I analysis, the committee was also tasked with analyzing breastfeeding trends and variability. Chapter 7 presents a review of breastfeeding trends in the U.S. and WIC populations, the impact of the food package on breastfeeding in WIC, and the promotion, motivation, and support of breastfeeding in WIC and low-income populations.

The 2009 revised WIC food packages were designed to accommodate a broader array of dietary needs and preferences than had been accommodated in the past. In Chapter 8, the committee considered issuance of food package III (for participants with qualifying medical conditions) and food package tailoring to accommodate other conditions, dietary needs, or dietary preferences.

In addition to considering nutrient intake (Chapter 4), food intake (Chapter 5), and health status of WIC participants (Chapter 6), the committee considered a number of other factors before developing its preliminary list of nutrient and food priorities for consideration during phase II evaluation of the food packages. Specifically, the committee reviewed the role of the WIC food packages as intended by the USDA-FNS; applicability of the 2015 DGAC report recommendations to WIC food packages; the science of functional ingredients added to foods and infant formulas in the WIC food packages; the infant formula regulatory and market landscape; choice and flexibility within the food packages; and cost considerations. The approach to considering these other factors is described in Chapter 9.

[2] The analysis comparing intakes from before to after the food package changes is not presented in this report because the National Health and Nutrition Examination Survey (NHANES) variable used to identify WIC participants was not available for the 2011–2012 release at the time the analysis was conducted. The comparison will be presented in the phase II report. Additional details are presented in Chapter 3.

In addition to its dietary intake tasks, the committee was tasked with the planning and implementation of a food expenditure analysis. Chapter 10 summarizes results of the phase I analysis illustrating the contribution of WIC foods to total household food expenditures.

Key findings from all chapters, except Chapter 3 because of its focus on methodology, are highlighted in Chapter 11. Also included in Chapter 11, and based on findings detailed in Chapters 4, 5 and 6, is the committee's preliminary list of food groups that could be used to address nutritional deficits in the WIC population; the committee-developed set of guiding principles, or criteria, for use in its phase II study; and a proposed process, or framework, to use as a basis for decision making during phase II of the study.

DEMOGRAPHIC SHIFTS AND TRENDS IN WIC PARTICIPATION

In the 10 years since the last IOM review of the WIC food packages, the WIC population has changed in ways that reflect demographic changes across the United States. Although the U.S. population has increased 9 percent since 2005, from 296 to nearly 322 million, births have contributed minimally to this increase (USCB, 2005, 2015; CDC, 2015). Since 2007, birthrates have been declining (CDC, 2015). The greatest contributions to population growth have come from immigration, temporary and permanent residency, and other population shifts (DHS, 2014). According to the U.S. Census Bureau, the majority of growth in the U.S. population from 2000 to 2010 resulted from an increase in Hispanic and Asian populations (USCB, 2011). The 2010 American Community Survey found that 92 percent of the U.S. Hispanic population comprises 10 subgroups, with the top three being Mexican, Puerto Rican, and Cuban (Motel and Patten, 2012).

The national WIC caseload increased between 2006 and 2010 (see Figure 1-1), reaching a peak participation of approximately 9 million in 2010, and then declined to approximately 8 million participants by 2014 (USDA/ERS, 2015a). A 2014 evaluation by the USDA-Economic Research Service (USDA-ERS) found that the largest decline in WIC participation since the program's inception occurred in fiscal year 2014, with 5 percent fewer eligible individuals participating in 2014 than in 2013 (USDA/ERS, 2015a). That declining trend has continued into 2015 (see Figure 1-2).

The overall decline in WIC participation may be at least partially attributed to decreasing U.S. birth rates, as well as to the nation's improving economic health. In order to examine whether trends in WIC participation reflected changes in the population eligible for the program, analyses of the number of participants per eligible person, the number of participants, and the number of persons eligible were carried out by the committee. Data were available through 2012, and as illustrated in Figure 1-3, changes in WIC

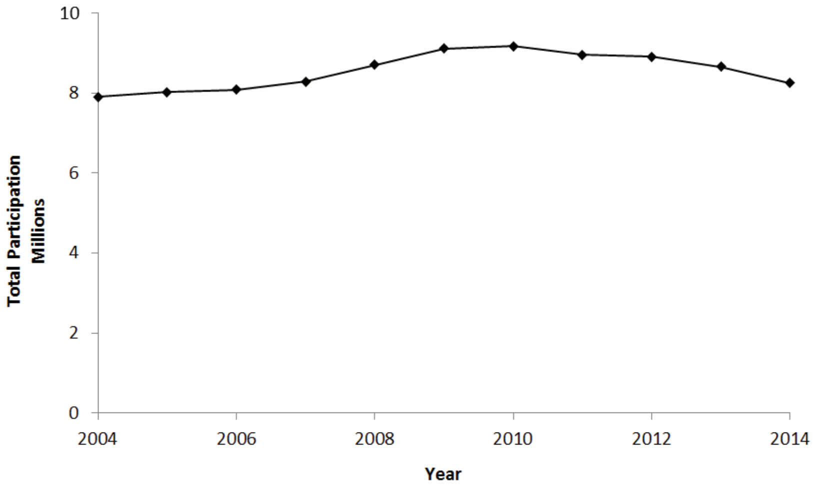

FIGURE 1-1 Annual number of participants in the WIC program constructed from monthly averages of participants, fiscal years 2004–2014.
NOTE: Fiscal year 2013 is the latest complete data. Data for fiscal year 2014 may be incomplete.
SOURCE: USDA/FNS, 2015e.

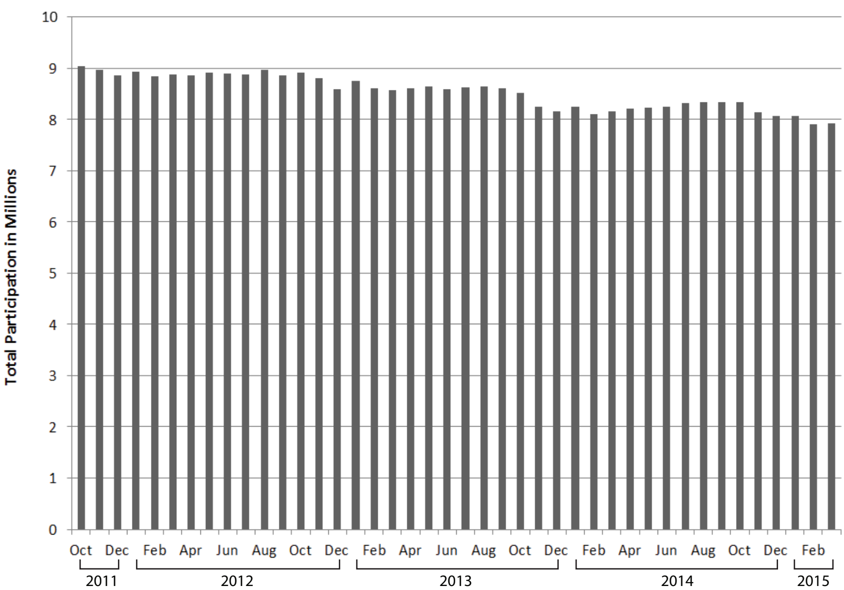

FIGURE 1-2 National monthly participation in the WIC program, October 2011–February 2015.
SOURCE: USDA/FNS, 2015e.

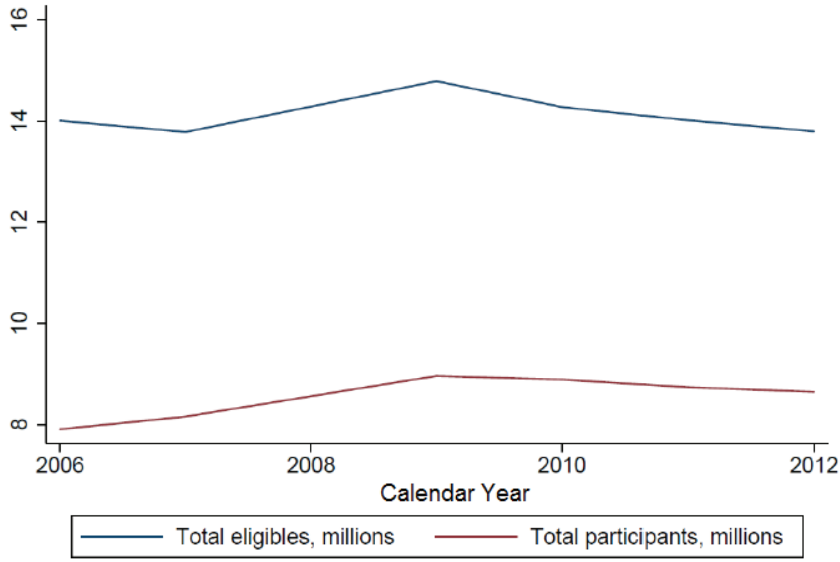

FIGURE 1-3 WIC participation and eligibility, by calendar year.
SOURCES: Bitler and Hoynes, 2013; USDA/FNS, 2011b, 2013b, 2014c, 2015f.

participation through 2012 largely mirrored changes in eligibility. A number of factors in play since 2006 have likely influenced WIC participation. First, from 2007 to 2009, the United States experienced an economic downturn that was followed by a still incomplete recovery. This recession may have caused more individuals to have incomes low enough to ensure eligibility for WIC and may also have affected fertility. Second, between October 1 and 16, 2013, the federal government experienced a shutdown, which resulted in a gap in funding for the WIC program at the beginning of the fiscal year. While most states maintained WIC services, some offered modified services. Outreach was increased to communicate that services were still available. For some states, program recovery was slow, lasting up to 1 year. Finally, Medicaid, Supplemental Nutrition Assistance Program (SNAP), and Temporary Assistance for Needy Families (TANF), all of which impact WIC eligibility, experienced increases in participation during the recession and received increased funding through the American Recovery and Reinvestment Act of 2009 (KFF, 2009, 2015; CBO, 2012; EOPUS, 2014). Since then, there have been other changes in these programs which could affect WIC eligibility and participation.

In general, the number of children in WIC has fluctuated more than the number of women and infants. Overall, more 1-year-olds than 4-year-olds participate in the program, a trend that has been stable since 2006 (USDA/FNS, 2011a). In 2014, as the number of women and infants fell by 4 and 3 percent, respectively, the number of children fell by 6 percent (see Figure 1-4). The year 2014 marked the fourth consecutive year—and only the fourth year in the program's history—that participation for all three groups fell (see Figure 1-4). In fact, overall expenditures in USDA nutrition assistance programs decreased 5 percent between fiscal years 2013 and 2014. During the same period, participation in SNAP and the National School Lunch Program (NSLP) decreased by 2 and 1 percent, respectively. Yet, at the same time, participation in the School Breakfast Program increased 2 percent, and the number of meals served in the Child and Adult Care Food Program (CACFP) increased 2 percent (USDA/ERS, 2015a).

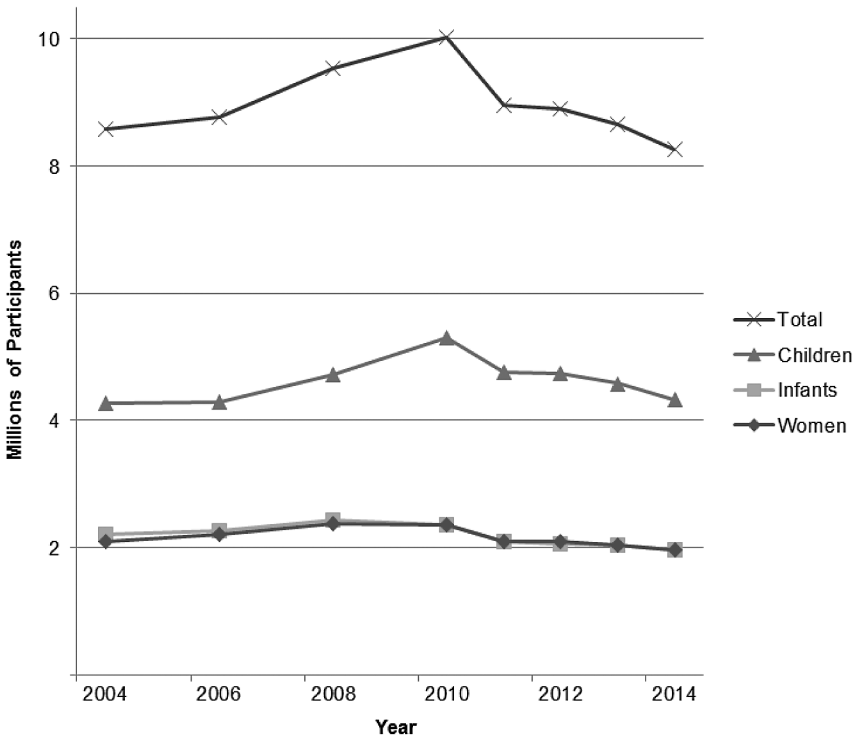

FIGURE 1-4 Average annual WIC participation by participant category, 2004–2014.
NOTE: No participation data were available for 2005, 2007, or 2009.
SOURCES: USDA/FNS, 2007a, 2010, 2015f.

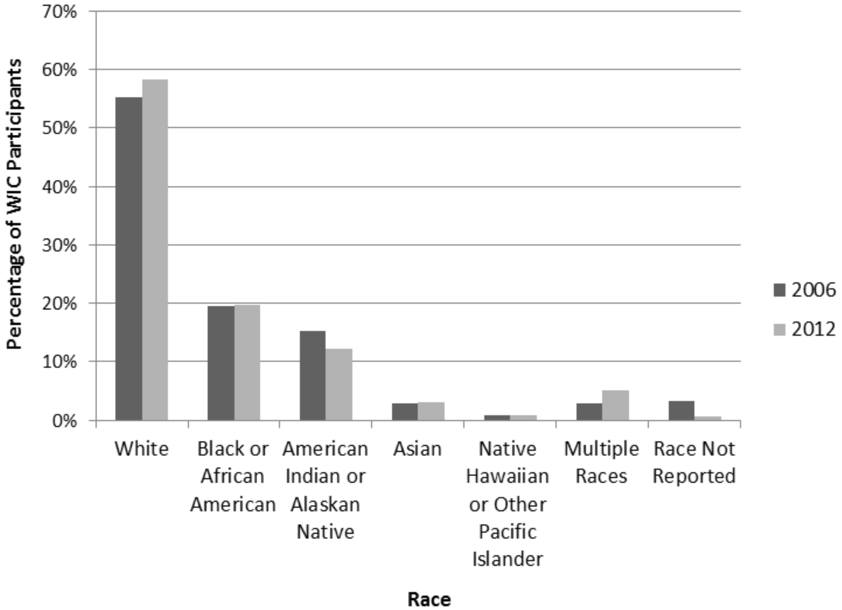

FIGURE 1-5a Distribution of race of WIC participants, 2006 and 2012.
SOURCES: USDA/FNS, 2007a, 2013a.

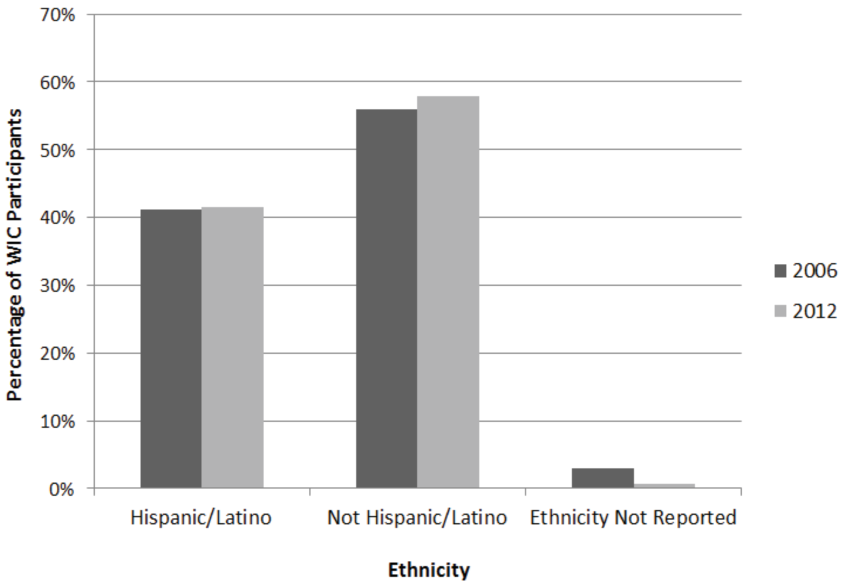

FIGURE 1-5b Distribution of ethnicity of WIC participants, 2006 and 2012.
SOURCES: USDA/FNS, 2007a, 2013a.

Changes in Racial and Ethnic Composition of the WIC Population

Figures 1-5a and 1-5b illustrate the racial and ethnic composition, respectively, of the WIC population in 2006 compared to 2012. Although the population remained diverse, the proportion of individuals in each category generally did not change more than 3 percent (USDA/FNS, 2007a, 2013a).

Effects of Food Package Changes on Program Participation

In addition to demographic and economic changes that may influence WIC participation, the committee considered whether food package changes implemented in 2009 may have influenced participation in the program. To do this, the committee used state-level data on participation and the number eligible for WIC from 2006 to 2012 (USDA/FNS, 2011b, 2013b, 2014c, 2015f; Bitler and Hoynes, 2013). The analysis considered the effects of national trends, time invariant state factors, the date of implementation of the new food package, the unemployment rate, births per capita and participation in TANF/SNAP/Unemployment Insurance (UI). Details of the estimation method are discussed in Appendix F. The results suggest no significant difference between participation before and participation after implementation of the new food packages. The estimated effect was not statistically significant, and it was small in magnitude.

CHANGES TO PROGRAM ADMINISTRATION

Implementation of the revised food packages in 2009 introduced not only new foods, but also the CVV,[3] a new type of benefit with a specific dollar value for purchasing vegetables and fruits. States are now required to allow "split tender," meaning participants may pay the difference out-of-pocket (or with SNAP benefits) if their vegetable and fruit purchase exceeds the amount on the CVV (USDA/FNS, 2014a). CVV redemption patterns are addressed in Chapter 9.

Since 2006, many states have also undergone significant changes to their management information systems. The changes typically allow states to move to newer Web-based technologies that are more efficient than older systems. Management information system changes in WIC programs and state-level administrative challenges related to those changes are addressed in Chapter 2.

Additionally, at the time of this report, 12 states had fully implemented EBT systems (see Figure 1-6). The transition to EBT potentially changes

[3] In states issuing EBT cards, the CVV is referred to as a cash value benefit (CVB).

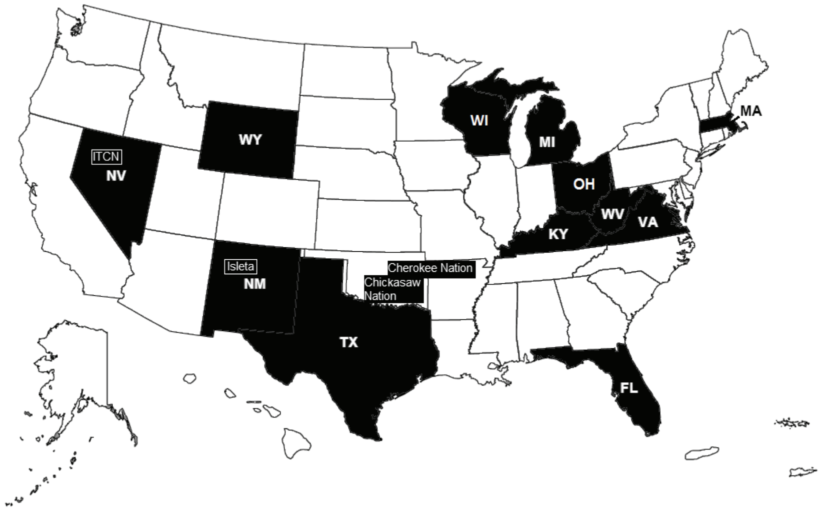

FIGURE 1-6 States and Indian Tribal Organizations (ITOs) with fully implemented WIC electronic benefit transfer (EBT) systems, November 2015.
NOTES: Isleta = Pueblo of Isleta; ITCN = Inter-Tribal Council of Nevada. Shading indicates statewide or ITO-wide WIC EBT implementation. No shading indicates states with no EBT activity or states in piloting, planning, or implementing phases.
SOURCE: Adapted from USDA/FNS, 2015g.

WIC participant food purchasing patterns by allowing more flexibility around whether and when to buy an item and the ability to purchase any foods loaded on the card at any time during the month. In contrast, the paper voucher often includes multiple eligible foods on a single voucher, which must be used in one shopping trip. The transition to EBT also creates the potential to capture data on foods purchased by allowing for the collection of specific information on exact foods redeemed and unredeemed by participants. The EBT system, however, does have some administrative trade-offs to which state agencies must adjust. State-level adoptions of WIC EBT systems are discussed in more detail in Chapter 2.

Changes in Program Costs

Any changes to the food packages to be recommended by the committee during phase II of this study are required to be cost neutral so the current average food package cost (with adjustments for inflation) can be maintained. Total WIC costs, including food and nutrition services administration, were $6.3 billion in 2014, representing a decrease of almost $900 million from 2011, when total costs were $7.2 billion. Average per participant monthly food costs have also declined, to $43.65 in 2014, from $46.69 in 2011 (see Table 1-2). As with all federal programs, unspent funds revert back to the federal government.

Major cost savings are made available to the WIC program through the infant formula rebate system. WIC state agencies are required to award infant formula rebate contracts competitively and grant winning infant formula manufacturers exclusive rights to provide formula to WIC participants in exchange for substantial discounts on infant formula and sometimes food (USDA/ERS, 2013). The total dollar value of rebates received from infant formula manufacturers by WIC state agencies in fiscal year 2014 was $1.8 billion, an increase of about $124 million since 2012, when $1.69 billion in rebates were received (see Table 1-3). The USDA-FNS request that recommended WIC food package modifications be cost neutral is discussed in more detail in Chapter 9. The methodology that the committee will use during phase II to predict the cost impact of recommended changes is described in Chapter 3.

TABLE 1-2 WIC Program Costs, 2005–2014

		Program Costs (millions of dollars)			Average Monthly Food Cost per Person (dollars)
Year	Participation (millions)	Food	NSA	Total	
2005	8,023	3,602.80	1,335.50	4,992.60	37.42
2006	8,088	3,598.20	1,402.60	5,072.70	37.07
2007	8,285	3,881.10	1,479.00	5,409.60	39.04
2008	8,705	4,534.00	1,607.60	6,188.80	43.40
2009	9,122	4,640.90	1,788.00	6,471.60	42.40
2010	9,175	4,561.80	1,907.90	6,690.10	41.43
2011	8,961	5,020.20	1,961.30	7,178.90	46.69
2012	8,908	4,809.90	1,877.50	6,799.70	45.00
2013	8,663	4,497.10	1,881.60	6,478.60	43.26
2014	8,258	4,325.70	1,903.10	6,293.70	43.65

NOTES: Participation data are annual averages in millions. In addition to food and NSA (Nutrition Services and Administrative) costs, total expenditures include funds for program evaluation, Farmers' Market Nutrition Program (fiscal year 1989 onward), special projects, and infrastructure. Nutrition Services includes nutrition education, preventative and coordination services (such as health care), and promotion of breastfeeding and immunization. Fiscal year 2014 data are preliminary; all data are subject to revision.
SOURCE: USDA/FNS, 2015e.

TABLE 1-3 WIC Infant Formula and Food Rebates, 2005–2014

Fiscal Year	Rebates (millions of dollars)
2005	1,709.77
2006	1,774.95
2007	1,902.74
2008	2,006.80
2009	1,937.42
2010	1,692.04
2011	1,314.10
2012	1,688.17
2013	1,876.85
2014	1,812.34

NOTES: Data for 2008–2011 are rebates billed during the fiscal year. Data for 2012–2014 are rebates received during a fiscal year. Values reflect rebates on infant formula and, to a lesser extent, infant food.
SOURCES: USDA/FNS, 2015e (years 2008–2014); Personal communication, V. Oliveira, USDA-ERS, July 23, 2014 (years 2005–2007).

CHANGES IN FOOD SYSTEMS, DIETARY PATTERNS, AND DIETARY GUIDANCE

In addition to WIC participant demographic and program administrative changes that have occurred since the 2006 committee issued its recommendations, the current committee examined the increasing focus on environmentally sustainable and local food systems; shifts in American dietary patterns; and updates in federal dietary guidance.

Changes in Food Systems

Since the publication of the 2006 IOM report, national focus on the impact of food production and consumption on environmental sustainability and long-term food security has increased. The 2015 DGAC report devoted two of seven chapters of the report to food environment and food sustainability and found consistent evidence that plant-based diets are associated with lower environmental impact (USDA/HHS, 2015). Additionally, the 2015 DGAC report reported strong evidence that the seafood industry has been rapidly expanding to meet demand and that, in contrast to past decades when fisheries collapsed because of overfishing, current fisheries are increasingly employing sustainable management strategies to avoid long-term collapse (USDA/HHS, 2015).

There has also been growing interest in local and regional food systems. Another recent report prepared by the USDA/ERS (2015b) at the request of the House Agriculture Committee focused on trends in U.S. local and regional food systems. The report indicated that that producer participation in local food systems trended upward from 2007 to 2014, with both the value of farmers' markets and direct-to-consumer sales of food increasing. Since 2007, the number of farmers' markets has increased by nearly 200 percent, regional food hubs by nearly 300 percent, and school districts with farm-to-school programs by more than 450 percent (USDA/ERS, 2015b).

Changes in the Dietary Patterns of Americans

For the U.S. population overall, after decades of increases, mean energy intake decreased significantly between 2003–2004 and 2009–2010 (Ford and Dietz, 2013). Food consumption trends between 2005 and 2012 for selected food groups among women 20 years and older are presented in Table 1-4a. Whole grain consumption increased 34 percent between 2007–2008 and 2011–2012. Consumption of seafood low in omega-3 fatty acids increased by 26 percent as did consumption of nuts and seeds by 28 percent over the same time period. In contrast, consumption of soy products decreased by 30 percent. Table 1-4b presents data for children ages 2 to 5 years. For this age group, consumption of seafood high in omega-3 doubled, yogurt consumption increased by 83 percent, and whole grains increased by 46 percent between 2007–2008 and 2011–2012.

Changes in Federal Dietary Guidance

The 2006 IOM review of WIC food packages drew on the 2005 DGA (USDA/HHS, 2005). The DGA are updated every 5 years, with the most recent being the 2010 DGA. The 2015 DGA will be released prior to completion of phase II of this study. As discussed in detail in Chapter 9, phase II recommended revisions to the WIC food packages for individuals aged 2 years and older will align with the 2015 DGA. Recommendations for infants and children less than 2 years of age will draw on the recommendations of the American Academy of Pediatrics (AAP) and other authoritative groups. Because the 2015 DGA are yet to be released, analyses in Chapter 9 are based instead on the 2015 DGAC report (USDA/HHS, 2015). Changes in the 2015 DGAC report relevant to the WIC food packages are summarized below.

TABLE 1-4a Trends in Food Consumption from Selected Food Groups: Mean Intakes for U.S Women, 20 Years and Older, NHANES 2005–2012

	Mean Intake per Day				Percent Change from Before to After the 2009 FP Changes (2007–2008 to 2011–2012)
Food Group	2005–2006	2007–2008	2009–2010	2011–2012	
Total fruit (c-eq)	0.88	0.92	1.06	0.96	4
Total vegetables (c-eq)	1.48	1.42	1.46	1.51	6
Whole grains (oz-eq)	0.67	0.68	0.81	0.91	34
Refined grains (oz-eq)	4.87	4.71	4.75	4.92	4
Seafood low omega-3 (oz-eq)	0.43	0.31	0.46	0.39	26
Seafood high omega-3 (oz-eq)	0.16	0.12	0.15	0.12	0
Eggs (oz-eq)	0.42	0.41	0.43	0.43	5
Soy products (oz-eq)	0.06	0.10	0.08	0.07	–30
Nuts and seeds (oz-eq)	0.54	0.54	0.58	0.69	28
Total protein foods (oz-eq)	4.89	4.72	4.87	4.82	2
Milk (c-eq)	0.85	0.75	0.78	0.70	–7
Cheese (c-eq)	0.59	0.57	0.63	0.63	11
Yogurt (c-eq)	0.06	0.06	0.08	0.07	17
Total dairy (c-eq)	1.51	1.41	1.50	1.43	1
Oils (g-eq)	19.20	19.06	19.92	22.83	20
Solid fat (g-eq)	33.94	33.02	30.84	30.64	–7
Added sugars (tsp-eq)	14.83	15.80	15.24	15.37	–3

NOTES: c-eq = cup-equivalents; FP = food package; g-eq = gram-equivalents; oz-eq = ounce equivalents; tsp-eq = teaspoon-equivalents.
SOURCES: NHANES 2005–2012 (USDA/ARS, 2005–2012); USDA/ARS, 2014.

Food Group Intakes

Compared to the 2005 DGA (see Table 1-5), the 2010 DGA reorganized the vegetable food group into five subgroups. The recommended food intakes increased for "red-orange vegetables," "starchy vegetables," and "beans and peas." The recommended quantities of "dark green vegetables" and "other vegetables" decreased. There were no changes in recommended intakes of

TABLE 1-4b Trends in Food Consumption from Selected Food Groups: Mean Intakes for U.S. Children, 2 to 5 Years of Age, NHANES 2005–2012

Food Group	Mean Intake per Day 2005–2006	2007–2008	2009–2010	2011–2012	Percent Change from Before to After the 2009 FP Changes (2007–2008 to 2011–2012)
Total fruit (c-eq)	1.38	1.49	1.46	1.41	–5
Total vegetables (c-eq)	0.74	0.70	0.67	0.66	–6
Whole grains (oz-eq)	0.49	0.46	0.70	0.67	46
Refined grains (oz-eq)	4.20	4.05	4.03	4.41	9
Seafood low omega-3 (oz-eq)	0.17	0.11	0.12	0.13	18
Seafood high omega-3 (oz-eq)	0.04	0.01	0.03	0.02	100
Eggs (oz-eq)	0.28	0.34	0.31	0.32	–6
Soy products (oz-eq)	0.03	0.03	0.04	0.03	0
Nuts and seeds (oz-eq)	0.27	0.24	0.32	0.29	21
Total protein foods (oz-eq)	2.86	2.90	3.00	2.90	0
Milk (c-eq)	1.63	1.67	1.70	1.62	–3
Cheese (c-eq)	0.47	0.49	0.59	0.56	14
Yogurt (c-eq)	0.07	0.06	0.08	0.11	83
Total dairy (c-eq)	2.18	2.23	2.38	2.30	3
Oils (g-eq)	13.83	13.23	13.03	15.00	13
Solid fat (g-eq)	29.21	29.88	28.96	29.77	0
Added sugars (tsp-eq)	13.72	12.96	12.45	12.92	0

NOTES: c-eq = cup-equivalents; g-eq = gram-equivalents; oz-eq = ounce equivalents; tsp-eq = teaspoon-equivalents.
SOURCES: NHANES 2005–2012 (USDA/ARS, 2005–2012); USDA/ARS, 2014.

total fruit, grains, protein foods, or oils. Recommended intakes of dairy foods were slightly increased for two calorie levels.

Compared to the 2010 DGA, the 2015 DGAC report included no changes to the recommended amounts from each of the major food groups or food subgroups, except for small changes to the subgroups of protein foods. One notable change was the specification of calories from saturated

TABLE 1-5 USDA Food Intake Patterns for Kcal Levels of Interest: Comparison of 2005 DGA and 2015 DGAC Report

	Kcal Pattern Represented							
	1,000		1,200		1,400		2,200[a]	
Food group	2005	2015	2005	2015	2005	2015	2005	2015
Fruits (c-eq/d)	1	1	1	1	1½	1½	2	2
Vegetables (c-eq/d)	1	1	1½	1½	1½	1½	3	3
Dark green (c-eq/wk)	1	½	1½	1	1½	1	3	2
Red-orange (c-eq/wk)	½	2½	1	3	1	3	2	6
Dry beans and peas[b] (c-eq/wk)	½	½	1	½	1	½	3	2
Starchy (c-eq/wk)	1½	2	2½	3½	2½	3½	6	6
Other (c-eq/wk)	4	1½	4½	2½	4½	2½	7	5
Grains (oz-eq/d)	3	3	4	4	5	5	7	7
Whole grains (oz-eq/d)	1½	1½	2	2	2½	2½	3½	3½
Other grains (oz-eq/d)	1½	1½	2	2	2½	2½	3½	3½

Protein Foods (oz-eq/d)[c]	2	2	3	3	4	4	6	6
Meat, poultry, eggs (oz-eq/wk)		10		14		19		28↓
Seafood (oz-eq/wk)		3		4 ↓		6		9
Nuts, seeds, soy (oz-eq/wk)		2 ↑ [d]		2		3		5 ↑
Dairy (c-eq/d)	2	2	2	2½	2	2½	3	3
Oils (g/d)	15	15	17	17	17	17	29	29
Limits for:								
Solid fats (g/d)[e]		10		7		7		18
Added sugars (g/d)[e]		17		12		13		32

NOTES: c-eq = cup-equivalents; DGA = *Dietary Guidelines for Americans*, oz-eq = ounce-equivalents.

[a] Food patterns for the 2,200 kcal diet were applied to women in this report because this is equivalent to the mean Estimated Energy Expenditure (EER) calculated for women reporting WIC participation in NHANES 2005–2008.

[b] In the USDA food patterns, dry beans and peas are first counted toward the protein foods group until recommendations for that group are met, then are counted toward the dry beans and peas vegetable subgroup (USDA, 2015).

[c] In 2005, key protein sources were categorized as "lean meats and beans," without protein subgroups.

[d] An arrow indicates that the recommended food group amount changed from 2010 to 2015 by 1 unit in the specified direction. Other food pattern amounts are the same in the 2015 DGAC report as those recommended in the 2010 DGA.

[e] In 2005, solid fats and added sugars were built into a "discretionary calorie allowance" instead of specific gram levels of intake.

SOURCES: USDA/HHS, 2005, 2010, 2015.

fats and added sugars, which was given as a single percentage of total energy intake in the 2010 DGA. In the 2015 DGAC report, limits were given separately for solid fats and for added sugars. The implication is that energy from these two dietary components is not interchangeable. As a result, low intake of one does not imply that a higher intake of the other would be appropriate.

The food patterns in the 2010 DGA included templates for several variations in the USDA Food Pattern, including the Dietary Approaches to Stop Hypertension (DASH) Eating Plan, and Mediterranean, vegetarian, and vegan patterns. The 2015 DGAC report included a healthy U.S.-style, healthy Mediterranean, and healthy vegetarian patterns (USDA/HHS, 2015).

Nutrient Intakes

The 2015 DGAC report identified nine nutrients (vitamin A, vitamin D, vitamin E, vitamin C, folate, calcium, magnesium, fiber, and potassium) as "shortfall" nutrients, that is, nutrients that are under-consumed relative to Dietary Reference Intake recommendations (see Table 1-6). For adolescent and premenopausal females, iron was also identified as a shortfall nutrient because of risk of iron deficiency. Within the larger category of shortfall nutrients, calcium, vitamin D, fiber, and potassium were classified as nutrients of public health concern because their under-consumption has been linked to adverse health outcomes. The 2015 DGAC report continues to recommend that women of reproductive age supplement a diet rich in vegetables, fruits, and grains with foods enriched with folic acid or with folic acid supplements. Compared to the 2010 DGAC report, the 2015 DGAC report no longer identified choline and vitamin K in adults, phosphorus in children, and vitamin B12 in adults older than 50 as shortfall nutrients. Folate, which was categorized as a nutrient of concern for women capable of becoming pregnant in the 2010 DGA, was categorized as a shortfall nutrient in the 2015 DGAC report. Iron was still considered a nutrient of public health concern for these women.

Food Components to Reduce

Both the 2010 DGA and 2015 DGAC report focus on limiting added sugars in the diet, and the 2015 DGAC report recommended limiting added sugars to no more than 10 percent of total calories. The 2015 DGAC report also retained the 2010 DGA recommendation to limit saturated fat to 10 percent of total calories. The 2010 DGA recommendation to limit cholesterol was not retained.

The 2010 DGA recommended that adults up to 50 years of age limit

TABLE 1-6 Shortfall Nutrients and Nutrients of Public Health Concern from the Reports of the Dietary Guidelines Advisory Committees: 2005, 2010, and 2015

	2005	2010	2015
	Adults		
Calcium	✓*	✓*	✓*
Potassium	✓*	✓*	✓*
Choline		✓	
Fiber	✓*	✓*	✓*
Magnesium	✓		✓
Vitamin A	✓	✓	✓
Vitamin C	✓	✓	✓
Vitamin E	✓*	✓	✓
Vitamin D		✓*	✓*
Vitamin K		✓	
Folate	✓		✓
	Children and Adolescents		
Calcium	✓*	✓*	✓*
Potassium	✓*	✓*	✓*
Fiber	✓*	✓*	✓*
Magnesium		✓	✓
Phosphorus		✓	
Vitamin A		✓	✓
Vitamin C		✓	✓
Vitamin E	✓*	✓	✓
Vitamin D		✓*	✓*
	Women of Reproductive Age		
Iron	✓*	✓*	✓*
Folate	✓*	✓*	✓

NOTES: ✓ = shortfall nutrient; ✓* = nutrient of public health concern; nutrients of public health concern are those shortfall nutrients that are linked to adverse health outcomes.
SOURCES: USDA/HHS, 2005, 2010, 2015.

their sodium intake to 2,300 mg per day and that those who are 51 years and older, African American, or with hypertension, diabetes, or chronic kidney disease limit sodium intake to 1,500 mg daily. The 2015 DGAC report recommended a sodium limit of 2,300 mg per day for all adults.

Dietary Guidance for Infants and Children Up to 2 Years of Age

Since the 2006 IOM report, minor updates have been made to dietary guidance for individuals less than 2 years of age. In 2008, the AAP issued guidance recommending reduced-fat milks for children over the age of 1 for whom overweight or obesity is a concern (AAP, 2008). As denoted in the final rule, USDA-FNS permits the issuance of reduced-fat milks for children 1 year of age and over who fall into this category (USDA/FNS, 2014a). Also in 2008, the AAP published a statement reporting insufficient data to document a protective effect of any dietary intervention on allergy development beyond 4 to 6 months of age (Greer et al., 2008). Results of the committee's review of changes in dietary guidance for infants and children up to 2 years of age and its implications for WIC food packages is described in Chapter 9.

Proportion of Recommended Food Groups Supplied by WIC Foods

As its name implies, WIC was designed to be a *supplemental* food program. In this context, supplemental foods are

> those foods containing nutrients determined by nutritional research to be lacking in the diets of pregnant, breastfeeding, and postpartum women, infants, and children, and foods that promote the health of the population served by the WIC program as indicated by relevant nutrition science, public health concerns, and cultural eating patterns, as prescribed by the Secretary.[4]

The term *supplemental* is not quantified in a regulatory context, but the term implies provision of less than 100 percent of what is needed, with specific focus on provision of foods that address shortfall nutrients, including nutrients of public health concern.

Given the WIC program objective to supplement participants' usual diets, it is useful to know the potential contribution of the WIC food packages to USDA-recommended food group intakes (USDA/HHS, 2015). Table 1-7 shows the proportion of each USDA major food group and subgroup supplied to an individual by a monthly food package if consumed in maximum amounts.

Although Table 1-7 was created by applying a 1,300 kcal weighted

[4] 95th Congress. 1978. Public Law 95-627, § 17: Child care food program.

food pattern for children equivalent to 1,225 kcal per day and 2,200[5] kcal per day for women using the 2015 DGAC report food patterns (USDA/HHS, 2015), the WIC food packages serve individuals with a wide range of energy needs. The data presented in the table are therefore only approximations of the proportion of food intake needs contributed by the WIC food package, assuming full redemption and consumption. As shown in the table, for children, WIC foods provide approximately 77, 36, 90, 55, and 60 percent of the recommended intakes for fruits, vegetables, dairy, grains, and protein, respectively. For pregnant and partially breastfeeding women, the food packages provide approximately 57, 19, 98, 25, and 47 percent of the recommended intakes for those same food groups.

[5] To evaluate the diets of all children 1 to less than 5 years of age in this report, the committee applied a weighted food pattern (a 1,000 kcal pattern weighted 1:3 with the average of 1,200- and 1,400-kcal patterns) as was applied in IOM (2011). The Estimated Energy Expenditure (EER) analysis conducted for this report indicated a mean EER for WIC women of approximately 2,200 kcals.

TABLE 1-7 Percentage of the Recommended Servings from the 2015 USDA Food Patterns Supplied by the Current Maximum Allowances for the WIC Food Packages by Category of Participant

			Children		
			FP IV: 1 to 4 Years		
WIC Food Category	USDA Food Pattern Group	Units/ Day	WIC Max	% of DGAC Report Rec	DGAC 1,300 Kcal Food Pattern[a]
Total fruit	*Fruits*	*c-eq*	*0.9*	*77*	*1.2*
Juice, 100%[c]	Fruit (juice only)	c-eq	0.5	107	0.5
Fruit[d]	Fruit, fresh	c-eq	0.4	57	0.7
Total vegetables	*Total vegetables*	*c-eq*	*0.5*	*36*	*1.4*
Vegetables[e]		c-eq	0.3	21	1.4
Dry legumes	Dry beans and peas	c-eq	0.3	353	0.1
Total dairy	*Dairy*	*c-eq*	*2.1*	*90*	*2.4*
Milk[f]		c-eq	2.1	90	2.4
Cheese[g]		oz-eq	0.0	0	2.4
Total grains	*Grains*	*oz-eq*	*2.3*	*55*	*4.1*
Breakfast cereal		oz-eq	1.2	29	4.1
Whole wheat bread[h]		oz-eq	1.1	26	4.1
Total protein[i]	*Total protein foods*	*oz-eq*	*1.9*	*60*	*3.1*
Dry legumes[j]	Dry beans and peas	oz-eq	0.3	NR	NR
Peanut butter[k]	Nuts, seeds, and soy	oz-eq	1.2	354	0.3
Eggs	Meat, poultry, eggs	oz-eq	0.4	19	2.1
Fish	Seafood	oz-eq	0.0	0	0.6

Women						
FP V: Pregnant and Partially BF, Up to 1 Year PP		FP VI: Up to 6 Months PP		FP VII: Fully BF, Up to 1 Year PP		
WIC Max	% of DGAC Report Rec	WIC Max	% of DGAC Report Rec	WIC Maximum Allowance	% of DGAC Report Rec	DGAC 2,200 Kcal Food Pattern[b]
1.1	*57*	*0.9*	*47*	*1.1*	*57*	*2.0*
0.6	91	0.4	61	0.6	91	0.7
0.5	40	0.5	40	0.5	40	1.3
0.6	*19*	*0.6*	*19*	*0.6*	*19*	*3.0*
0.4	13	0.4	13	0.4	13	3.0
0.3	88	0.3	88	0.3	88	0.3
2.9	*98*	*2.1*	*71*	*3.6**	*118**	*3.0*
2.9	98	2.1	71	3.2	107	3.0
0.0	0	0.0	0	0.4*	8*	4.5
1.7	*25*	*1.7*	*25*	*1.2**	*17**	*7.0*
1.2	17	1.2	17	1.2	17	7.0
0.5	8	0.5	8	0.0*	0.0*	7.0
1.9	*31**	*1.9*	*31**	*3.3*	*54**	*6.0**
0.3	NR	0.3	NR	0.3	NR	NR
1.2	168	1.2	168	1.2	168	0.7
0.4	10	0.4	10	0.8	20	4.0
0.0	0	0.0	0	1.0	78	1.3

continued

TABLE 1-7 Continued

NOTES: * Denotes material updated after report's initial release. BF = breastfeeding; c-eq = cup-equivalents; DGAC = Report of the 2015 Dietary Guidelines Advisory Committee; FP = food package; NR = no recommendation; oz-eq = ounce-equivalents; P = pregnant; PP = postpartum; Rec = recommendation; WIC Max = WIC maximum allowance.

[a] The food pattern recommendation for children ages 1 to less than 5 years was created by using the 1,000 kcal pattern and the average of the 1,200 and 1,400 kcal pattern (Table D1.10 of USDA/HHS, 2015), weighted in a 1:3 ratio as per the method of IOM, 2011.

[b] A 2,200 kcal food pattern was applied to women based on the mean Estimated Energy Expenditure of WIC women respondents from NHANES 2005–2008, calculated assuming the second trimester of pregnancy and low-active physical activity level (Table D1.10 of USDA/HHS, 2015; IOM, 2005).

[c] The maximum allowance of juice provided to children equates to 4 ounces per day, which is on the lower end of the American Academy of Pediatrics recommendation of 4 to 6 ounces per day (AAP, 2001). Although the 2015 DGAC report does not specify a juice recommendation for adults, in this table 33 percent of fruit intake is allotted to 100% juice, according to the DGAC's finding that 33 percent of fruit intake comes from fruit juice in the overall U.S. population (USDA/HHS, 2015).

[d] To determine the maximum allowance, a composite of fruits purchased was developed using percentage of total food group intake data (supporting Appendix E-2 of the 2015 DGAC report; Personal communication, P. Britten, 2015). Fruits contributing to 5 percent or more of intake were included in their respective proportions and matched to 2014 price data. Only fresh fruit was included as all states allow fresh forms. Fifty percent of the cash value voucher (CVV) was assumed ($4 for children and $5.5 for women, respectively).

[e] To determine the maximum allowance, a composite of vegetables was developed using the percentage of total food group intake data (supporting Appendix E-2 of the 2015 DGAC report; Personal communication, P. Britten, 2015). Vegetables contributing to 5 percent or more of intake in each subgroup were included in their respective proportions and matched to 2014 price data. Only fresh vegetables were included as all states allow fresh forms. Fifty percent of the CVV was assumed ($4 for children and $5.5 for women, respectively).

[f] Milk was selected to represent the maximum allowance for this WIC food category as it allows for the largest number of dairy servings per day. Substitutions may include soy milk, cheese, or tofu. In the USDA food patterns, tofu is categorized as a dietary contributor to the protein group.

[g] For package VII, milk and cheese provided in WIC are added together to compare to the USDA dairy food group; 1.5 oz of natural cheese = 1 serving-equivalent of dairy.

[h] Whole wheat bread was selected to represent the maximum allowance for this WIC food category as it allows for the same number of grains servings per day as other possible substitutions. The Grains category here includes both whole wheat bread and breakfast cereals. Substitutions include brown rice, bulgur, oatmeal, barley, tortillas, or whole wheat pasta.

[i] Note that in packages IV and VI, legumes or peanut butter can be selected. Total protein for these packages as presented in the table includes peanut butter and not legumes because peanut butter is more regularly purchased (USDA food package options report). In packages V and VII, both are provided; therefore, total protein includes legumes plus peanut butter.

[j] Legumes were considered a protein substitution (in addition to a vegetable option) as it alternates with peanut butter, another protein source, in the food packages. If considered a contributor to vegetable intake, the contribution would be 21 percent and 10 percent of the 2015 DGAC report recommendations for vegetable intake for children and women, respectively.

[k] 0.5 ounces of peanut butter = 1 ounce-equivalent serving of nuts, seeds, and soy.

SOURCES: USDA/FNS, 2014a; USDA/HHS, 2015; Personal communication, P. Britten, USDA/CNPP, December 9, 2014.

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2

The WIC Participant Experience

The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) participant experience, illustrated in Figure 2-1, is influenced by a number of factors, including racial and ethnic differences in food preferences and infant and child feeding practices; behavioral barriers and motivators; environmental and economic factors affecting the availability of and access to food; and administrative and vendor challenges associated with the WIC food packages. A better understanding of these factors can help to ensure that WIC food packages are culturally suitable, efficient for nationwide distribution, and nonburdensome to administration. This chapter reviews available evidence relevant to these factors in relation to the WIC participant experience.

ASSESSING PARTICIPANT ACCEPTANCE OF WIC FOODS

Given the racial and ethnic diversity of the WIC population, which was described in Chapter 1, the committee conducted a review of the literature to evaluate racial and ethnic differences in satisfaction with the 2009 food package revisions and in infant and child feeding styles and practices. A summary of findings is included here.

Racial and Ethnic Differences and Acceptance of the WIC Food Packages

Although multiple studies have documented moderate to high satisfaction with the 2009 changes in the WIC food packages (Gleason and Pooler, 2011; Whaley et al., 2012; Ishdorj and Capps, 2013; Bertmann et al., 2014;

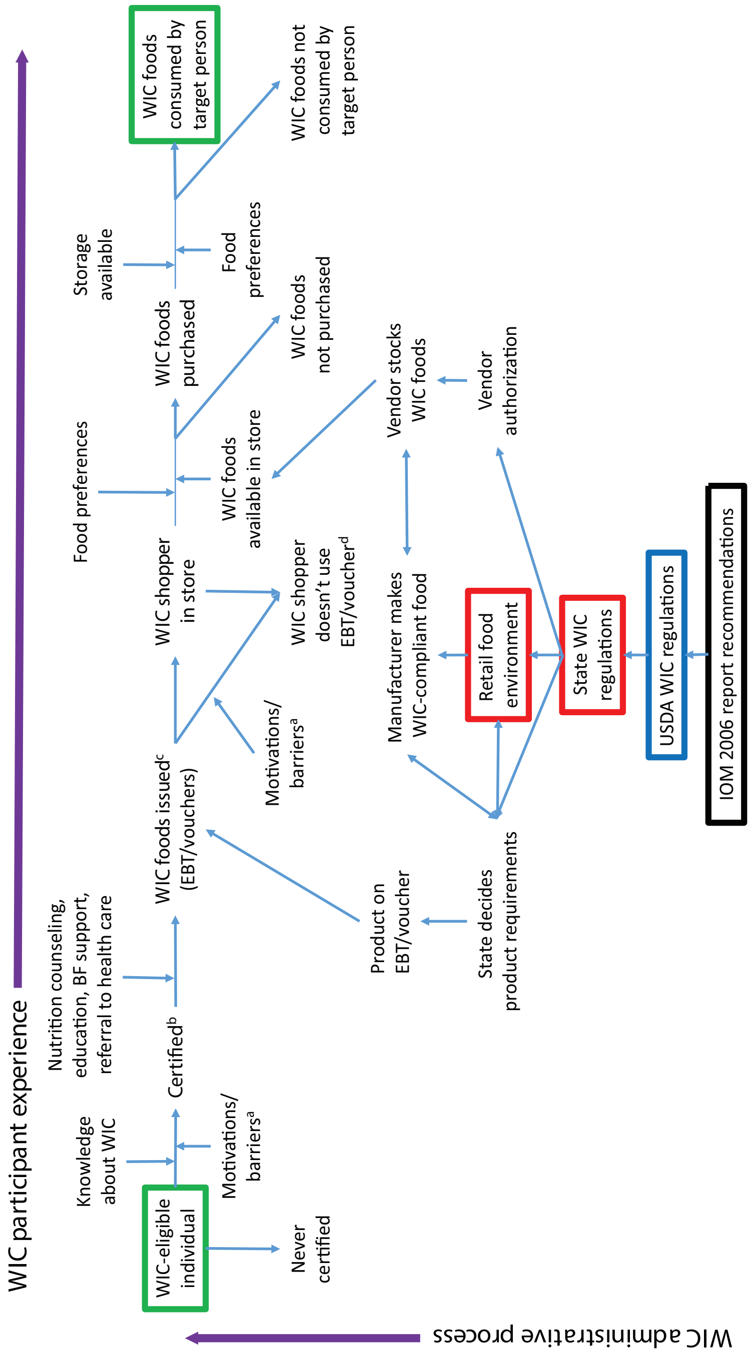
WIC participant experience
WIC administrative process
WIC-eligible individual
Never certified
Knowledge about WIC
Motivations/ barriers[a]
Certified[b]
Nutrition counseling, education, BF support, referral to health care
WIC foods issued[c] (EBT/vouchers)
Product on EBT/voucher
State decides product requirements
Motivations/ barriers[a]
WIC shopper in store
WIC shopper doesn't use EBT/voucher[d]
Food preferences
WIC foods available in store
WIC foods purchased
WIC foods not purchased
Storage available
Food preferences
WIC foods consumed by target person
WIC foods not consumed by target person
Vendor stocks WIC foods
Vendor authorization
Manufacturer makes WIC-compliant food
Retail food environment
State WIC regulations
USDA WIC regulations
IOM 2006 report recommendations

FIGURE 2-1 Overview of the WIC program administrative and participant processes.

NOTE: This figure is a theoretical representation; it does not consider effects of other individual or household resources.

[a] Potential participant barriers may include lack of access to transportation to the WIC site and/or the vendor, time required to visit a WIC site, inconvenient WIC clinic hours, lack of knowledge about the program or lack of preference for WIC foods, among other barriers.

[b] Certification for WIC requires the individual to be categorically eligible (pregnant, postpartum woman; infant; child up to age 5), meet income eligibility guidelines (< 185 percent of the federal poverty level), provide proof of residence in the state where benefits are issued, and have a nutritional risk. Women certified during pregnancy are certified for the duration of pregnancy plus up to 6 weeks postpartum. Postpartum recertification following the birth of the infant is for either 6 months (if not breastfeeding) or 12 months (if breastfeeding), after which time the mother is no longer eligible for WIC. In the case of a fetal or pregnancy loss, women remain eligible and can be recertified for the program for 6 months after the end of the pregnancy. Beginning in 2013, the Federal Rule gave states the discretion to certify infants and children for either a 6- or 12-month period. As of this writing, certification periods for infants and children are 6 or 12 months depending on state-level decisions. The need for the participant to visit the program site for recertification is not illustrated in this diagram.

[c] EBT benefits/food vouchers are valid for a 1-month period. States have the discretion to decide whether the 1-month benefit period is a calendar month (e.g., June 1–30) or a rolling month based on the date of benefit issuance (e.g., June 20–July 19). For an individual who is certified, up-to-date on all required documentation, and has no high-risk conditions, benefits can be issued for up to a 3-month period. This means that, although WIC foods are issued for a 1-month period, a participant may be issued up to 3 months of benefits at one visit. Only the current month of benefits can be used immediately. The remaining benefits issued for use in future month(s) must be retained and used only in the future month(s). Valid dates for future month benefits are printed on the voucher or included on the EBT receipt. The need for the participant to visit the program site to obtain EBT benefits/food vouchers is not illustrated in this diagram.

[d] Significant lack of redemption or under-redemption of a WIC food is information used by WIC state agencies to make decisions about available products. This feedback loop is not represented in this diagram.

Ritchie et al., 2014), evidence also indicates cultural variation in participants' satisfaction with certain types or amounts of food items (Black et al., 2009, Ritchie et al., 2014). Black et al. (2009) conducted interviews and focus groups with WIC participants and caregivers throughout Maryland to assess perceptions of the proposed food package changes and examine differences in food preferences by race and ethnicity. Although food preferences appeared to be similar between non-Hispanic black and non-Hispanic white participants, more Hispanic respondents preferred beans compared to peanut butter and expressed dislike for frozen and canned vegetables. In a statewide survey of WIC participants and caregivers in California, Ritchie et al. (2014) reported that of the nearly 3,000 participants and caregivers surveyed, most (91 percent) were satisfied with the new food items introduced (fruits and vegetables, whole grains, and lower-fat milk). However, participant satisfaction was significantly higher among individuals who spoke primarily Spanish compared with individuals who spoke primarily English. Additionally, a higher proportion of primarily Spanish speakers were satisfied with vouchers for whole grains, vouchers for lower-fat milk, and the amount of juice, and a higher proportion of primarily English speakers were satisfied only with the amount of milk and not with other amounts of other foods.

Racial and Ethnic Differences in Infant and Child Feeding Styles and Practices

Parental styles and practices for infant and child feeding may shape early food preferences and eating patterns and, as discussed in Chapters 6 and 7, have been associated with the risk of being overweight or obese and related health conditions. Studies of WIC participants and low-income populations have reported cultural differences in breastfeeding initiation and duration, foods available and accessible to young children in the home, parent modeling, parent encouragement, and family rules (Bonuck et al., 2005; Kasemsup et al., 2006; Hurley et al., 2008; Mistry et al., 2008; Arthur, 2010; Evans et al., 2011; Skala et al., 2012; Marshall et al., 2013; Odoms-Young et al., 2014; St. Fleur et al., 2014). The American Academy of Pediatrics (AAP) (2014) reviewed racial and ethnic similarities and differences related to parental feeding styles, and although differences in feeding styles were evident among subjects, the results were too heterogeneous to draw general conclusions for racial or ethnic groups. In terms of specific feeding practices, the AAP acknowledges the strong influence of culture on parental behaviors related to food choice, preparation, and consumption (AAP, 2014).

Racial and Ethnic Differences in the Prevalence of Breastfeeding

The national prevalence of breastfeeding is increasing, with proportions of breastfeeding women at or near their historic highs in 2011, with the exception of the non-Hispanic American Indian/Alaska Native category (HHS/CDC, 2015). However, even at their historic highs, rates have varied among other racial and ethnic groups as well (see Table 2-1). From 2008 to 2011, the prevalence of breastfeeding at 6 months was consistently lowest for non-Hispanic black (30 to 36 percent of infants) and highest for non-Hispanic Asian (60 to 70 percent of infants) (HHS/CDC, 2015). Studies of breastfeeding prevalence in the WIC population have similarly shown variation by cultural group, with fewer African American women initiating and sustaining breastfeeding compared to other racial and ethnic groups (Hurley et al., 2008; Marshall et al., 2013). The underlying reasons for racial and ethnic differences in breastfeeding prevalence are not well understood at this time, but it is clear that the greatest differences occur at the point of initiation (AAP, 2014). Chapter 7 summarizes the committee's evaluation of breastfeeding trends and barriers, motivation, and support of breastfeeding.

Racial and Ethnic Differences in Provision of Foods to Young Children

Evidence suggests that cultural variations in infant and child feeding practices may affect the use of specific WIC foods. Kim et al. (2013) reported that satisfaction with jarred baby foods varied across ethnic groups; whereas, about half of whites and African Americans preferred cash

TABLE 2-1 6-Month Breastfeeding Prevalence by Race

	Breastfeeding Prevalence (%)			
Race/Ethnicity	2008	2009	2010	2011
Hispanic	45.2	47.4	48.6	48.4
Non-Hispanic white	46.6	48.6	49.3	52.3
Non-Hispanic black	30.1	33.4	36.1	35.0
Non-Hispanic Asian	66.7	65.2	60.2	71.2
Non-Hispanic American Indian/ Alaska Native	40.2	39.4	44.6	37.3
Two or more races	43.5	44.4	45.1	48.4

NOTE: Data are not adjusted for income.
SOURCE: National Immunization Survey Data, as analyzed by the Office of Disease Prevention and Health Promotion, Healthy People 2020 (HHS/CDC, 2015).

value vouchers (CVVs) for fruits and vegetables compared to jarred baby foods, more than two-thirds of Latinos and those identifying as "Other" preferred CVVs for fruits and vegetables. However, redemption of jarred infant foods declined at similar rates with increasing infant age across all ethnic groups.

BARRIERS AND INCENTIVES TO WIC PARTICIPATION AND REDEMPTION

The extent to which the WIC food packages can affect food and nutrient intake is dependent on whether eligible individuals elect to participate and how participants make use of the food benefit. This section summarizes the committee's review of evidence of barriers to participation in WIC or other national food assistance programs, barriers to redemption of WIC foods, and incentives to WIC participation and redemption. An overall summary of the literature review related to barriers to participation and redemption is presented in Box 2-1. Also included in this section is a discussion of concepts from the field of behavioral economics that might be helpful during phase II of the study when considering ways to incentivize WIC participation and redemption and strengthen breastfeeding promotion efforts.

BOX 2-1

Summary of Literature Findings on Barriers to WIC Participation and Redemption

Barriers to Participation
Long wait times; crowded physical environment
Lack of transportation
Belief that family is ineligible; changing eligibility restrictions
Program requires too much effort; difficult paperwork
Language barriers

Barriers to Redemption
Embarrassment; negative interactions in stores
Gaps in knowledge (e.g., determining amount of F&V with CVV); food preparation
Limited selection of WIC foods at local vendors; products not available in allowable forms
Vendor challenges anticipating demand and maintaining adequate supply of some WIC foods
Maintaining food freshness at the vendor (particularly small vendors)

Barriers to Participation

A number of qualitative studies and reports include information about barriers to participation in WIC (Tiehen and Jacknowitz, 2008; USDA/ERS, 2010; Gleason and Pooler, 2011; Gleason et al., 2011, 2014; Bertmann et al., 2014; Phillips et al., 2014; see Appendix G, Table G-1) or in national food assistance programs generally (Martin et al., 2003; Algert et al., 2006; USDA/ERS, 2013). Based on an examination of nationally representative data from the Early Childhood Longitudinal Study-Birth Cohort, Jacknowitz and Tiehen (2007) examined WIC program exits and found that those participants who exited the program early reported that taking part required too much effort (25.7 percent) or they had scheduling or transportation problems (10 percent). Transportation has been cited in other studies as a barrier to participation (Gleason et al., 2014). Some studies have noted language spoken by WIC staff as a barrier to participation (e.g., Tiehen and Jacknowitz, 2008), but others note that some groups like Hispanics tend to enroll earlier in WIC than their non-Hispanic counterparts (e.g., Swann, 2007).

The most extensive quantitative study on barriers to WIC participation was conducted in New York State (Woelfel et al., 2004).[1] In this study, a total of 3,167 parents and caretakers at 51 local agency sites completed a survey on barriers that was developed through qualitative and focus group work. Of the 68 potential barriers included in the survey, 11 were identified by more than 20 percent of respondents. Waiting too long in the waiting room was the most frequently cited barrier (48 percent). Difficulties in bringing the infant or child to recertify and rescheduling appointments were key variables associated with failure to pick up WIC benefits. Features of the physical environment (e.g., crowded, with limited kid-friendly areas) were reported as reducing participant interest in coming to the WIC site. Duration of appointment wait time, customer service, and to a lesser extent facility environments, were identified by WIC participants as potential areas for improvement in a smaller study in Florida conducted by Christie et al. (2006).

Barriers to participation in other national food assistance programs may have implications for WIC, although eligibility and certification requirements differ substantially among programs. Algert et al. (2006), for example, showed that lack of a permanent address, language barriers, changes in eligibility restrictions, and stigma were associated with lower rates of participation in the Supplemental Nutrition Assistance Program (SNAP). Moreover, participants often perceived that the differing

[1] Although this study fell outside the committee's search parameters in terms of publication year, the committee considered its findings to be particularly applicable to the current task (see Chapter 3 for the literature search strategy details).

administrative requirements for food assistance programs were complicated (Gilbert et al., 2014). Also of note, participation patterns generally followed patterns of national economic health (USDA/ERS, 2013) with increasing participation during times of recession. In a study of food assistance programs not including WIC, Martin et al. (2006) described lack of comfort, difficulty with paperwork, and difficulty carrying food home as barriers to participation. Both Martin et al. (2006) and Jacknowitz and Tiehen (2007) found that believing one's family was ineligible was a reason for either not participating or exiting a program early.

Redemption Patterns and Barriers to Redemption

Redemption of WIC Foods

Publicly available data on redemption of WIC foods have not yet been collected on a national level. Limited data are available at the state level on redemption after the implementation of the 2009 rule. The most comprehensive study of WIC food package redemption thus far was conducted by the Altarum Institute using electronic benefit transfer (EBT) data from three states: Kentucky, Michigan, and Nevada (Phillips et al., 2014). The findings are summarized in Box 2-2. From January through March 2012, full redemption[2] of issued food packages ranged from 9.5 to 16.4 percent, partial redemption ranged from 75.6 to 84.4 percent, and nonredemption ranged from 4.1 to 8.0 percent. Differences in redemption were related to race and ethnicity, geography, household size, and the number of WIC family members. The likelihood of nonredemption did not differ greatly based on race or ethnicity in any of the three states and was lower for rural compared to urban residents only in Nevada. Odds of full redemption were significantly higher in households with an infant less than 6 months of age. Based on focus group work, barriers to redemption included receiving too much of a food, dislike of a food, and lack of knowledge on how to prepare a food.

Foods with the highest redemption rates included infant formula, fruits and vegetables, milk, and eggs (Phillips et al., 2014). The final rule specified that, for individuals more than 2 years of age, only skim or 1% milk could be issued, barring any qualifying medical conditions (USDA/FNS, 2014a). In a recent study, Rimkus et al. (2015) found that the availability of lower-fat milks was limited in certain communities. They surveyed 8,959 food stores in 468 communities where a nationally representative sample

[2] Full redemption means that all foods prescribed were purchased. Partial redemption means that some of the foods were redeemed. Nonredemption means that none of the prescribed foods were redeemed.

BOX 2-2

Factors Related to Redemption of the WIC Food Packages in Kentucky, Michigan, and Nevada

(Phillips et al., 2014)

Full Redemption

Racial and ethnic differences:

- Full redemption was greatest for non-Hispanic Asian families (25 percent) and lowest for non-Hispanic white and non-Hispanic American Indian/Alaska Native families (12.5 percent).

Geographic differences:

- Urban families tended to fully redeem packages more often than rural families.

Differences in household size:

- A larger number of household members was associated with greater food package redemption rates.

Differences in number of family members on WIC:

- Greater monthly full redemption was associated with fewer family members on WIC.

Factors Related to Partial Redemption

- Accessibility, availability, food preferences, or not purchasing prior to benefit expiration.

Racial and ethnic differences:

- No differences across racial/ethnic groups.

Factors Related to Nonredemption

Racial/ethnic differences:

- No differences across racial/ethnic groups.

Geographic differences:

- Higher in rural areas (only found in Nevada)

Differences in household size:

- Greater monthly nonredemption was associated with smaller household size.

of students attending public schools resided and found that the odds of carrying lower-fat milks was up to 67 and 58 percent lower in majority black or Hispanic communities, respectively, than in white communities. Important to note is that data for this study were collected between 2010 and 2012, before the final rule eliminating milks of 2 percent fat or higher was implemented (in 2014).

Despite the potentially limited availability of lower-fat milks, milk had one of the highest redemption rates of the WIC foods in 2012 (Phillips et al., 2014). Foods with the lowest redemption rates included jarred baby meats, beans, peanut butter, infant cereal, jarred fruits and vegetables, and whole grains (Phillips et al., 2014). Gleason and Pooler (2011) found that redemption of infant food was low compared to other foods in a study of Wisconsin WIC participants. At 18 months after the implementation of the 2009 package changes, infant fruit and vegetable vouchers were redeemed at 50 percent and infant meat at 34 percent, compared to cheese, eggs, juice, and milk, which were redeemed at 91 to 97 percent post-implementation. Kim et al. (2013) found that redemption rates of jarred infant foods declined with age in a study of WIC participants in California. In this study, participants indicated high satisfaction with jarred infant foods although 66 percent reported that they would prefer to have CVVs for fruits and vegetables for their 6- to 11-month-old infants instead of the jarred foods if permitted. The 2014 final rule allows a $4 or $8 CVV for fruits and vegetables in place of a portion of jarred infant food (USDA/FNS, 2014a).

A major change in the 2009 WIC food package was inclusion of the CVV for purchase of fruits and vegetables. As discussed in the committee's Letter Report, very little information is available in the published literature or from reports to describe the extent to which the CVV is redeemed or how WIC participants apportion the CVV across types and forms of fruits and vegetables (IOM, 2015). As noted in Chapter 3, for this report the committee investigated potential sources for data on foods redeemed by WIC participants. Although obtaining nationally representative data remains challenging, available state agency redemption data indicate that the 74 to 78 percent of the CVV was redeemed in Texas from January to March 2015 (Texas Department of Health Services, 2015). Additional information on CVV redemption may become available to the committee during phase II of this study.

Barriers to Redemption of WIC Foods

Although studies are limited, qualitative work among WIC programs nationwide suggests that the participant shopping experience can be a key barrier to redemption of WIC foods. Prior to the food package revisions, a survey administered to parents and caretakers of WIC participants in New York State found that issues with food procurement (e.g., store policies, food availability) and the WIC food packages (e.g., adequacy, satisfaction with the items) were barriers to participation (Woefel et al., 2004). Since the 2009 food package change, factors identified that negatively affect the WIC shopping experience include food package policies (e.g., container size), grocery store experiences (e.g., cashier interactions), and personal misunderstanding and embarrassment. Positive factors include helpful vendors and both vendor and participant understanding about the use of the CVV (Najjar, 2013).

With respect to the CVV, several small studies were carried out after implementation of the 2009 food package changes to evaluate the perception and use of the CVV by WIC participants. Bertmann et al. (2014) reported that CVVs were inconsistently redeemed in Arizona. They identified several barriers to redemption: participants' perception of annoyance or anger expressed by cashier or other shoppers; cashiers' lack of training; fluctuation in enforcement of WIC redemption rules from store to store and week to week; and feelings of embarrassment or judgment when using the CVV. The authors cautioned, however, that their findings might not be generalizable to other WIC populations. In a Wisconsin study of WIC participant CVV redemption patterns, Gleason and Pooler (2011) reported positive responses overall to the package changes, but with differences in non-use and maximum use of the CVV among some WIC subpopulations. Some participants described a level of discomfort with having to do math in the store, which the researchers hypothesized may be enough to deter use of the benefits. Other vendor-level challenges noted included difficulty maintaining fresh foods (particularly in smaller stores), anticipating client demand, and having the correct package sizes available. The effect of allowing split tender for CVV purchases (using a different payment method for the amount over the CVV benefit) on redemption has yet to be comprehensively evaluated.

Maximizing Participation and Redemption

The committee searched for literature exploring strategies to increase both participation in WIC and redemption of WIC benefits. Potential strategies identified included streamlining the registration process (Gilbert et al., 2014), enhancing customer service and reducing wait times for participants (Christie et al., 2006), informing participants of local vendors (Gleason et al., 2014), ensuring culturally appropriate nutrition messaging (Phillips et al., 2014), enhancing the perceived value of packages (Gleason and Pooler, 2011), and examining the impact of minimum stocking requirements on food availability (Gleason et al., 2011).

In the Altarum study described previously, Phillips et al. (2014) examined the transition to the EBT system and found that in WIC, EBT is preferred by vendors and participants over paper vouchers. Most participants considered the use of EBT a positive shopping experience that improved use of the benefits and minimized waste because of its convenience and portability, allowance for benefit balance tracking, and ease of checkout.

The researchers concluded that, although some technical challenges persist, EBT appears to have a promising positive effect on participant satisfaction and redemption.

Behavioral Economics

This section highlights concepts from the field of behavioral economics that might be helpful during phase II when considering incentives to promote WIC participation and redemption. Consumers often behave in ways (e.g., make decisions about foods) that contradict standard assumptions of economic theory (Just and Payne, 2009). Individuals often exhibit biases, a prime example being loss aversion (Kahneman and Tversky, 1984), when making choices. Loss aversion refers to the tendency to treat losses differently than gains, that is, people will pay less for an object they do not already have compared to what they will accept to give that object up. People also exhibit a tendency to remain within the status quo, even if choosing an alternative action seems clearly better. The implication for WIC is that there may be ways to frame food package choices to influence participant decisions, for example to make the breastfeeding package the status quo or "default" choice, or alternatively, to make it clear that when one chooses the partial or nonbreastfeeding package, the mother receives less food. There is evidence to suggest that when selecting new goods, individuals tend to focus on utilitarian characteristics (functional features of a good; an example for food is "healthful"), but when deciding what to give up, they focus instead on hedonic characteristics (experiential features of a good; an example for food is "taste") (Dhar and Wertenbroch, 2000; USDA/ERS, 2007). Thus, individuals might be willing to consider healthfulness when adding foods to their diet, but be less willing to give up a food that is perceived as tasting good. In the context of WIC, an example would be a greater willingness to add low-fat yogurt compared to giving up higher-fat milk. The U.S. Department of Agriculture-Economic Research Service (USDA-ERS) also reviewed research showing that specific cues (i.e., appearance, brand, name, price, and information) can influence product choices, which may be relevant for the labeling of food items (USDA/ERS, 2007).

Cognitive overload can also affect choice. When there are too many options competing for one's attention, one is more likely to make decisions based on habits or rules of thumb than on logic. This might be relevant for WIC participants trying to find the least expensive brands, which can change frequently in states with least-expensive-brand rules. Labeling of products as "WIC" food items or prepackaging fruits and vegetables in even-dollar amounts reduces the time and difficulty in making decisions for program participants and may also reduce the vendor costs of handling WIC products at the checkout. In the context of WIC, making healthier choices easier to identify and select might increase purchase and consumption of these foods.

In terms of how choices affect consumption, additional evidence cited in USDA-ERS (2007) indicates that when the salience of food is increased, people consume more of it, suggesting that increasing the salience (how much particular items stand out or are noticed) of better food choices might increase consumption. In the context of WIC, making better food choices in the food packages more salient through advertising might increase purchase and consumption of those foods. USDA-ERS (2007) also cited evidence showing that more variety can lead to more consumption.

Based on evidence from SNAP literature, mental accounting, another type of bias whereby people make choices based on having allocated specific funds for specific purposes, might also have implications for WIC food packages (USDA/ERS, 2007). If participants think of their WIC vouchers as special, they might purchase and consume more WIC foods than they would otherwise (i.e., if they were making their food choices based on total income and treating the vouchers as cash).

Finally, there is considerable evidence from the field of behavioral economics that the present time is valued more than future time and that individuals respond differently when asked what they would trade "now" for $10 provided in 2 weeks compared to what they would trade 1 month from now for $10 provided in 6 weeks (Loewenstein, 1988).[3] In the context of this decision being faced by a new WIC woman participant, the trade-off would be what the participant might receive *now* compared to the value of what would be received *later*. The choice now is the value of 806 fluid ounces of formula right away and less food in her package compared to the value of the breastfeeding package now (extra food in the package for the mother and nothing for the infant). The option (choice) later in the period of 6 to 12 months from now is the relatively lower value of the formula package but no benefits for the mother compared to the value of the breastfeeding package (maternal food and some additional food [meats] for the infant). The participant might be inclined to select the breastfeeding package at higher rates than if she had made the decision at some point before the baby was born, over both choices which occur in the future. Recommitment has been suggested as a strategy to address this tendency, or present bias. In the WIC program, periodic WIC office visits and breastfeeding peer counseling offer participants continuing opportunity for (re)commitment.

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[3] There is a body of literature that suggests food assistance recipients consume more of their allotment right around the time the benefits are disbursed (e.g., Wilde and Ranney, 2000). One explanation for this is that recipients have a high personal discount rate and value the present much more than the future.

FACTORS AFFECTING ACCESS TO FOOD

The committee was tasked (during its phase II portion of the study) with ensuring that foods recommended in the food packages are available to WIC participants. This section summarizes findings from the literature on factors that affect availability and access to food in low-income populations. Studies have examined where WIC participants shop for WIC foods; means of transportation; employment; food prices; and the effect of the 2009 food package changes.

Where WIC Participants Shop for WIC Foods

Several studies have examined the distance to WIC food stores and the number of stores within a defined radius. Ford and Dzewaltowski (2010) found that WIC mothers had access to many food stores within a 3-mile radius of their home, whether residing in a micropolitan or a metropolitan area. A recent study of SNAP and WIC households using nationally representative data from National Household Food Acquisition and Purchase Survey (FoodAPS) indicated that the nearest store was an average of 2.0 miles from the household, but the store primarily used for grocery shopping was, on average, 3.4 miles from the household (USDA/ERS, 2015a).

In the National Survey of WIC Participants II (NSWP-II) study conducted in 2009 (USDA/FNS, 2012), WIC participants redeemed their benefits primarily at large grocery stores and supermarkets (63 percent) or combination food store and retail outlets (22 percent). Only 7 percent redeemed vouchers primarily at small grocery stores. Most WIC participants used their vouchers and did most other food shopping at the same store (84 percent). Reasons provided for shopping at a different store for WIC foods included convenience (44 percent) and cost (32 percent). More recently, the USDA-ERS reported that 52 percent of WIC households in the survey shopped primarily at a supercenter-type store, and 39 percent at a supermarket (USDA/ERS, 2015a) (see Table 2-2).

Transportation

The ability of WIC participants to use the food packages may be limited by transportation. The USDA's FoodAPS survey includes information on transportation resources for shopping for WIC foods (USDA/ERS, 2015c). Eighty-seven percent of WIC households responding to the survey accessed grocery stores using their own vehicle, and 8 percent of WIC households reported walking, biking, using public transport, shuttle, delivery, or some other form of transportation (USDA/ERS, 2015c). Using one's own vehicle allows more flexibility in store choice; lack of a vehicle limits the ability to

TABLE 2-2 Preference for Type of Store for WIC or Non-WIC Households

		Percentage			
Household Type	Observations	Supercenter[b]	Supermarket[c]	Other[d]	Unknown
Non-WIC Households[a]	389	45	49	2	5
WIC Households	461	52	39	3	5

[a] Non-WIC, income below 185% of federal poverty threshold.
[b] Supercenters include mass merchandisers.
[c] Supermarkets include supermarkets, commissaries, and other large grocery stores.
[d] Other includes smaller grocery stores, specialty retailers, convenience stores, pharmacies, and dollar stores.
SOURCE: USDA/ERS, 2015a.

transport large or heavy items or a large number of items. Distance to the grocery store also affects food safety, since spoilage may occur with longer travel times.

Employment

When the 2006 Institute of Medicine (IOM) committee issued its recommendations, data from the National Survey of WIC Participants (NSWP) had been used to determine that approximately 25 percent of women were employed when applying to WIC and about 28 percent of WIC mothers were employed, with the highest employment rate among pregnant WIC women (32 percent) (USDA/FNS, 2001). At the time of delivery of this report, current data were not available on the employment status of WIC participants, and the most recent NSWP (NSWP II, published in 2012) did not include employment information.

National Census Bureau data for 2013 indicate that 20.3 percent of working women (15.1 million women) were below 185 percent of poverty. Thirty-seven percent of these were working full-time (5.6 million), and 62 percent were working part-time (9.5 million) (USCB, 2014). The number of low-income working families in the United States rose from 10.2 million in 2010 to 10.4 million in 2011 (Roberts et al., 2013). In 2012, 39 percent of these families were headed by working mothers. Of all families, the share of low-income female-headed working families increased from 54 percent in 2007 to 58 percent in 2012 (Povich et al., 2014). Families with working adults may have expenses for transportation to work that reduce money available for other transportation purposes, such as shopping for WIC foods.

In addition to its effect on access to WIC foods, employment may affect dietary patterns and the extent to which acquired or purchased WIC foods are actually consumed. Data from the American Time Use Survey (2003–2011) indicates that full-time employment appears to be associated with significantly reduced time spent preparing food (Sliwa et al., 2015). Data from the same survey (2006–2008) show that lower income and the presence of young children are both associated with significantly more time spent in food preparation (Senia et al., 2014). A smaller study of more than 2,000 mothers in Minnesota supports this finding, indicating that those with full-time employment spent less time on food preparation and consumed fewer fruits and vegetables compared to mothers with part-time or no employment (Bauer et al., 2012). Working mothers may also experience additional time stress that can affect preparation of healthy meals at home (Jabs and Devine, 2006; Beshara et al., 2010). Time constraints and a need for convenience are important when considering possible modifications to the WIC food packages.

Cost as a Factor in Access to Healthy Food Choices

Because WIC provides vouchers based on quantity, not value, WIC participants may pay less attention to food prices when redeeming their vouchers. The CVV, however, is a cash benefit, and purchasing power may vary regionally. In a study of 26 metropolitan market areas, Leibtag and Kumcu (USDA/ERS, 2011) found that the 20 most commonly purchased fruits and vegetables cost 30 to 70 percent more in the highest-priced market areas compared to the lowest.

Effect of the 2009 Food Package Changes on Food Availability

Several research groups have examined the effects of the 2009 changes to the WIC food packages on food availability, and therefore access. In a study of Illinois WIC vendors, Zenk et al. (2012) compared the availability of five fruit and vegetable types before versus after the 2009 food package changes. Overall, changes were positive for most vendor types and were statistically significant for several categories of fruits and vegetables (see Appendix G, Table G-2). Similarly, after comparing the availability of fruits, vegetables, and whole grains pre- and post-2009 in 252 stores and convenience stores in Connecticut, Andreyeva et al. (2011) concluded, "When facing new government regulations to stock certain healthy foods, Connecticut convenience and grocery stores found ways to deliver healthy foods that were previously lacking in their stores and communities." Some carryover to stores that did not participate in WIC was also noted, possibly attributable to changes in the food supply chain. The greatest impact was observed in low-income communities. Havens et al. (2012) likewise reported that the 2009 WIC food package revisions increased availability of healthy foods (defined as fresh fruits, fresh vegetables, whole grains, and lower-fat milk) among WIC-certified vendors compared to those without WIC authorization in Hartford, Connecticut. Improvement in the "healthy food supply score" varied from 16 percent in WIC convenience and grocery stores in higher-income neighborhoods to 39 percent in lower-income areas.[4] Most of the increases were attributed to increased availability and variety of whole grain products (Andreyeva et al., 2012). O'Malley et al. (2015) also reported changes between 2009 and 2010 in both medium and small WIC stores and increased availability of cereals and grains, juices and fruit, and jarred infant fruits and vegetables. Rose et al. (2014) also reported the 2009 WIC food package changes improved the availability of these foods in small stores in New Orleans. A recent systematic review confirmed overall improved availability of WIC foods at WIC-authorized vendors in the four studies identified (Schultz et al., 2015).

Relationship of Food Availability to Food Choice

Changes in WIC package food availability may translate into healthier food choices. For example, Black et al. (2009) reported that participants viewed whole wheat bread as healthier and a majority indicated that they and their children would increase consumption if it were provided by WIC. In California, 94.6 percent of WIC participants reported they would use their WIC benefits to purchase whole grain bread (California WIC, 2007). Once made available, national EBT data reflecting redemption of WIC foods will provide an indication as to whether WIC participants actually do purchase whole grain options. Likewise, data on grain intake before and after the 2009 food package changes that will be presented in the phase II report may provide an indication of the degree to which the food packages may have affected intake of healthier options.

ADMINISTRATION OF THE WIC FOOD PACKAGES

At the request of the USDA's Food and Nutrition Service (USDA-FNS), changes to the WIC food packages must not unduly add to the burden of the numerous state and local agencies responsible for WIC program administration. Nor should they unduly add to WIC vendor burden, given

[4] The "healthy food supply" score was a composite of data on availability, variety, quality, and prices of foods, including cow's milk; soy milk; tofu; fresh, canned, and frozen fruit and vegetables; canned sardines and salmon; whole grain bread and tortillas; brown rice; and whole-grain cereals (Andreyeva et al., 2012).

that ease of WIC program administration is closely linked to the ability of WIC-authorized vendors to provide WIC foods (see Figure 2-1). This section summarizes the multileveled complexity of challenges to administering WIC food packages.

The complexity of the challenges with administering the WIC food package is perhaps best illustrated with an example. The 2006 IOM report recommended the inclusion of 1 to 2 pounds of whole wheat or whole grain bread in the food packages for women and children and specified that other whole grain foods, including brown rice, bulgur, oatmeal, barley, and soft corn or whole wheat tortillas, could substitute for whole wheat bread on an equal weight basis. The 1-pound size was recommended by the IOM committee as a way to provide a specific number of additional whole grain servings to better align the food package with the 2005 *Dietary Guidelines for Americans* (DGA). This size was available in the market, but not widely available at the time. The IOM committee did not fully recognize the consequences of this recommendation. USDA implemented the whole grain recommendation in interim and final rules (USDA/FNS, 2007, 2014a), requiring states to offer whole grain bread in a 1-pound loaf and permitting states the option to authorize an equivalent amount of any of the other whole grain options identified in the IOM report. As of 2015, all state agencies reported allowing at least one alternative to whole grain bread, and more than 90 percent offered at least two alternatives (USDA/FNS, 2015b). The diversity of whole grain options available from state to state reflects the different choices made at the state level.

Although a 1-pound-sized loaf of whole grain bread was not widely available in the marketplace when the interim rule was released in 2007, prior to the 2009 implementation of the rule, food manufacturers were able to begin production and distribution of a 1-pound loaf of whole grain bread and meet the demand for the new size (USDA/FNS, 2015a). However, doing so required substantial changes to production. At the vendor level, the rule required changes to purchasing and distributing whole grain bread, as well as the dedication of shelf space and clear labeling of the 1-pound loaf for WIC participants. Similarly, 1-pound packages of soft corn and whole wheat tortillas were not commonly available in 2007, and manufacturers and vendors began producing and distributing tortillas in a 1-pound package size.

At the local agency and participant level, WIC education focused on the new whole grain option in the food package and specified clearly the package size and type of bread (100% whole wheat) that was authorized. Additional education was provided in those states allowing substitutions. Finally, the WIC participant had to find the 1-pound loaf of bread at the store, which was initially challenging as supply was not immediately abundant in 2009. The fact remains that commercially packaged WIC bread is smaller than all other bread and is often difficult to locate in the store.

State-Level Challenges

Administrative Challenges: Package Sizing and the CVV

A key benefit of the 2009 food package changes was the ability for states to tailor the package where state options were allowed (USDA/FNS, 2007). Although this led to some inconsistencies in specific foods available from state to state, it enabled state administrators to make decisions that maximize the suitability of the foods to their regional population and also contain costs. For example, the final rule allowed children ages 12 to 24 months to receive fat-reduced milks if overweight or obesity was a concern (USDA/FNS, 2014a). Seventy-two percent of WIC state agencies adopted this option as of 2015, covering 60 percent of WIC participants (USDA/FNS, 2015b). Thirty percent of WIC state agencies, covering 41 percent of WIC participants, allowed organic forms of some WIC-eligible foods. WIC state agencies have the option to allow organic options for all foods except fruits and vegetables covered under the CVV, for which state agencies must allow organic purchases. Thirty-nine percent of WIC state agencies, covering 15 percent of WIC participants, allow infants to receive a $4 CVV and 64 ounces of jarred infant fruits and vegetables instead of 128 ounces of jarred fruits and vegetables. Eighty-five percent of state agencies provide package tailoring for homeless participants, making this option available to 87.8 percent of WIC participants nationwide (USDA/FNS, 2015b). Tables 2-3 and 2-4 provide data on forms of milk, cheese, peanut butter, beans and peas, whole grains, canned fish, and fruits and vegetables allowed by WIC state agencies, further illustrating the variability in WIC-approved food lists among states.

Although the 2009 changes were well received, two notable administrative challenges were package sizing and the new CVV. The package size challenges around whole grain bread were illustrated above. As another example, to meet the maximum allowance of milk specified in the interim rule, states had to authorize the purchase of a quart size in addition to gallons and half gallons. The quart size of milk is not only less available across both large and small vendors, but often more expensive. The final rule now allows states to substitute yogurt for one quart of milk and cheese for three quarts of milk (USDA/FNS, 2014a), reducing but not eliminating the need to authorize the quart container. Furthermore, manufacturers changed some package sizes between the time of the interim and final rules, with many peanut butters available in the marketplace changing from 18 to 16 ounces

TABLE 2-3 Substitutions Allowed by WIC State Agencies, Fiscal Year 2015

	All WIC State Agencies		
Authorized Forms	Number of Agencies	Percentage of Agencies	Percentage of WIC Participants
	Milk and milk substitutes[a]		
Soy beverages	82	95	99.9
Tofu	54	63	72.7
Nonfat, 1%, and 2% milk	61	71	69.1
Nonfat and 1% milk	22	26	28.8
	Cheese		
Low sodium	22	26	48.3
Fat free	16	19	37.1
Low cholesterol	11	13	18.3
	Peanut butter		
Low sodium	25	29	45.3
Low sugar	17	20	34.4
Reduced fat	17	20	15.6
	Beans and peas[b]		
Canned beans	73	85	84.9
	Whole grains[c]		
Brown rice	83	97	99.8
Tortillas	77	90	99.6
Oats	66	77	85.9
Bulgur and/or barley	22	26	22.8

TABLE 2-3 Continued

	All WIC State Agencies		
Authorized Forms	Number of Agencies	Percentage of Agencies	Percentage of WIC Participants
Whole wheat pasta	25	29	29.7
	Canned fish[d]		
Any tuna	86	100	100
Any salmon	80	93	97.7
Sardines	54	63	45.7
Any mackerel	20	23	6.9

NOTE: Data are from the WIC Food Package Policy Options II study (USDA/FNS, 2015b); responses for the study were received from 86 of 90 state agencies, covering 99.98 percent of WIC participants.

[a] The final rule established 1% and nonfat milk as standard issuance for women and children age 2 and older (a change from the interim rule, which also included 2% milk as standard issuance). The final rule authorizes 2% milk, soy-based beverages, and tofu as substitutions for 1% and nonfat milk based on nutrition assessment and consultation with a health care provider if necessary. The final rule also permitted yogurt as a milk alternative for women and children. However, since this option was not implemented until after data collection for the study from which this table was derived was completed, data on number of state agencies authorizing yogurt are not documented here.

[b] The final rule permits any type of mature dry beans, peas, or lentils in dry or canned forms. All WIC state agencies authorize some form of dry beans and peas; 81 percent of state agencies authorize all varieties of dry beans and peas.

[c] WIC state agencies are required to offer whole wheat or whole grain bread. They also have the option to offer whole grain alternatives.

[d] WIC state agencies are required to offer at least two types of canned fish.

SOURCES: USDA/FNS, 2014a, 2015b.

and some juices from 64 to 59 ounces, requiring states to modify their WIC-approved food lists in these categories (with permission from USDA).

Addition of the CVV marked the first time the WIC food package included a food item with a specified dollar value, meaning states had to decide if participants would be able to use their own funds or SNAP benefits to pay the difference. States were required to offer fresh fruits and vegetables with the CVV and were given the option to include dehydrated, frozen, and canned varieties (with no added sugars, fats, or oils). Implementation required extensive education for participants and vendors alike. Now that implementation is complete nationwide and all states have systems that allow split tender, further use of the CVV is not anticipated to present significant challenges. However, a hypothetical requirement that all states include canned fruit and vegetables has the potential to be challenging for

TABLE 2-4 Forms of Fruits and Vegetables Allowed by WIC State Agencies, Fiscal Year 2015

	All WIC State Agencies		
Authorized Forms	Number of Agencies	Percent of Agencies	Percent of WIC Participants
Fresh	86	100	100
Frozen	70	81	85.5
Canned	51	59	63.4
Dried	5	6	16.5

NOTE: Data are from the WIC Food Package Policy Options II study (USDA/FNS, 2015b); responses for the study were received from 86 of 90 state agencies, covering 99.98 percent of WIC participants.
SOURCE: USDA/FNS, 2015b.

some states, primarily due to the very large number of canned options that would have to be authorized. The October 2015 change to the mother's CVV from $10 to $11 is unlikely to pose an administrative burden, with the exception of food package VII for women who are exclusively breastfeeding twins.[5] These women are prescribed 1.5 times the maximum allowance, which will result in a CVV benefit of $16.50; some state systems do not allow programming of cents and will therefore be required to average the benefit over a 2-month period until their systems can be modified to accommodate cents.

Finally, the final rule's allowance for states to substitute a CVV for fruits and vegetables in lieu of a portion of infant food for the 9–11-month-old infant (USDA/FNS, 2014a) is slow to be implemented. Although some states are moving toward implementation of this option, other states cannot implement it because of the requirement that the substitution be only fresh fruits and vegetables. Limiting the infant CVV to only fresh fruit and vegetables creates a significant burden for participants and local agencies in states whose EBT systems do not readily accommodate the issuance of a fresh-only fruit and vegetable voucher (Personal communication, public comment submitted by Texas WIC, July 30, 2015).

State Management Information Systems and Electronic Benefit Transfer Systems

Some state-level administrative challenges arise from the specifications and limitations of management information systems (MISs) and EBT

[5] Reissued WIC Policy Memorandum 2015-4, Increase in the Cash Value Voucher (CVV) for Pregnant, Postpartum, and Breastfeeding Women.

systems being implemented. Although some states have linked their MIS changes with the adoption of EBT systems, others have elected to update their MIS and adopt EBT in separate steps. There is not a single MIS or EBT system that has been adopted nationwide. While some states are developing their own systems, other states and Indian Tribal Organizations (ITOs) have grouped together to share a common MIS platform (e.g., the Mountain Plains States Consortium) (USDA/FNS, 2013a). The diversity in MIS and EBT systems offers states unique abilities to tailor their systems to meet local needs. However, all systems are required by USDA-FNS to ensure consistent MIS standards and meet basic program administration and reporting requirements (USDA/FNS, 2013b).

All states are required to adopt EBT technology by 2020, and as of this writing, 12 states and four ITOs have completed the transition to EBT. Although there are many benefits to EBT, including improved tracking of issued and redeemed benefits, the challenges to state agencies in the planning and implementation of EBT are not trivial. The EBT system is developed to limit purchases to only those foods authorized by the program, and the linked databases that code "WIC-approved" foods must be updated continually in response to changes in the marketplace. USDA-FNS is in the process of developing a nationally representative Universal Product Code (UPC) database in collaboration with states, which should help to alleviate some of this burden. The effort is anticipated to improve efficiency across the WIC program. WIC benefits are grouped by EBT systems at the household rather than individual level, allowing more flexibility in food acquisition when more than one family member is a WIC participant. However, having more than one family member receiving benefits makes determining individual redemption rates more difficult. The early adopters of EBT systems have worked out a number of these challenges, paving the way for all states to move toward EBT by 2020.

Two methods of WIC EBT are currently in use: (1) offline EBT in which the food benefit data are placed on a "smart card" (a plastic card with an embedded computer chip), and (2) online EBT in which access to the food benefit data occurs through real-time communication between the WIC vendor and the entity maintaining the EBT prescription information. The decision about which method to employ is based on a variety of factors, including each state agency's unique regulations and information systems capacity, technology costs and benefits, and the impact on WIC vendors and participants.

Cost Containment

All states must balance diversity and availability of WIC foods with cost, and cost-containment strategies are often viewed as limiting consumers' choice. One of the WIC program's primary cost-containment practices is negotiating rebate contracts with manufacturers of infant formula. These rebates have contributed to significant savings and enabled WIC to serve a larger number of participants, but at the same time these rebates may limit the ability of the WIC program to protect, promote, and support breastfeeding (see Chapter 7). Additional cost-containment practices include limiting authorized vendors to stores with lower food prices and limiting approved brands, package sizes, forms, or prices (e.g., least expensive brand requirements).

Local Agency Challenges

At the local agency and participant level, education plays a role in the successful implementation of the WIC food package. Although local agency staff members typically do not have authority to make decisions about the foods that will be authorized, they are instrumental in providing participant-centered one-on-one and group education and nutrition counseling. This education and counseling is designed to both maximize participant understanding of what can be purchased with their WIC benefit and how to organize purchases at the vendor (e.g., separate their WIC foods from other foods they are purchasing), as well as how to provide and prepare WIC foods for the family in alignment with the DGA.

The introduction of new foods in the food package is facilitated at the local agency level by staff training and participant education prior to the changes. As an example, for the 2009 food package change, the California WIC program started a statewide campaign for staff training 9 months prior to the October 1 changes. Statewide participant education began 6 months prior to the changes. Together, these efforts eased the transition to the new food packages, which took effect all at one time (Ritchie et al., 2010, 2014). With release of the final rule in 2014, additional changes to the food packages have been implemented incrementally, which may have been more challenging. For example, all states were required to offer only skim and 1% milk to all women and children ages 2 and older by September 29, 2014 (most states allowed 2 percent milk prior to this date), and all states were allowed to offer yogurt, but few were able to implement both changes at the same time because of the approval processes required to add yogurt.

Vendor Challenges

Ensuring the Availability of WIC-Approved Foods

To become an authorized WIC vendor, individual stores must meet certain criteria established by the state agency, which may include minimum stocking requirements, geographic need, and history of compliance. After receiving approval from the state agency and participating in required training, the vendor may enter into a vendor agreement with the state agency, consenting to comply with the agency's rules and regulations (USDA/FNS, 2013c).

The 2007 WIC food package redesign challenged food vendors to supply some new food items and provide some existing items in unprecedented quantities, affecting the demand for food items and, in some cases, requiring vendors to change their supply systems. For example, authorized vendors are required by USDA to stock at least two different fruits and two different vegetables, but minimum stocking requirements vary from state to state. California requires vendors to stock at least five different fruits and five different vegetables, while other states require only the federal minimum (USDA/FNS, 2014b).

Vendors appeared to face some challenges when adapting to the 2009 revisions in WIC-eligible foods. Managers of small stores reported that they had difficulty in finding suppliers for some items (e.g., a 1-pound loaf of bread, fresh fruit, and low-fat milk), as demand was perceived to be low for healthier food items among the general population (Andreyeva et al., 2011; Gittelsohn et al., 2012). Gleason et al. (2014) reported that vendors serving American Indian communities found it difficult to anticipate demand and therefore maintain the supply of some WIC foods. Vendors have also reported issues with delivery of spoiled items (Gleason et al., 2014) and maintaining freshness (Gleason et al., 2011).

The 2009 WIC Food Package Changes and Vendor Sales

Despite challenges to ensuring WIC foods were available, most evidence suggests that the food package revisions were beneficial for vendors. They increased both sales and profitability for the items offered in the revised food package (Andreyeva et al., 2011) and sales of newly eligible food items to non-WIC customers (Gittelsohn et al., 2012). Increased demand, without a compensating change in supply, is frequently associated with an increase in price. Some vendors reported difficulty finding and maintaining suppliers for some foods. However, available evidence finds that prices did not increase for those items, suggesting that vendors adjusted their supply quantities without incurring increased costs (Zenk et al., 2014).

The revised food packages were designed to be cost neutral to WIC (not more than 10 percent above or below the current level of funding), and while sales apparently increased from WIC foods for some items (reduced-fat milk, whole grains, fruit and vegetables), sales likely decreased for others (whole milk, juice) (Andreyeva and Luedicke, 2013; Andreyeva et al., 2013, 2014).

The Electronic Benefit Transfer System

The Altarum study described earlier in this chapter (Phillips et al., 2014) reported that EBT implementation both improved the ability of vendors to track inventory and stabilized inventory because participants were able to make purchases throughout the month instead of during a single visit. Plus, vendor reimbursement occurred more quickly. Vendors also reported improved checkout experiences for participants. However, challenges remain. Maintenance of the UPC database is challenged by ever-changing package sizes and price changes. Vendors surveyed in Phillips et al. (2014) also mentioned the additional staff training needed during the transition to EBT.

Vendor Approaches to Offering WIC-Approved Foods

Shelf space is an important and limited asset for food retailers. Indeed, retailers often charge fees to suppliers for shelf space ("slotting allowances") (FTC, 2003). Demand for foods in the WIC package affects how retail vendors allocate their shelf space. When WIC agencies require participants to purchase an item in a size or a style that is different from the size or the style that is predominantly purchased by non-WIC customers, retail vendors have been challenged to offer that item (see, e.g., Gittelsohn, 2012). Saitone et al. (USDA/ERS, 2014) found that smaller vendors, because of their typically higher operating and procurement costs, are more likely to charge higher prices for WIC products than larger vendors do. They also found, however, that small vendors comprise only a small percentage of total WIC redemptions. In a study in Texas, fruits and milk (two key WIC foods) were both significantly more expensive (approximately 27 cents more) per pound in rural than urban areas (Tisone et al., 2014).

The Case of "WIC-Only" Vendors

As mentioned earlier in this chapter, the majority (52 percent) of WIC households report using supercenter-type stores as their primary food shopping store (USDA/ERS, 2015a) (see Table 2-2). Research also suggests that low-income households in general are more likely to economize in their food shopping practices by purchasing more private-label products and buying in larger volumes (Leibtag and Kaufman, 2003). In the late 1990s and early 2000s, a new store type evolved that catered to WIC households. These "WIC-only" stores offered only WIC-approved foods and were usually located in the vicinity of WIC offices. Because these stores catered only to WIC participants, they were unconcerned about sales to non-WIC participants. Studies at the time showed that prices for some items at WIC-only stores were 13 to 16 percent higher than similar items at other stores (Neuberger and Greenstein, 2004). Since then, USDA has implemented procedures to limit the ability of WIC-only stores to price WIC items higher than retailers that sell both WIC and non-WIC foods.[6] There are few peer-reviewed papers that examine pricing at WIC-only stores, but McLaughlin et al. (2013) showed in a conference paper that WIC-only stores have an incentive to set prices at the maximum level allowed by USDA regulations. Saitone et al. (USDA/ERS, 2014) found that A-50 vendors (WIC-only stores fall in this category of vendor) in California redeemed food packages at the maximum allowable level 81 to 94 percent of the time. The "WIC-only" experience highlights the importance of competitive pricing to contain costs to the WIC program. The pressure on retail food stores to keep prices low to attract sales from non-WIC customers is a powerful incentive that keeps prices low for WIC items (Neuberger and Greenstein, 2004). If that pressure is missing, then prices are likely to rise.

Manufacturer Challenges

Like WIC vendors, manufacturers of WIC foods play a central role in the WIC participant experience (see Figure 2-1). A common perception is that food manufacturers will therefore respond to changes in the WIC foods or food package to meet the needs of this population. As mentioned previously, manufacturers were able to begin production and distribution of the 1-pound loaf of bread before 2009 implementation of interim rule (USDA/ERS, 2015b), but doing so required substantial changes to production. Even though a 1-pound loaf provides fewer servings than the more common 24-ounce loaf of bread, it is usually sold at the same or a higher price. As per the 2014 final rule, whole wheat pasta at a 1-pound size is permitted as a substitute for whole wheat bread. However, 87 percent of whole wheat pasta is sold in 12 and 13.5 ounce sizes. The Pasta Manufacturers Association conducted a cost analysis and determined that moving from the smaller to a 1-pound size would cost the two primary pasta manufacturers approximately $5 million per year, concluding that the change was economically infeasible (National Pasta Association, 2015).

[6] USDA groups vendors into peer groups and establishes maximum allowable redemption rates (MARRs) for WIC food packages for each peer group. In effect, MARRs serve as price ceilings. WIC-only stores are designated as A-50 vendors, vendors that have 50 percent or more of their food sales coming from WIC sales (USDA/ERS, 2014).

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3

Approach to the Task

For this interim report, the committee was tasked with collecting the information and data needed to support recommendations for potential modifications to the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) food packages. These recommendations will appear in the final, phase II report. In this section, the committee's approach to information collection and data analysis is reviewed. The approach included

- Convening public workshops;
- Conducting literature searches;
- Analyzing food and nutrient intakes and diet quality of WIC and WIC-eligible (low-income and for women, also pregnant, breast-feeding, or postpartum) populations;
- Developing an approach to WIC food package food, nutrient, and cost profiles;
- Conducting a food expenditure analysis;
- Developing approaches to sensitivity and regulatory impact analyses to be conducted during phase II;
- Visiting WIC sites and shopping for WIC foods; and
- Reviewing public comments.

WORKSHOPS

For phase I of this review, two public workshops were held. The first, held on October 15, 2014, specifically supported the information-gathering process for the first report of this three-report series, *Review of WIC Food Packages: An Evaluation of White Potatoes in the Cash Value Voucher: Letter Report* (IOM, 2015). The agenda for this workshop is available in Appendix H. The second workshop, "Methods and Approaches to the Assessment of WIC Food Packages," was held in Washington, DC, on March 12, 2015, and included a public comment session on March 13, 2015. The agenda for this workshop is available in Appendix H. Presentations from both events are available on the Institute of Medicine (IOM) Web page for this study.[1] A public comment session was also held in Irvine, California, on June 26, 2015. Two additional workshops will be held in phase II to focus specifically on topics that relate to the development of the final report and its recommendations.

LITERATURE AND REPORT REVIEW

Comprehensive Literature Reviews

The committee was tasked with conducting a comprehensive literature review[2] to gather evidence to support its final recommendations. The first step was development of a draft of key research questions based on the statement of task (see Chapter 1, Box 1-1), the literature review questions developed for the letter report (IOM, 2015), and other topics outlined by the U.S. Department of Agriculture's Food and Nutrition Service (USDA-FNS) for committee consideration. In collaboration with IOM staff and committee consultants, committee members refined the key questions, as well as the literature search strategy, study eligibility criteria, and the synthesis of search results, using an iterative process.

The key questions were organized by topic area:

1. Nutritional status of WIC populations;
2. Health status of WIC populations;
3. Breastfeeding promotion;
4. The role of WIC food packages in preventing food insecurity;
5. Racial or ethnic differences in infant/child feeding practices and personal food intake patterns;
6. Market availability of current WIC foods;
7. Administrative feasibility and efficiency for vendors; and

[1] Study details can be accessed at the following Web page: http://iom.nationalacademies.org/Activities/Nutrition/ReviewWICFoodPackages.aspx.

[2] Time and resources were inadequate to carry out a full systematic review. Specifically, the last two steps of a systematic review process were not completed: (1) risk of bias evaluation and (2) evidence synthesis (which includes evaluation of the strength of the evidence).

8. Barriers and incentives for WIC participants, potential participants, and their families.

Literature Search Strategy

Electronic literature searches of studies indexed in MEDLINE, PubMed, Agricola, CINAHL (Cumulative Index to Nursing and Allied Health Literature), ERIC (Educational Resources Information Center), PsychINFO, and Scopus (including Embase) were conducted. First, a broad search was conducted to identify all studies including WIC programs or WIC populations without restrictions to any outcome or study design. Searches were conducted using the National Library of Medicine's Medical Subject Headings (MeSH) keyword nomenclature. All relevant studies with human subjects that were published in the English language from 2005 onward were identified. Duplicate citations across databases were removed before screening. Separate search strategies were developed to identify studies conducted among low-income populations living in the United States. The MEDLINE database was searched using a combination of search terms relating to Medicaid, poverty, and low income, plus search terms relating to firstly, culture or race/ethnicity and diet or feeding behavior or, secondly, food access or accessibility, food environment, food costs, store, and vendor. Furthermore, another Medline search strategy was developed for identifying interventional breastfeeding studies conducted among low-income populations living in the United States using the combinations of the low-income search with additional MeSH terms for culture and continental population groups and a broad search for breastfeeding, infant nutrition, and human milk. The full search strategy is described in Appendix I, Table I-2. The search was repeated before report completion to identify newly published papers.

Study Selection

Abstrackr software (abstrackr.cebm.brown.edu), EndNote, and Microsoft Excel were used to manage the search outputs, screening, and data abstraction. After a training session to ensure understanding of the inclusion and exclusion criteria, title/abstract screening was conducted in duplicate using a screening form that listed the inclusion and exclusion criteria and allowed selection of reasons for exclusion. A third reviewer reconciled the discrepant title/abstract selections. Full-text articles of all accepted title/abstracts were then retrieved and screened by one reviewer based on the study eligibility criteria. Second-level screening of full text articles was conducted by two reviewers and differences reconciled by a third reviewer. The literature search and study selection flow and study eligibility criteria for each key question are both described in Appendix I (Figure I-1 and Table I-1, respectively).

Challenges with Evaluating WIC-Specific Data

Since its creation, it has been difficult to evaluate the effect of WIC participation on any outcome with a study design that is suitable for causal inference. Only limited experimental options are available (e.g., random assignment of a WIC service area to delayed start of a new benefit) because random assignment of individuals to receive or not receive WIC benefits is not considered ethical. In the 1980s, Rush and his colleagues used studies of several different designs (e.g., historical, longitudinal cohort, and cross-sectional), each with different weaknesses, to provide a comprehensive assessment of the WIC program (Rush et al., 1988a,b,c,d). Such a large and comprehensive study has not been repeated. As a result, nearly all studies reviewed for this report compare WIC participants to a group of nonparticipants or use a pre-post design (relative to a change in the food package). These study designs are not sufficient for causal inference. Kreider et al. (2016) used nonparametric partial identification methods to jointly account for selection and measurement problems and evaluate the causal impacts of WIC on food insecurity in children, using the National Health and Nutrition Examination Survey (NHANES) data. Their methods offer an alternative approach and bound the average treatment effects of WIC on observed outcomes.

A challenge to analyzing WIC-specific data is a phenomenon known as selection bias, which occurs when individuals who choose to participate in a program are different from eligible individuals who choose not to participate. These differences can be either observable or unobservable. With many social assistance programs, participants are likely to be negatively selected, that is, less well off, for example with less education or less wage income (compared to nonparticipants). This leads to results that make it appear that the program is not as effective as it really is. Conversely, participants may be positively selected for unobserved or unobservable characteristics, such as motivation or the eagerness to keep their children healthy (Besharov and Germanis, 2001). This leads to results that are biased upward that make it appear that a program, such as WIC, has more positive effects than it really does. For WIC specifically, positively biased effects could also result from longer-lasting pregnancies, with longer pregnancies increasing the chances that WIC-eligible women will enter the program, and also giving them a longer time period over which to benefit from the program.[3]

Using 1992–1999 data from the Center for Disease Control and Prevention's (CDC's) Pregnancy Risk Assessment Monitoring System, Bitler and Currie (2005) conducted a survey of mothers at 6 months postpartum and found that WIC participating women were negatively selected for several observable characteristics compared to WIC-eligible, nonparticipating women whose birth was paid for by Medicaid. Specifically, they found that WIC participants were less educated, less likely to be married, more likely to be of minority race, more likely to be teen mothers, less likely to report the father's information on the birth certificate, more likely to be obese, more likely to use public assistance and less likely to have wage income in the past year, and more likely to have had a previous low birth weight or premature infant if not a first-time mother. More recently, in a study of birth records from New York City, Currie and Rajani (2015) examined women who were pregnant more than once but who chose to participate in WIC only for one birth. They found that WIC pregnancies were more likely when women were younger, unemployed, unmarried, or had experienced a bad previous birth outcome. When there is negative selection on observable factors, as shown in these two studies, it seems likely that there is also negative selection on at least some unobservable factors (e.g., the woman's propensity to have negative birth outcomes outside of any conditions that can be measured by the researcher) as well. There is little reason to expect that there is solely an upward bias in the reported program effects because of the likely cumulative effect of negative selection on these factors (Altoni et al., 2005, 2008).

Evaluation of WIC participant outcomes before and after the 2009 adoption of the new food package is complicated by the fact that adoption of the new package took place at the tail end of a recession and at a time when families were facing the worst labor market since the deep recession of the early 1980s. The American Recovery and Reinvestment Act of 2009 provided the funds necessary to increase the maximum benefit level of Supplemental Nutrition Assistance Program (SNAP) of about 15 percent (EOPUS, 2014). Inasmuch as the SNAP recipients are automatically eligible for WIC, many WIC participants also receive SNAP benefits. Among those

[3] One important possible source of bias that is prominent in the recent WIC literature is gestational age bias. For example, suppose two women are similar on every dimension but for idiosyncratic reasons, one gives birth at 7.5 months and the other at 9 months. The woman with the premature birth would have enrolled in WIC at 8 months had her pregnancy lasted to 8 months, and the second woman does enroll at 8 months. A comparison of prenatal WIC use and gestation would lead to the mistaken conclusion that WIC participation caused longer gestation.

who were receiving both benefits, food expenditures and consumption may have changed because SNAP increased the maximum benefit level.

Identification of Relevant Reports

In addition to the literature search described above, relevant IOM reports and government reports related to the task, also published since 2005, were identified and evaluated. The USDA Economic Research Service (ERS), FNS, and Agricultural Research Service (ARS) websites were searched for reports relevant to WIC and other topics identified as relevant by the key questions.

Additional Literature Searches

Additional literature searches were conducted to address specific chapter topics, for example, to identify information to support a review of relevant nutrition-related health risks in Chapter 6, to understand food allergies, and other food intolerances, and to understand the health effects of fruit juice or high-fat dairy in Chapter 9, as examples.

Special Task: Approach to Identifying Literature on Functional Ingredients

The committee was asked to consider the current science on functional ingredients added to foods for adults, children, and infants, particularly infant formula (see Chapter 9 for a review of infant formula developments since the 2006 review of food packages). This information will be used in phase II to consider how USDA-FNS might approach the inclusion of foods containing these ingredients in the WIC food packages. A unique search was conducted to address this task. The functional ingredients investigated were those currently added to infant formula, because this is the item in the WIC food packages of primary interest to USDA-FNS with respect to these ingredients. The literature search used common names for ingredients, along with expanded variations. Health effects of these ingredients relevant to the WIC population (women, infants, and children) were considered.

From an initial broad literature search, the committee narrowed the evidence base to three sources of information on health effects: (1) statements from authoritative bodies on nutrition and health (e.g., American Academy of Pediatrics [AAP], Academy of Nutrition and Dietetics [AND], American Heart Association [AHA], Agency for Healthcare Research and Quality [AHRQ]); (2) U.S. Food and Drug Administration [FDA] qualified health claims; and (3) Cochrane Reviews. Search results were retained only if they related to dietary and/or supplemental sources of a functional ingredient. Evidence related to enteral or parenteral administration was excluded, as were outcomes not anticipated to affect a large portion of the WIC population (e.g., gout) as well as outcomes not anticipated to be affected by the short-term, supplemental nature of the WIC food packages (e.g., cardiovascular disease).

NUTRIENT AND FOOD INTAKE: EVALUATING ADEQUACY

The committee was tasked with estimating nutrient intake and intake adequacy in the WIC population based on recommended Dietary Reference Intakes (DRIs) and comparing food intakes to those recommended in the 2015 *Dietary Guidelines for Americans* (DGA), bearing in mind that the purpose of WIC is to provide supplemental food to correct for nutritional intake inadequacies. This section describes the methods used to assess the prevalence of inadequate and excess nutrient intake in the WIC subpopulations and, for this phase I report, compare food intakes to the recommended food patterns in the *Scientific Report of the 2015 Dietary Guidelines Advisory Committee* (2015 DGAC report) (for the phase II report, they will be compared to the 2015 DGA).

Dietary Reference Intakes for Micronutrients

The different types of DRI standards for nutrients are described in Box 3-1. For the past two decades, IOM committees have been developing and releasing nutrient intake recommendations to update the DRIs (see Appendix J, Tables J-1a through 1c (IOM, 1997, 1998, 2000a, 2001, 2002/2005, 2005, 2011a). The most recently updated DRIs were for calcium and vitamin D (IOM, 2011a). Wherever possible, the IOM DRI reports present a review of the available science base for quantitative recommendations and the amount of each nutrient needed to meet the nutritional requirements to maintain health in apparently healthy individuals, grouped by age and sex, in the United States and Canada. For this report, the Estimated Average Requirement (EAR) and Tolerable Upper Intake Level (UL) were applied to assess the nutrient intakes of the various WIC population subgroups; the Adequate Intake (AI) value was applied in cases where an EAR has not yet been determined. The EAR is appropriate for population or group-level evaluations of nutrient adequacy. Mean intakes at or above the AI imply a low prevalence of inadequacy in the group (IOM, 2000b).

BOX 3-1

Dietary Reference Intakes

The Dietary Reference Intakes (DRIs) were developed to serve as standards for nutrient intake and include

Estimated Average Requirement (EAR): An average daily nutrient intake value that is predicted to meet the requirement of half of healthy individuals in a specified age range. The requirement is based on a specific indicator of adequacy.

Recommended Dietary Allowance (RDA): An average daily nutrient intake level that is sufficient to meet the nutrient requirements of 97 to 98 percent of healthy individuals in the specified life stage and gender group. If the requirements in a specified group are normally distributed, the RDA is equivalent to the EAR plus two standard deviations.

Adequate Intake (AI): In the case that the available evidence is not adequate to determine the EAR for a nutrient, an AI is set. The AI is the recommended average daily nutrient intake value based on experimentally derived intake levels or approximations of mean nutrient intakes by a group of apparently healthy people who are maintaining a defined criterion of adequacy. It is not certain where an AI level of intake fits relative to an actual nutrient requirement, as no EAR or RDA have been specified for these nutrients. It is generally believed that the AI would be equal to or exceed "RDA levels" (if there were an RDA).

Acceptable Macronutrient Distribution Range (AMDR): A range of intakes for a particular energy source that is associated with reduced risk of chronic disease while providing adequate intakes of essential nutrients. An AMDR is expressed as a percentage of total energy intake.

Tolerable Upper Intake Level (UL): The highest average daily nutrient intake level that is likely to pose no risk of adverse effects to nearly all individuals in the specified life stage and gender group.

These reference points are identical to those applied in the previous review of WIC food packages (IOM, 2006). These can be applied to population-level nutrient intake assessments, with the exception of the RDA which is intended for assessment of individuals.

SOURCES: IOM, 2000b, 2002/2005.

Dietary Reference Intakes for Macronutrients and Energy

DRIs for Macronutrients

Macronutrients include carbohydrate, protein, and fat. These nutrients have associated DRIs known as the Acceptable Macronutrient Distribution Ranges (AMDRs) (for children and adults only), and may also have an EAR or AI value. For protein, an EAR has been established for individuals 6 months of age and older (see Appendix J, Table J-1c), but only an AI for infants younger than 6 months. Protein intakes are assessed using these values. For carbohydrate and total fat, intakes of women and children are compared to the AMDR, but intakes of infants are compared to the AI.

Although the IOM (2002/2005) report recommended limiting the amounts of saturated fat and cholesterol for all individuals more than 2 years of age, analyses of these macronutrients in this report are based on updated recommendations in the 2015 DGAC report (USDA/HHS, 2015). The latter report indicates limits for saturated fat, and does not specify a limit for cholesterol intake. Cholesterol intake was therefore not evaluated in this report.

Estimated Energy Expenditure

Comparing food group intakes to those recommended in the 2015 DGAC report required calculating Estimated Energy Requirements (EERs) for the various WIC subgroups. A 2002 IOM committee developed equations to derive EERs that balance total energy expenditure at a level of physical activity consistent with health and support growth rates in children that are compatible with a healthy body size and composition (IOM, 2002/2005). In children, the EER was calculated based on an individual's age, body weight, height, and activity level. For adults, the EER was calculated based on age, gender, body weight, height, and physical activity level. The EER calculations applied in this report assumed a low-active physical activity level (PAL) for women and children 2 to 5 years of age. The EER for pregnant and breastfeeding women also includes energy needs associated with the deposition of tissue or the secretion of milk. This committee used these equations. For pregnant women, the second trimester of pregnancy was assumed to cover all stages of pregnancy because a woman's specific stage of pregnancy at the time her intake was assessed is not recorded in NHANES. For breastfeeding women, the EER assumed the first 6 months postpartum. Recent research suggested that the IOM (2002/2005) formula may overestimate energy needs for children (Butte et al., 2014), although this finding is yet to be validated broadly. Interpretations of data in this report were considered in light of these recent findings.

Recommended Limits for Other Dietary Components

The 2015 DGAC report recommended limiting intake of added sugars to not more than 10 percent of total energy intake. In July 2015, the FDA issued a proposed rule for the inclusion of percentage of calories from added sugars on the Nutrition Facts label (FDA, 2015), indicating that regulatory action is underway to support limits on added sugars intake. For sodium, the 2015 DGAC panel set an upper limit of 2,300 mg per day (in agreement with the established IOM UL) for adults, and a goal of less than the established DRI (UL) for other age groups (USDA/HHS, 2015). For children age 1 to 3 years, this is 1,500 mg per day and for children 4 to 8 years, this is 1,900 mg per day (IOM, 2005).

Using the DRIs to Assess Nutrient Adequacy

The committee used the DRIs to assess nutrient adequacy, which involved examining both inadequate and excessive intakes of nutrients. The methods applied in this report are the same as those used in IOM (2006) and originally designed by Nusser et al. (1996) and Carriquiry (1999) (see Appendix C of IOM [2006]). Brief descriptions of the approaches are provided here, with modifications noted as appropriate. Nutrients analyzed for this report are listed in Appendix J, Table J-2.

Estimating Usual Intake Distributions

Assessing nutrient adequacy involves, first, estimating usual distributions of intake. The Iowa State University (ISU) method proposed by Nusser et al. (1996) and applied in the IOM (2006) report for determining usual intake distributions is generally accepted in the nutrition community, and several software packages are now available to generate the mean and variance of usual intake as well as percentiles of intake of the user's choosing. For this report, PC Software for Intake Distribution (PC-SIDE) was used to implement the ISU method (nutrients). To estimate the distribution of dietary components consumed episodically (food groups and subgroups), the Statistical Program for Age-adjusted Dietary Assessment (SPADE), a method similar to the National Cancer Institute method was implemented (Dekkers et al., 2014). These software packages are specifically designed for estimating the usual intake distributions of populations, and are not appropriate for application to individuals (IOM, 2000b).

Assessing the Prevalence of Inadequate Nutrient Intake with EARs

In all of the statistical analyses, intake data were weighted to population values by using survey weights associated with survey participants. Fractional jackknife replicate weights (Fuller, 2009) were used to estimate standard errors of estimated percentiles. Usual nutrient intake distributions were estimated using methods that account for the statistical properties of the data (intra-individual variation and reported data that are not normally distributed [Nusser et al., 1996; IOM, 2000b]). Beaton (1994) and Carriquiry (1999) suggested that the prevalence of inadequate intakes in the group can be estimated by the proportion of persons in the group whose usual intakes do not reach the EAR for the nutrient. This approach is known as the EAR cut-point method.

A difficulty arises when one wishes to estimate prevalence of inadequacy in a group that includes persons from groups that have different EARs. If the sample size is too small to carry out separate analyses for each group, it is possible to proceed as proposed by IOM (2000b). This approach for estimating prevalence of inadequacy when combining population subgroups with different EARs consists of rescaling daily intakes for one of the population subgroups so they can be compared to the EAR of the other group (a similar re-scaling was used in IOM, 2006). This approach was applied to two of the population subgroups of interest in this work: children aged 2 to less than 5 years, and women aged 19 to 50 years of age. Neither of these two groups aligns with the DRI gender and age groups; this is particularly true for women. As a result of low sample sizes, pregnant, breastfeeding, and postpartum (not breastfeeding) women were grouped into single analytic samples by WIC participation and income status. The resulting prevalences of inadequacy must be interpreted carefully when the EARs for the groups that are being combined are very different. For example, the EAR for iron for pregnant women is approximately three-fold that for lactating (breastfeeding) women 19 to 30 years of age.[4] Thus, the overall prevalence of iron inadequacy for the combined group may conceal a relatively high prevalence among pregnant women and a much lower prevalence among lactating women. For iron specifically, another caveat is that requirements are not normally distributed for women, mostly because of menstrual losses of iron. As a result, the EAR cut-point method cannot be used to estimate the prevalence of inadequacy of iron. Inasmuch as most of the women in the analytical sample were either pregnant or breastfeeding and the sample size was small, the EAR cut-point method was nonetheless implemented. These limitations were considered when interpreting the data.

In addition to analyzing nutrients in reference to EARs, means and usual

[4] The EARs for iron during pregnancy and lactation are 22 and 6.5 mg per day, respectively.

intake distributions were also determined for nutrients with AIs (IOM, 2006). Interpretation of intake differs for nutrients with AIs in that only limited inferences can be made about the prevalence of nutrient inadequacy. If a mean intake level is equal to or exceeds the AI, it is likely that the prevalence of inadequacy is low, but no *conclusion* can be drawn about the prevalence of inadequacy for a mean intake level that falls below the AI (IOM, 2000b). For this reason, in this report the prevalence of inadequacy was not evaluated for nutrients with AIs.

Note that only AIs are available for infants 0 to less than 6 months of age, therefore the prevalence of inadequacy of any nutrient could not be calculated for this age group.

Assessing the Prevalence of Excessive Intakes

Excessive intakes of micronutrients were assessed by comparing observed nutrient intake to the UL for that nutrient, as described in IOM (2006). Not all nutrients have ULs and, for some nutrients, the UL is based on intake of supplements that were not evaluated for this report. In this report, the probability of exceeding the UL was determined only for retinol, vitamins C and B6, calcium, iron, phosphorous, zinc, copper, and selenium. Inasmuch as there is no evidence of adverse effects from the consumption of folate, vitamin E, niacin, and magnesium naturally occurring in food, the ULs for these four nutrients are set in reference to intake from supplements, fortificants, or pharmacological agents only (IOM, 1997, 1998, 2000a). Therefore, intake relative to the UL was not evaluated for folate, vitamin E, niacin, and magnesium. Excess zinc intake was not considered of concern for formula-fed infants or children 1 to less than 2 years because the method used to set the UL resulted in a narrow margin between the Recommended Daily Allowance (RDA) and the UL (IOM, 2001). For other age groups, there exists no evidence for adverse effects from zinc naturally occurring in food (IOM, 2001), and the committee considers infant formula (and zinc provided therein) to be tightly regulated for safety by the FDA. Excess retinol intake was not considered of concern because of a similarly narrow margin between the UL and the RDA (IOM, 2001). Toxicity from excess consumption of retinol rarely occurs without supplemental intake (IOM, 2001).

Special Case: Vitamin D

Both dietary intake and sun exposure contribute to an individual's vitamin D status. It is generally agreed that dietary intake of vitamin D is of limited value in the evaluation of vitamin D adequacy because the relationship between the two is nonlinear (IOM, 2011a). Further, the current USDA Food and Nutrient Composition Database does not separate vitamin D from 25-hydroxyvitamin D (25(OH)D) in foods. This results in an underestimate of the bioequivalent vitamin D in foods because 25(OH)D is four to five times more bioequivalent than is the parent form of vitamin D (Cashman, 2012; Cashman et al., 2012).

In contrast, serum 25(OH)D captures both total dietary intake of parent vitamin D and 25(OH)D and sun exposure and has been validated as a biomarker for assessing vitamin D adequacy (IOM, 2011a; Taylor et al., 2013). Data on adults aged 19–70 years from NHANES 2005–2006 indicate that approximately 71 percent of the U.S. population consumes less than the EAR for dietary vitamin D, but the prevalence of inadequacy assessed by 25(OH)D is only about 19 percent (Taylor et al., 2013). Food package content of vitamin D will be determined in phase II, primarily to serve as a reference point for food package changes (i.e., if, during phase II, the committee determines that foods containing vitamin D should be added to the WIC packages, the potential difference from baseline dietary intake can be estimated). Only vitamin D intake data are presented only for infants 0 to less than 12 months of age in this report because serum 25(OH)D data are not available for this group. Data on serum 25(OH)D were available for individuals ages 1 year and older for NHANES survey years 2005–2006 (see the next section in this chapter for a description of the NHANES survey).

Assessing the Prevalence of Inadequate and Excessive Consumption of Macronutrients

As noted above, for macronutrients, protein intakes were compared to recommended intakes in g/kg/d but, for carbohydrates and fats in most age subgroups, the proportions above and below the AMDR were estimated. AMDRs are expressed in terms of percentage of total calories contributed by the macronutrients. Carbohydrate intakes below the AMDR are not considered of concern given lack of evidence for harm. Because the 2015 DGAC report emphasized saturated and not total fat (USDA/HHS, 2015), intakes of total fat exceeding the AMDR were likewise not considered to be of concern.

Comparing Food Intakes to Dietary Guidelines

The DRIs serve as the basis for nutrient targets in the DGAs. Recommended food patterns developed as part of the DGA consider nutrient requirements (as specified by the DRIs) as the foundation, in combination with usual dietary intake patterns of Americans (see Appendix E-3.1 of USDA/HHS, 2015). The committee was tasked with evaluating nutrient and food intake of the WIC-eligible population in comparison to both the DRIs and the DGA. The DGA cover only individuals ages 2 years and older, therefore, a review of authoritative guidance other than the DGA was conducted for individuals less than 2 years of age.

Dietary Guidance for Individuals Ages 2 Years and Older

The food patterns indicative of a healthy diet are developed by the USDA every 5 years and released as new DGA. For this report, the committee applied the recommendations and food patterns outlined in the 2015 DGAC report (USDA/HHS, 2015), which provides the scientific underpinnings for development of the 2015 DGA (anticipated for release in early 2016). For the phase II report, the 2015 DGA will serve as the basis for recommendations, superseding use of the 2015 DGAC report.

Table 1-5 in Chapter 1 illustrates the food patterns recommended in the 2015 DGAC report for various energy intake levels. To evaluate the diets of all children 1 to less than 5 years of age, the committee applied a weighted food pattern (a 1,000 kcal pattern weighted 1:3 with the average of 1,200- and 1,400-kcal patterns [IOM, 2011b], referenced herein as the "1,000–1,300 kcal weighted diet"). This approach generated a single food pattern that could be applied across all children, simplifying the analysis.[5] For all WIC women, a 2,200-kcal pattern was applied, which was the mean calculated EER among WIC women in the NHANES analyses conducted for this report.

Also as described in Chapter 1 (see Table 1-6), the 2015 DGAC report identified the following shortfall nutrients: vitamins A, D, E, and C; folate; calcium; magnesium; fiber; potassium; and iron for adolescent and premenopausal women. The 2015 DGAC report further identified a subset of these (vitamin D, calcium, potassium, and fiber, as well as iron for adolescent and premenopausal women) as nutrients of public health concern because they are linked to specific adverse health outcomes (USDA/HHS, 2015). The committee paid particular attention to the adequacy of intake of these nutrients.

Dietary Guidance for Infants and Children, 0 to 24 Months of Age

The DGA do not provide dietary guidance for individuals from birth to 24 months of age, although the possibility of expanding the DGA to include these individuals is currently being explored (Raiten et al., 2014). In this report, the adequacy of food intakes of infants and children 1 to less than 2 years of age could not be evaluated using a dietary pattern due to small

[5] Ultimately, the sample sizes were too low for children 1 to less than 2 years of age to generate adequately precise data for "% below recommendations" and only means are presented in Chapter 5.

sample sizes, but rather, mean intakes were compared across subgroups and to other nationally representative data. The committee searched and compiled dietary guidance information for these age groups from AAP, AND, the World Health Organization (WHO), and other sources. This guidance is presented in detail in Table 3-1.

TABLE 3-1 Dietary Guidance for Infants and Children Less Than 2 Years of Age

Feeding Mode	Reference
Breastfeeding	
Exclusive breastfeeding for about 6 months, followed by continued breastfeeding as complementary foods are introduced, with continuation of breastfeeding for 1 year or longer as mutually desired by mother and infant.[a]	WHO, 2009; IOM, 2011c; AAP, 2014; AND, 2015
At 4 months of age exclusively breastfed infants should be supplemented with iron.	AAP, 2010
All breastfed infants should receive an oral supplement of vitamin D, 400 IU per day, beginning at hospital discharge.	AAP, 2012
For breastfeeding women, 1–2 servings of "ocean-going" fish per week is recommended to achieve an intake of 200–300 mg of omega-3 long-chain fatty acids. [b]	AAP, 2014
Formula Feeding	
For infants who are not breastfeeding, iron-fortified formula is the recommended alternative for feeding the baby during the first year of life.	AAP, 2014
Supplementary fluoride should not be provided to formula-fed infants during the first 6 months of life. After 6 months of age, the need for fluoride supplementation depends upon the fluoride concentration of water used to prepare formula.	AAP, 2014
There are a limited number of medical conditions in which breastfeeding is contraindicated. Therapeutic (non-contract) formula should be made available through physician prescription for specific medical conditions.	AAP, 2012, 2014
Complementary Feeding	
Complementary foods should be gradually introduced to infants after 6 months of life.	AAP, 2014

continued

TABLE 3-1 Continued

Feeding Mode	Reference
Complementary food rich in iron and zinc (fortified cereals and meats) should be introduced to exclusively breastfed infants at about 6 months of age depending on developmental readiness. Recommended amounts are 2 servings/d of cereal (1–2 tablespoons/serving) or 1–2 ounces of meat/d or 1–2 small jars of commercially prepared meat.	AAP, 2010, 2012, 2014
Avoid cow's milk until 1 year of age. Whole milk may be provided at 1 year of age. At 2 years of age, low-fat milk may be considered if weight gain is appropriate, if weight gain is excessive, or family history is positive for obesity, dyslipidemia, or cardiovascular disease. Recommended total daily milk intake is 16 to 24 ounces. Intakes above 25 ounces/day may contribute to iron deficiency.	AAP, 2008, 2014; NHLBI, 2011
Allow lower fat milks for children 1 year of age and older for whom obesity or overweight is a concern.	AAP, 2008
Total daily juice intake should be limited to 4 to 6 ounces per day from 1 to 6 years of age.	AAP, 2014
Introduce single-ingredient new foods, one at a time, observing for adverse reactions or intolerance.	AAP, 2014
Introduce a variety of foods. By 7 to 8 months, infants should be consuming foods from all food groups. Provide foods of varying textures (e.g., pureed, blended, mashed, finely chopped, and soft lumps). Gradually increase table foods. Avoid mixed textures, such as broth with vegetables.	AAP, 2014
Avoid added sugar and added salt.	AAP, 2014
Avoid foods that could cause choking or aspiration (e.g., hot dogs, nuts, grapes, raisins, raw carrots, popcorn, hard candies).	AAP, 2014

[a] There is some controversy regarding whether exclusive breastfeeding meets energy requirements of infants at 6 months of age in developed countries (Fewtrell et al., 2007). Fewtrell et al. (2007) states, "A reasonable interpretation of the available scientific data is that there are currently insufficient grounds to confidently recommend an optimal duration of exclusive breastfeeding of 6 as opposed to 4–6 months for infants in developed countries."

[b] Concern regarding the possible risk from intake of excessive mercury or other contaminants is offset by the neurobehavioral benefits of an adequate DHA intake and can be minimized by avoiding the intake of predatory fish (e.g., pike, marlin, mackerel, tilefish, swordfish) (AAP, 2014).

SOURCES: As indicated in the Reference column.

Inadequacy or Excess: The Basis for Concern

The committee was tasked with developing nutrient intake adequacy estimates referenced to the DRIs. On a population level, inadequate or excessive intake of any nutrient is usually considered to be of concern when present in 2.5 percent or more of the population of interest (IOM, 2003). This percentage should translate to an equivalent prevalence of impaired function or adverse effect. For example, a 5 percent prevalence of dietary iron inadequacy should translate to a 5 percent prevalence of low iron stores. For this report, a 5 percent threshold was applied (as in IOM, 2011b). This is a slightly relaxed standard, which accounts for some of the uncertainty in setting the EARs, as well as some of the generally accepted errors associated with dietary assessment. The same threshold was applied to proportions of the population with intakes falling above or below the AMDR, or above the UL. For nutrients with an AI, an assessment of adequacy cannot be made. Rather, it can only be stated that the mean usual intakes above the AI implies a low prevalence of inadequacy (IOM, 2000b).

Food group intakes can be compared to recommended food patterns for a specific energy level, as described previously. Because the food patterns are designed to ensure nutrient intakes that meet almost all of the RDAs, it would be ideal if almost everyone in a population reported usual diets that conformed to the food patterns. However, this goal is almost never achieved, so the committee chose a less restrictive approach in selecting foods group intakes that should be improved: if 50 percent or more of the population falls below the recommended level, then improving intake should be a priority. This approach improves on past assessments that prioritized food groups with mean or median intakes below the recommendation, but that did not quantify the percentage of the population with low intakes.

NUTRIENT AND FOOD INTAKE IN THE WIC POPULATION

Nutrient and food intakes in the WIC-eligible population were estimated using NHANES 2005–2008 and 2011–2012. The intent of these analyses was to identify priority nutrient and food group needs that could be addressed by making additional changes to the food packages. The methods of these analyses are described here. The results are discussed in Chapter 4 (nutrient intake) and Chapter 5 (food intake).

Dataset

The primary source of data on food and nutrient intake of the U.S. population is the *What We Eat in America* (WWEIA) component of NHANES

(USDA/ARS, 2005–2008, 2011–2012). The survey data used for this report were dietary intake data (foods and nutrients from food sources only, not dietary supplements[6]) collected using the Automated Multiple-Pass Method,[7] and demographic information, including age, gender, and physiological status (e.g., pregnant, breastfeeding, or postpartum women [0–1 year after delivery][8]). The only filter applied to create the analytic datasets was the indicator DR1DRSTZ (or DR2DRSTZ for day 2), which identified complete and reliable records. No outliers were removed. By and large, the published NHANES databases have few missing values, in particular for nutrient intake. The population survey weights were applied to all analyses, generating estimated intake values representative of the U.S. population, including by income categories. However, participation in programs such as WIC is not considered in the survey design (Johnson et al., 2014). In addition, pregnant, breastfeeding, or postpartum women are not oversampled (Johnson et al., 2014), which results in small sample sizes for these physiological states, apart from narrowing to low income.

Food intake data for each survey respondent were translated to USDA equivalent values using the Food Patterns Equivalent Database (FPED), a file that identifies the food group and subgroup intakes associated with the DGA recommendations (USDA/ARS, 2013). A reasonability check was conducted to compare the output for this report to the nationally representative WWEIA data. The food groups selected for analyses are presented in Appendix J, Table J-3.

Utility of NHANES Datasets for Addressing the Task

The committee was tasked with assessing the nutrient and food group intakes of the WIC-eligible population. USDA-FNS also requested an evaluation of intakes before and after 2009 food package changes, and a comparison of WIC participants to eligible non-WIC participants. USDA-FNS required full implementation of the 2007 (interim rule) food package changes by October 2009, and most states implemented the changes at

[6] At the request of the study sponsor, USDA-FNS, dietary supplement intake was excluded from the analysis. The purpose of the WIC food packages is to improve nutrient intakes from foods alone. It would not be appropriate to assume that all WIC participants are taking specific supplements or to design the food packages based on such an assumption. Thus, although the committee recognizes that dietary supplements can provide additional nutrients, it was important to examine intakes from foods alone.

[7] The Automated Multiple-Pass Method is a computerized method for collecting interviewer-administered 24-hour dietary recalls. In NHANES it is applied in person for the first day, and by telephone for the second day of data collection.

[8] Women were selected from NHANES if coded as breastfeeding, or if not breastfeeding, but coded as 0 to 5.9 months postpartum. Some women reporting WIC participation did not report being pregnant, breastfeeding, or postpartum.

some point between issuance of the 2007 interim rule and the October deadline (USDA/FNS, 2012). Given the number of complications with dividing the NHANES 2009–2010 data,[9] the committee estimated pre-package change intakes using NHANES 2005–2008.

The WIC identifier for the NHANES 2011–2012 dataset was not available at the time of this analysis. Therefore, a comparison of nutrient or food intakes among WIC participants before the 2009 food package changes to those after the changes could not be conducted. Moreover, the comparison of WIC participant intakes to WIC-eligible nonparticipants could be conducted only with the NHANES 2005–2008 release.[10] The pre/post comparison will be available in the phase II report, in which NHANES 2011–2012 will be analyzed using WIC participant and WIC-eligible non-participant subgroups as the sample sizes allow.

For each WIC subgroup comparison, the committee evaluated the population subgroup sizes to determine which combinations of individuals relevant to the task would allow adequately robust sample sizes. Oversampling of some NHANES population subsets has been discontinued (CDC, 2014), which was a concern for several of the WIC subgroups of interest because small subgroup sizes may result in statistically unreliable population-level estimates.[11] The committee's initial goal was to analyze WIC participants[12] and WIC-eligible nonparticipants in subgroups of infants (formula-fed or breastfed), children (1 to less than 2 and 2 to less than 5 years of age), and women (19 to 50 years of age, eligible being pregnant, breastfeeding, or postpartum). These subgroups allow for comparison of nutrient and food intake of all individuals who participate in WIC compared to individu-

[9] NHANES respondents are assigned weights specific to the 2-year datasets. Separation of a 2-year dataset requires re-computation of population weights, which was beyond the scope of this study. It also required knowledge of the location of the participant and the dates of the interviews. Both of these variables are unpublished to preserve privacy of participants.

[10] In addition to the difficulties with separation of the NHANES 2009–2010 dataset noted in footnote 7, this period spanned the change in food packages. It was therefore not considered appropriate for either the pre- or post-food package change assessments.

[11] The committee determined that a mean usual intake can be calculated within 3 percent of the true value (95 percent confidence interval) with a minimum of 17 individuals, for most nutrients. This minimum is not adequate for accurate calculation of population-level intake adequacy.

[12] Capturing WIC participation is dependent on accurate reporting in NHANES. The committee's comparison of the weighted total number of recipients reporting WIC as well as extensive experience with reporting of programs like WIC suggest that WIC use is underreported. There is also a challenge in identifying the low-income group as eligible: The concept of income reported in NHANES does not correspond to state-level income requirements for eligibility. Some individuals may be income ineligible but may still legitimately participate in the program if adjunctively or automatically eligible due to participation in Medicaid, Temporary Assistance for Needy Families (TANF), or the Supplemental Nutrition Assistance Program (SNAP).

als who qualify but do not participate in the program. Inspection of the data in the survey years of interest (2005 through 2012) indicated that modification of these initially outlined population subgroups was required. Table 3-2 details the limitations of NHANES for developing these initially designed population subsets and the modifications made to accommodate the limitations.

Following careful consideration of these limitations, the committee designed the final population subgroups that would be analyzed for this report (see Table 3-3). Subgroups identified as low income include all individuals with income ≤ 185 percent of the poverty-to-income ratio (PIR) (based on PIR guidelines in HHS, 2015, and USDA/FNS, 2015). The WIC subgroups include only individuals reported as being on WIC in the NHANES survey (these individuals may or may not have a PIR of ≤ 185 percent). There are two reasons for inclusion of any income level in the WIC group: (1) income could change within the certification period, but the individual remains in the program at the new income level, and (2) the objective is primarily to evaluate the effect of the food package, not the effect of income. WIC-eligible non-participating individuals were identified in the survey by not reporting being on WIC, but with a PIR of ≤ 185 percent and for women, having a qualifying physiological state (e.g., pregnant, breastfeeding, or postpartum).

TABLE 3-2 Limitations of the NHANES Datasets Relevant to the Task and Resulting Subgroup Modification

NHANES Dataset Limitation Related to the Task	Modification Implemented	Modification Anticipated for the Phase II Report
At the time of analysis, the Food Security Survey Module[a] containing the WIC identifier was unavailable for survey years 2011–2012. Thus, WIC and non-WIC individuals could not be compared for these survey years	Subgroups including all low-income individuals were analyzed (no breakout of WIC versus non-WIC) as a proxy for WIC	Use the NHANES 2011–2012 WIC identifier to create WIC and non-WIC subgroups for this time period in place of the low-income proxy
Women 14 to 18 years old were not identified as participating in WIC in the public use versions of the 2007–2008 and 2009–2010 datasets[b]	Analyses of these data were limited to women 19 to 50 years old	Analyses of these data will be limited to women 19 to 50 years old

TABLE 3-2 Continued

NHANES Dataset Limitation Related to the Task	Modification Implemented	Modification Anticipated for the Phase II Report
NHANES discontinued the supplemental sampling of pregnant women after 2006, which limited the number of pregnant low-income and WIC women surveyed	Pregnant, breastfeeding and postpartum women were combined for all subgroups	Same action as for the current report; size of WIC versus non-WIC groups in NHANES 2011–2012 to be evaluated
Breastfeeding and postpartum women are not oversampled and are therefore limited in sample size	Pregnant, lactating and postpartum women were combined for all analyses; variance adjustment applied to the 2011–2012 subgroup; only mean food intake is presented	Combine women as for the current report; size of WIC versus non-WIC groups in NHANES 2011–2012 to be evaluated
Breastmilk intakes were not quantified for breastfed infants[c]	Intake of breastfeeding infants was not analyzed	Iron and zinc nutrient adequacy will be evaluated because breastmilk is not a major source of these nutrients[c]
Vitamin D intake data were available for survey years 2007–2008 and 2011–2012 only	Vitamin D dietary intakes estimated for these years only, intake of infants 0 to < 12 mo to appear in this report because serum data are not available for this subgroup	Vitamin D intake estimates presented for all subgroups
Serum 25(OH)D data available for 2005–2006 survey years only and for individuals ages 1 year and older	25(OH)D status estimated for this survey period and subgroups ages 1 year and older only	Same action as for the current report

NOTES: non-WIC = WIC-eligible nonparticipants; WIC = individuals participating in WIC.

[a] NHANES (National Health and Nutrition Examination Survey) includes a Food Security Survey Module that contains an identifier for individuals currently receiving WIC benefits and those who received WIC benefits in the past 12 months. This identifier can be used to identify subgroups of individuals receiving WIC with WIC-eligible women not receiving WIC benefits and also with low-income women who are not currently pregnant, lactating, or postpartum (i.e., eligible for WIC).

[b] The typical age distribution for WIC participation is 18–34 years (USDA/FNS, 2013a).

[c] This information has been updated since the initial release of this report.

TABLE 3-3 NHANES Sample Sizes of Population Subgroups Selected for Nutrient and Food Intake Analyses: Phase I

	Women			Infants		
	19–50 y, P/BF/PP			0 to < 6 mo, FF		
Analysis	A	B	C	A	B	C
Nutrients	260	90	34	204	21	86
Foods	222	76	29	12	19	71

NOTES: BF = breastfeeding, FF = formula fed; P = pregnant; PP = postpartum up to 1 year. Numbers may differ between the nutrient and food intake analyses because 2 days of food intake data are required to estimate usual intakes for food. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Population subgroups for phase II may vary from what is presented here, depending on the "WIC" and "non-WIC" sample sizes in NHANES 2011–2012.

Adjustment for Small Sample Sizes

As indicated in Table 3-2, some of the sample sizes were small. The committee determined that means for subgroups other than women were adequately precise, despite sample sizes as small as 19. For example, to estimate mean usual intake of calcium for infants ages 0 to less than 6 months, a minimum sample size of 17 infants is required to obtain an estimate that is no more than 20 mg below or above the true mean with 95 percent certainty. For zinc, a minimum of seven infants is required to estimate the mean usual intake within 0.2 mg of the true value. This is because the estimated variance of usual intake tends to be small, in particular for infants. For quantities (i.e., "% Inadequacy") other than means, the required sample sizes are significantly larger.

For women, some samples remained small and the variance large despite combining all pregnant, breastfeeding, and postpartum individuals into one group. To generate more robust nutrient intake estimates of the ratio of the within- to the between-person variance in intake, the method of Jahns et al. (2005) was applied. In this method, the variance ratio estimated from the subgroup intake data is combined with a ratio estimate obtained from the group of all women. To do this, an estimate of within-person variance (external variance) is generated using PC-SIDE to assess intake information of all low-income, pregnant, lactating, or postpartum women in all survey years. An internal ratio estimate is obtained separately for each subgroup. A new within- to between-person variance ratio, is then computed as a weighted average of the external and internal variance ratio estimates. On average, the external variance was weighted by 100, and the

Children								
6 to < 12 mo, FF			1 to < 2 y			2 to < 5 y		
A	B	C	A	B	C	A	B	C
252	35	82	311	106	112	474	397	406
136	31	73	254	82	93	398	329	340

A = Individuals identified as participating in WIC at the time of the survey, NHANES 2005–2008.

B = WIC-eligible nonparticipants (≤ 185% of the poverty income ratio; for women also P, BF, or PP), NHANES 2005–2008.

C = All individuals ≤ 185% of the poverty income ratio, NHANES 2011–2012.

SOURCES: NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012).

internal variance was weighted by the number of women in the subgroup who provided 2 days of information. When this number is small (as in the case of pregnant or lactating women in 2011–2012), the external variance plays a larger role in the combined estimate. The resulting estimates are less subject to the large degree of variability in the within-person variance estimate that can be introduced by a small sample size. Both means and the "% Inadequacy" have improved reliability.

For the analysis of episodically consumed foods, small samples add enormous challenges. Neither the National Cancer Institute (NCI) method nor SPADE (used here) results in reliable estimates of distributions of usual food intake when the sample size is small and the proportion of zero consumption is large. In many cases, the programs fail to converge, and no estimation beyond the usual intake mean is possible. Further, neither of the two approaches (NCI or SPADE) permit combining an external and an internal within-person variance estimate when estimating the intake distribution, so the approach followed for nutrients (described above) cannot be implemented for foods. Consequently, with the small sample sizes that were available for women, and the large proportion of zero intakes observed for many of the food subgroups, estimates of the proportion of usual intakes of foods below recommendations are less reliable. Estimates of mean food intake are, however, adequately precise and only these are presented for women (Dekkers et al., 2014).

TABLE 3-4 Tasks Related to Infant Formula Requirements in the Food Packages and the Approach

Aspect for Evaluation	Information Collection Strategy	Information in Phase I
The current required minimum energy level of 20 kcal/100 milliliters	Literature review	Summary of evidence
The current WIC minimum iron requirement of 1.5 mg per 100 kcal formula	Current FDA requirements for infant formula; iron DRI for infants; iron intake of infants; EER for infants	Comparison of iron intake with requirements and anticipated iron intake given the EER
The current maximum allowances of infant formula in the food packages	EER calculations for the relevant infant population in NHANES	EER calculation results and comparison to current infant food package energy content

NOTE: DRI = Dietary Reference Intake; EER = Estimated Energy Requirement; NHANES = National Health and Nutrition Examination Survey.

Tasks Specific to Infant Formulas

In addition to the science supporting functional ingredients in infant formulas, the IOM committee was asked to evaluate three additional aspects of infant formula requirements in the food packages: energy concentration, iron concentration, and volume provided. The three tasks and the evaluation approach are outlined in Table 3-4.

Assessing Diet Quality

The committee was tasked with evaluating the diet quality of WIC-eligible subpopulations using the Healthy Eating Index-2010 (HEI-2010) (Guenther et al., 2013; see Box 3-2) and one additional index of the committee's choosing. A second index was developed, as detailed in the Letter Report (IOM, 2015):

> Options for a second index were considered by the committee, based on its evaluation of the literature on existing diet quality indexes other than the Healthy Eating Index (HEI), and with consideration to three criteria: (1) the index can be applied to adults and children, (2) 24-hour recall data are applied, and (3) the index is based on a metric other than comparison to the DGA. After reviewing potential indexes, the committee determined that responding to the task would require an index that focuses mainly on nutrient content to provide a contrast to the food-group focus of the

HEI-2010. However, the committee found that existing nutrient-based indexes could not be applied directly for two reasons. First, they could not be applied because they use Daily Values based on a 2,000 calorie diet as reference standards for nutrient intake rather than age-appropriate DRI values. Second, they do not necessarily include all of the nutrients and dietary components the committee was interested in assessing, based on current knowledge about nutrients of concern in the diets of young children and women of childbearing age (the 2010 DGA) and the committee's assessment of the nutrient intakes of WIC-eligible populations. The committee developed an adapted nutrient-based diet quality index to be scored by comparison to DRI values.

Briefly, the committee developed a Nutrient-Based Diet Quality (NBDQ) index based on the mean probability of adequacy for the 9 shortfall nutrients, calculated for each individual (see Box 3-2).[13] The possible scores range from 0 to 100. This approach is very similar to that recently published by Verger et al. (2012), except that the NBDQ includes only shortfall nutrients as defined by the 2015 DGAC report. When tracked with energy intake, the association between the NBDQ index and energy intake was not strong, which suggests that the index is a summary measure that predicts dietary quality beyond simply being a measure of overall energy intakes (see Appendix K, Figures K-1 through K-3). Further details of the committee's development of NBDQ are described in Appendix K. The NBDQ was applied to all subpopulations excluding infants.

Because it is based on the DGA food patterns, which apply only to individuals ages 2 and older, the HEI was likewise applied only to individuals ages 2 years and older (see Appendix K, Table K-1). The NBDQ was applied to individuals aged 1 year and older because nutrient adequacy can be defined for these individuals based on the EARs or AIs.

Statistical Comparisons in NHANES Analyses

For this report, the only statistical testing of hypotheses conducted by the committee were for a difference between means of WIC participants and eligible non-WIC participant subgroups. Participants in the 2011–2012 NHANES were not included in statistical comparisons because individual samples in these years represented a different time period and the available data combined both WIC participants and eligible nonparticipants. As a result, data from 2011–2012 did not provide an appropriate comparison

[13] There are ample precedents for the use of a composite nutrient adequacy index. Mean adequacy ratios have been used for many years and have more recently been updated to reflect the DRIs. The NBDQ is essentially the same as the indexes used in several published studies (Foote et al., 2004; Murphy et al., 2006).

BOX 3-2

Diet Quality Indexes Employed

1. The Healthy Eating Index-2010

The Healthy Eating Index-2010 (HEI-2010) was designed to measure compliance with the key recommendations in the 2010 *Dietary Guidelines for Americans* (DGA). It covers 12 components: Total Fruit, Whole Fruits (not including juice), Total Vegetables, Greens and Beans (dark green vegetables and beans and peas), Whole Grains, Dairy (all milk products and soy beverages), Total Protein Foods, Seafood and Plant Proteins, Fatty Acids (ratio of poly- and monounsaturated fat to saturated fat), Refined Grains, Sodium, and Empty Calories (all calories from solid fats and added sugars plus calories from alcohol). Adequate consumption of all components except Refined Grains, Sodium, and Empty Calories raises scores. Consumption of the latter lowers scores. A perfect overall score for the HEI-2010 is 100. Subscores for the components can be up to 20, with the ranges for each individual component being 0 to 5, 0 to 10, or 0 to 20. The HEI-2010 is the only metric in this report that applies the 2010 DGA as a point of comparison. Details of the HEI-2010 components can be found in Appendix K, Table K-1.

2. The Nutrient-Based Diet Quality Index

The committee developed an adapted Nutrient-Based Diet Quality index to be scored by comparison to DRI values. "Positive" nutrients examined included the 2015 DGAC report shortfall nutrients and nutrients of concern, to be updated upon release of the 2015 DGA: potassium, dietary fiber, calcium, iron, vitamins C, A, E, folate, and magnesium. The index is the mean probability of adequacy for these 9 nutrients, calculated for each individual. The possible range is from 0 to 100.

- For nutrients with an EAR: the probability of adequacy is calculated for each individual for each day.
- For the nutrients with an AI value (potassium and dietary fiber), reasonable intake ranges based on the AI are applied, to assign 0, 25, 50, and 100 percent probability of adequacy.

Further details on calculations and validation of the index are provided in Appendix K.

group. In all cases, pairwise t-tests were applied with estimated standard errors that account for the complex design of the NHANES surveys. Tests were implemented for differences in means of the usual intake distributions of nutrients and foods, for the prevalence of inadequate intakes, and for overall mean HEI scores. The NBDQ index, constructed as a combination of estimated percentage of adequacy of nutrients with and without an EAR was not included in the statistical comparisons because an estimate of the standard error of the mean index requires approximations that are justified only in large samples. Because of the lack of reliability of reported energy intake values (Subar et al., 2015), statistical comparisons were likewise not applied to this measure. A p-value of less than or equal to 0.05 was considered statistically significant.

APPROACH TO DEVELOPMENT OF THE BASELINE FOOD PACKAGE: NUTRIENTS AND COST

Several of the committee's tasks related to dietary intake estimation and food package costs required an evaluation of baseline packages representative of the foods acquired through the WIC food packages. Accurately representing baseline package composition is fundamental to subsequent (phase II) assessment of changes in nutrient intake, food intake, and cost. The methods used to construct baseline food packages and evaluate their costs are summarized here. The approach used here parallels that applied in the 2006 WIC report (IOM, 2006), but it will use updated food options and selection (redemption) data.

Baseline Food Package Composition and Nutrient Profiles

Each of the food packages prescribed by WIC (see Appendix D, Tables D-1 and D-2) includes specific food categories (e.g., milk or breakfast cereals) with specifications for foods allowed under each category (i.e., skim or 1 percent milk, breakfast cereals with ≤ 6 g sugar per serving). The set of prescribed food categories constitutes the "package" under the revised 2009 food packages. For some food packages, only one choice of food is offered (i.e., whole milk as the "Milk" for children 1 to 2 years of age). However, for other food packages or ages, multiple choices are available within one food category (e.g.,, either skim milk or 1% milk could be chosen within the category of "Milk" for women). To create a baseline "Milk" category from which to evaluate dietary intake and cost changes, the committee will develop a composite of the available options. For example, the committee considered milk choices based on the regulations defining allowed substitutions and rates of substitutions, USDA-FNS studies of state allowed substitutions (USDA/FNS, 2011) and state data on redemptions (which were available from some of the states that are using electronic benefit transfer [EBT] for redemption of WIC benefits). State data on redemption of issued WIC foods is useful for this purpose because it provides information about the proportions (weights) of "Milk" category redemptions that are skim, 1%, yogurt, soy beverage, tofu, or cheese among the available substitutions. These data will be used to develop reasonable selections (allocations) for specific foods. Information from redemption shares as well as allowable substitutions and state options will be used to determine the proportions of each type of food in a food category (e.g., the "Milk" category is 50 percent skim milk, 40 percent 1% milk, 10 percent low-fat yogurt). Nutrient and costs for each food "category" will then be determined from the proportion-weighted component of foods.

The baseline composite food categories containing foods purchased with a cash value voucher (CVV) were computed differently than for other WIC food categories. Because the CVV can be used to purchase many different fruits and vegetables, the composition of baseline representative CVVs for the different categories were computed as weighted averages of several specific items based on their rates of purchase. The contribution (weight) of vegetables (e.g., broccoli) to each vegetable category (e.g., dark greens) will be determined by USDA's Center for Nutrition Policy and Promotion (CNPP) for use by the 2015 DGAC report (Personal communication, P. Britten, USDA/CNPP, September 24, 2014).

For each composite food category, the relative proportions of different options will be used to construct nutrient profiles. The protocol for estimating these nutrient profiles will be similar to that used in the previous evaluation of WIC food packages (IOM, 2006). Food composition data will be obtained from the USDA National Nutrient Database for Standard Reference, Release 27 (USDA/ARS, 2014). For some foods, nutrient data from USDA will be used without modification (e.g., whole milk). For most foods, however, weighted composite nutrient data will be created, for example, the nutrient profile for "milk" will be composed of nutrients contained in all the various types of milk and milk substitutes included in the baseline composite milk food category, weighted accordingly.

Nutrient profiles for the composite fruit and vegetable food groups and subgroups will be created based on weighted contributions of only those individual fruits and vegetables contributing 5 percent or more to each group or subgroup. Although CVVs can be used to purchase fruits and vegetables in canned, frozen, fresh, or dehydrated forms, depending on state regulation, for baseline compositions used in the phase II report, allocation for most fruits and vegetables was assumed to be in fresh form, because all states are required to allow purchase of this form. This, as well as the relative proportions of foods in the WIC food categories (i.e., types of milk), maybe revised in phase II pending the availability of additional redemption data.

Baseline Prices

To evaluate the costs of the baseline food packages, the committee will need to determine a baseline time period to use for the evaluations. Although July 2015 would be appropriate as this date occurred after implementation of allowing the purchase of white potatoes with the CVV, as well as the substitution of whole grain pasta (allowed effective May 2014), price and other product and program data for 2015 are limited at the current time (e.g., the yogurt substitution deadline is ongoing) and some data are not available at the time of this report. Therefore, 2014 price and other program data will be used for the initial phase II analysis, with an update to 2015 price data later in phase II.

The average price of each food category in the WIC food package will be determined by assessing prices for qualifying foods (USDA/FNS, 2013b). The same approach will be used for infant formulas. Baseline price data for all food products except fruits and vegetables are available from retail scanner data (from the Information Resources Incorporated, Chicago, Illinois, through a third-party agreement with the ERS). These data will be supplemented, when needed, by other sources such as the Bureau of Labor Statistics national average price data, Internet sources, or local store price data. For fruits and vegetables, ERS price data will be used. Recently, the ERS updated its computation of prices for fruits and vegetables using market purchase data from retail sales data for 2013 (USDA/ERS, 2015a). These 2013 prices will be updated to the most current (2014 or 2015) prices using the relevant Consumer Price Index (CPI) for fresh or processed fruit and vegetables (BLS, 2015).

Determining the Cost and Redemption Rates for the Baseline Package

The cost of the baseline packages will be determined by multiplying the amounts of foods (which vary by package size) by their prices. Available redemption data will be evaluated, with adjustments applied to account for differences among the specific packages. Because redemption data do not account for different redemption rates between women and children for some products (e.g., ready-to-eat cereals), the effects of this variation will be further investigated in the phase II sensitivity analysis. Calculation of program costs for each baseline package will be based on cost, redemption rates, number of participants and, for infant formula, the rate of state contract rebate. All of this information will be presented in phase II.

Limitations of Redemption Data

There are several limitations to the application of redemption data for development of baseline food package nutrient profiles and costs. First, redemption data are not differentiated by package (e.g., food redeemed from a children's package, or from a woman's package). Second, it is not possible to extract preferred rates of substitutions (e.g., the substitution of cheese for a portion of milk). Some substitutions may affect cost or nutritional composition. For example, the price and nutritional composition of milk per ounce differs from the price and composition of cheese per ounce. Finally, available state redemption data are limited in applicability on a national level, although the data might provide insights into preferences or product availability. The committee will weigh merits and limitations of the available data in determining the relative product shares for foods in the representative WIC packages.

SENSITIVITY ANALYSIS APPROACH

The committee is tasked with conducting a sensitivity analysis in phase II to assess the effect of potential food package changes on nutrient composition of each package relative to the DRIs, food groups and subgroups relative to the 2015 DGA recommendations, and cost. Changes in nutrients, food groups, and costs will be determined for each proposed change in the food package relative to the baseline composite food packages described above. The planned approach for this analysis is outlined here.

Developing a List of Potential Package Changes

To evaluate the effect of changes to the food packages, the committee first plans to develop a list of potential changes. This could include, for example, changes in food categories (e.g., specific foods added, increased or decreased quantities, changes in the value of the CVV) and changes in combinations of the package components (i.e., allowable substitutions and alternates, with respective changes in substitution or redemption assumptions). Combinations will be tested and compared to the "baseline food package" to ensure that any changes being considered are, overall (for the WIC program), cost neutral or not more than 10 percent above or below the current level of funding.

Testing Changes to the Food Packages

The committee plans to consider food package changes based on consideration of the totality of evidence. The sensitivity analysis will determine the effect of any change on nutrient intake, food intake, and cost. For all WIC food categories within the baseline food packages, the committee plans to evaluate options to add/eliminate/increase/decrease/alter the baseline composition. The effects of each food change will be assessed at the food package level (i.e., how each food package recipient would be affected) for changes in nutrient intake, food group (i.e., dairy) and food subgroup (i.e., milk) intake, and cost. For each option explored, an assumption will be assigned regarding any change in the "weight" of the foods within the composite packages. For example, if a new food were added, would it be expected to change redemptions of the foods in that composite package?

As with the nutrient profiles for the baseline composite food packages, nutrient data for each food change will come from the USDA Standard Reference Database, Release 27 (USDA/ARS, 2014). Should major changes to the food packages be considered, the amount of change in nutrient intake will be evaluated in terms of its effect on the risks of nutrient inadequacy by adjusting the intake distribution by the amount of the nutrient change. For minor changes, the amount of change in nutrient intake will be assessed without looking at distribution shifts. Changes in food group and subgroup intake will be evaluated with respect to changes in the degree to which 2015 DGA food group recommendations are met. Finally, cost changes will be evaluated for all food and combination changes.

Qualitative Assessment of Food Package Changes

The committee plans to consider additional dimensions that could be affected by changes to the food packages. These include the effects of changes on participation (uptake) for the package and/or effects on the redemption rates of each package. The likely effects will be based on available data on current redemption rates and literature reviewed. These changes will be important to consider when conducting the Regulatory Impact Analysis (RIA) (see below), and major changes may be included as an option in the RIA.

Variations from Cost Neutral

While the committee was tasked with ensuring overall cost neutrality for recommended changes to the WIC food packages, they were also asked to offer prioritized recommendations in the event that USDA-FNS's WIC funding is either above or below the cost-neutral level. These priorities will appear in the phase II report.

FOOD EXPENDITURE ANALYSIS

The committee was tasked with the planning and implementation of a food expenditure analysis for the WIC population using nationally representative purchasing and price data. A summary of the data sources is described here, details of the analysis are presented in Appendix L, and the results discussed in Chapter 10. A portion of this task included determining expenditures on food groups. This task will be completed in phase II. The Information Resources Incorporated (IRI) household panel scanner and the National Household Food Acquisition and Purchasing Survey

(FoodAPS) data were acquired in phase I, however the process was lengthy and did now allow adequate time to conduct analysis of food group data for the expenditure analysis. In addition, the work required to match foods acquired (FoodAPS) to the USDA food groups is extensive and was not feasible in the time allotted to produce the phase I report.

Data Sources

Sources of Purchasing Data

Nationally representative data on food expenditures by WIC households are limited. However, data collected as part of the USDA's FoodAPS have recently been released (USDA/ERS, 2015b). Using these data, the committee compared shopping patterns of WIC participants, based on categorical eligibility and self-report, to low-income and higher-income nonparticipants. FoodAPS is a nationally representative survey of 4,826 American households, covering 14,317 individuals, that provides detailed information about foods purchased or otherwise acquired for consumption at home and away from home between April 2012 and January 2013. The survey includes identifiers for households reporting participation in WIC and reports whether a WIC voucher was used in a food acquisition transaction.

Another source of data available for analysis of food product purchase is in the 2011 and later IRI household panel scanner data on household purchases from retail stores. The data cover the 48 continental states. Participating households use a scanner at home to record retail food purchases after shopping and the resulting information includes items purchased, quantities bought, amount of money paid, and date of purchase. Household scanner data panelists are instructed to scan all purchases from all outlets, including supermarkets, supercenters, club stores, convenience stores, drugstores, farmers' markets, and other types of retail facilities. The household panel scanner data provide information on the purchases of a large number of households and can be used to assess expenditures and quantities of detailed products that may be evaluated in determining likely costs of baseline and alternative package foods. Sample weights will be applied to derive nationally representative estimates of retail food purchases and unit values (prices) for all households across the contiguous United States. The primary subpopulation of interest in the IRI household panel scanner dataset is low-income households. In addition, households with young children present can be identified.

Sources of Price Data

For the analysis conducted in this report, two sources of price data were available: IRI retail scanner data and USDA ERS data on fruit and vegetable prices (USDA/ERS, 2015a). As described previously, these are the same data sources used to determine prices for the baseline composite food packages. The IRI scanner data allow estimation of quantity-weighted prices for aggregated food groups representative of WIC package foods. Price data developed for the Thrifty Food Plan with food group quantities updated to reflect the 2010 DGA are not available. As with price data used for determining prices of the baseline composite food packages, all prices will be updated to the 2014 base year using the Bureau of Labor Statistics (BLS)-CPI for food at home.

Information on household food expenditures comes from sources listed in Table 3-5. The sources not available in time for delivery of this report will continue to be pursued for phase II, and the committee is open to the identification of additional resources. Analysis of food expenditures conducted during phase I focused on the reported expenditures (transactions to purchase and acquire food) in the FoodAPS.

APPROACH TO THE REGULATORY IMPACT ANALYSIS

The committee developed an approach for a RIA to be conducted during phase II and based on the approach detailed in the Office of Information and Regulatory Analysis document, "Regulatory Impact Analysis: A Primer" (OIRA, 2011). The objective of the RIA will be to evaluate the effect of the committee's recommended changes in WIC food packages on program participation, value of selected food packages, and program cost and administration. Details of the proposed RIA approach are presented in Appendix M.

NATIONWIDE DISTRIBUTION AND COSTS OF FOOD

Also during phase II, the committee will gather information on the nationwide costs and distribution of foods (including low-income neighborhoods). Part of the purpose of this is to ensure that the new food packages are efficient for nationwide distribution. Particularly, all of the specific changes recommended for the WIC food packages should be based on consideration of whether it is feasible to make the recommended foods available, from both the perspective of federal/state administration in allowing local agencies to make substitutions (i.e., select combinations from among the WIC-approved foods) and the perspective of vendors that directly provide the foods included in the packages. Variability in seasonal availability,

TABLE 3-5 Availability of Nationally Representative Price and Expenditure Datasets as of November 2015

Dataset, Owner	Year of Data Collection	Description	Availability
		Purchasing Data	
Household scanner data, USDA-ERS through Information Resources Incorporated (IRI)	2008–2013	National panel of households. Purchase records from participating households cover retail food purchases for at home use.	Access obtained with USDA-ERS
National Household Food Acquisition and Purchasing Survey (FoodAPS)	2012–2013	FoodAPS collected the data from a nationally representative, stratified sample of 4,826 households between April 2012 and January 2013. Data include a one-week diary from all members of the household on food purchase and acquisition.	Access obtained with USDA-ERS
		Price Data	
Retail scanner data, USDA-ERS through Information Resources Incorporated (IRI)	2008–2013	Weekly retail sales data from grocery stores, supermarkets, supercenters, convenience stores, drug stores, and liquor stores across the United States (revenue and quantity).	Access obtained with USDA-ERS
Price data supporting the Thrifty Food Plan (TFP) update, USDA-CNPP	2014	Price data applied to update the 2006 TFP	Release date not determined

NOTE: FoodAPS = National Household Food Acquisition and Purchasing Survey; IRI = Information Resources Incorporated; TFP = Thrifty Food Plan; USDA-CNPP = U.S. Department of Agriculture-Center for Nutrition Policy and Promotion; USDA-ERS = U.S. Department of Agriculture-Economic Research Service.

seasonal pricing, and types of vendors available in different locales (e.g., supermarket versus trading post) will be factored into the recommendations. Issues of local distribution (e.g., availability of neighborhood grocery outlets) will be considered. All output will be provided in the final report.

COMMITTEE WIC SITE VISITS AND SHOPPING EXPERIENCE

USDA-FNS asked that the majority of committee members visit a state WIC clinic and experience shopping as a WIC participant prior to development of the phase II report. Between March and June 2015, committee members visited a total of 14 WIC sites and vendors either in their home state, another state, or both. The visits were organized to ensure geographic and cultural diversity, a balance of sites issuing paper vouchers versus using EBT, committee member availability, site staff availability, and activity at the site (e.g., days of greater participant flow and provision of group education). A list of sites visited by city and state is presented in Table 3-6. The committee members adhered to the following agenda during site visits:

- Become familiar with the flow of clinic operations and intake.
- If possible, observe a WIC enrollment from start to finish. Alternatively, observe a WIC certification appointment from start to finish.

TABLE 3-6 WIC Sites Visited by the Committee to Review WIC Food Packages

State	City
Connecticut	Hartford
Illinois	Chicago
Iowa	Ames
Kentucky	Newport
Massachusetts	Sommerville
Michigan	Detroit
Nevada	Las Vegas
New York	Kenmore
Oklahoma	Chickasaw Nation
Texas	McAllen
Vermont	Burlington
Virginia	Alexandria
West Virginia	Charleston
Wyoming	Cheyenne

- If occurring at the time of the visit, observe a group education class.
- If occurring at the time of the visit, observe a prenatal and/or breastfeeding class.
- Observe the orientation to WIC foods and use the voucher/EBT card.
- If a breastfeeding peer counselor is available, learn about delivery of such services at that site.
- Obtain an EBT card or voucher to complete the shopping experience.
- Visit a local WIC authorized vendor to locate and purchase WIC foods.

Committee members prepared written reports and shared their experiences during a closed meeting. A summary of the committee's key observations is presented in Appendix N.

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4

Nutrient Intakes of WIC-Eligible Populations

In phase I, the committee was tasked with assessing nutrient intakes of the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC)-eligible populations. The committee first conducted a review of the literature specific to WIC participants. Next, the committee analyzed National Health and Nutrition Examination Survey (NHANES) data to evaluate current nutrient intakes among WIC-eligible women, infants, and children in comparison to the Dietary Reference Intakes (DRIs) (using NHANES 2011–2012 data) and to compare intakes between WIC participants and income-eligible nonparticipants (using 2005–2008 NHANES data). Chapter 5 provides data on food group intakes of these same groups. In combination, these analyses support identification of nutrient and food group priorities for the WIC food packages. Details of the methodologies used for these tasks were presented in Chapter 3. The results of the literature search, NHANES analyses, and nutrient profile estimates are summarized here.

LITERATURE AND REPORT FINDINGS: NUTRIENT INTAKES

This section summarizes the committee's literature and report findings regarding nutrient intakes among WIC participants. Chapter 6 provides additional details about the prevalence of nutrient inadequacy and excess, on a per-nutrient basis, for mothers (before, during, and after pregnancy), infants, and children (less than 5 years of age).

Literature Findings on Change in Nutrient Intakes Since the 2009 Food Package Change

Few studies in the published literature have reported the nutrient intakes of WIC participants. The committee identified three reports that compared nutrient intakes before and after the 2009 WIC food package revisions. Odoms-Young et al. (2014) assessed dietary intake of 273 Hispanic and African American children ages 2 to 3 years from 12 WIC clinics in Chicago both before and after the food package changes. They found that Hispanic children had reduced saturated fat and increased fiber intakes following the food package changes. African American children significantly increased their caloric intake. Kong et al. (2014) collected data immediately before the food package revisions and 18 months post-revision and found decreases in total and saturated fat and increases in dietary fiber and overall diet quality among Hispanic children only. No significant changes in nutrient intake were observed for any other group. Thornton et al. (2014) reported results from a small study (2009, n = 84; 2011, n = 120) in central Texas among children ages 4 to 24 months. They found lower energy intakes after the food package changes. Mean usual intakes of retinol and zinc exceeded the Tolerable Upper Intake Level (UL) for all groups, although the proportion of individuals exceeding the UL for zinc decreased after the package changes.

In summary, some beneficial changes in food intake after the introduction of the new food packages were identified in all of these studies, but specific findings were inconsistent from study to study. It is noteworthy that the committee was unable to identify any published studies of nutrient intake in WIC participating women or infants apart from the U.S. Department of Agriculture's Food and Nutrition Service (USDA-FNS) (USDA/FNS, 2015) for which sample sizes for women and for infants were unreliably small as noted below.

Diet Quality of American Young Children: USDA-FNS Report

The committee reviewed the recently released USDA-FNS report *Diet Quality of American Young Children by WIC Participation Status* (USDA/FNS, 2015), which used the same NHANES 2005–2008 data that were examined in this report. In both cases, nutrient intakes were compared to the appropriate age-specific DRIs. The committee used these reported nutrient intakes for comparison with estimates generated by its own NHANES analyses. However, there were two methodological differences relevant to nutrient intake estimation between the USDA-FNS analysis and the analysis conducted here. First, the committee examined WIC participating compared to WIC-eligible nonparticipating children, but USDA-FNS analyzed three subgroups of children: WIC, non-WIC lower income (≤ 185 percent of poverty), and nonparticipating higher income children. Second, the committee applied the Iowa State University (ISU) method while USDA-FNS applied the National Cancer Institute method for usual intake estimation and also made statistical comparisons when possible. The USDA-FNS report focused on children ages 1 to less than 5 years of age because the samples for infants and FOR women were too small to yield reliable estimates. Nutrient intake results in the USDA-FNS (2015) report are presented in Appendix O and summarized briefly here.

A key finding of USDA-FNS report was that large proportions of children ages 1 to less than 5 years old had inadequate intakes of vitamin E as well as vitamin D and calcium. Non-WIC-participating higher-income children were significantly more likely to have lower vitamin E intakes than WIC participating children. Mean potassium and fiber intakes were below the adequate intakes (AIs)[1] for these nutrients across all groups. The majority (74 percent) of all children had excessive intakes of sodium.

For macronutrients, intakes of total fat were outside the appropriate range for 30 percent of children and their intakes and were more likely to be too low than too high. Saturated fat intakes were above recommended levels for 83 percent of children. Consumption of energy from "empty calories" (i.e., solid fats and added sugars) was two to three times the recommended UL of 10 to 14 percent of total calories.

NHANES ANALYSIS: NUTRIENT INTAKES

This section presents intakes of micronutrients, macronutrients, and energy for three groups (2005–2008 WIC participants, 2005–2008 income-eligible nonparticipants, and 2011–2012 low-income individuals) across relevant WIC age categories (pregnant, breastfeeding, and postpartum women, 19 to 50 years; formula-fed infants 0 to less than 6 months; formula-fed infants 6 to less than 12 months; children 1 to less than 2 years; and children 2 to less than 5 years). Too few breastfeeding infants with reported food intake were included in NHANES to estimate their usual intakes of foods for any survey years of interest. Micronutrient, macronutrient, and energy intake means and distributions of the adequacy percentages discussed in this chapter are presented in Appendix P.

Although USDA-FNS was interested in comparing intakes among WIC participants before and after the 2009 food package change, the indicator of WIC participation for the NHANES 2011–2012 dataset became available only after completion of these analyses. Therefore, a comparison of nutrient intakes among WIC participants before the 2009 food package

[1] Definitions of adequate intake (AI) and other Dietary Reference Intake (DRI) values are provided in Chapter 3, Box 3-1.

changes to those after the changes could not be conducted. Moreover, only the 2005–2008 NHANES data were considered appropriate for comparison of WIC participants to WIC-eligible nonparticipants.[2] All individuals who were income-eligible for WIC from NHANES 2011–2012 were analyzed as a proxy for WIC participants. In phase II, the WIC indicator will be applied to the NHANES 2011–2012 dataset so that, depending on the sample sizes in 2011–2012, intakes of WIC participants in 2011–2012 can be compared to those of income-eligible nonparticipants. With adequate sample sizes, WIC participant intakes can also be compared before and after the 2009 food package changes.

Nutrient intakes were compared to the DRI references values appropriate for evaluation of groups, the Estimated Average Requirement (EAR) or the AI values, the UL, and the Acceptable Macronutrient Distribution Range (AMDR). PC Software for Intake Distribution (PC-SIDE) was used to implement the ISU method of determining usual nutrient intake distributions. The methods used to conduct these analyses of NHANES data are described in detail in Chapter 3. As indicated in Chapter 3, the prevalence of inadequacy or excess was estimated by determining the proportion of persons in the group whose usual intakes do not reach the EAR, fall outside of the AMDR, or exceed the UL. When combining groups with different EARs, intakes in one of the groups were rescaled so they can be compared to the EAR of the other group (IOM, 2000a). This re-scaling approach was applied to the group with children 1 to less than 5 years of age, and to the combined group of pregnant, breastfeeding, and postpartum women (IOM, 2001). No conclusion can be drawn about the prevalence of inadequacy for an intake level that falls below the AI (IOM, 2000a); therefore, mean intake values are presented for these nutrients.[3] Intakes of macronutrients that fall above or below the AMDR may increase the risk of chronic disease. A prevalence of inadequacy or excess greater than 5 percent was considered of concern.[4] Vitamin D intake data are presented only for infants ages 0 to less than 12 months because serum vitamin D data are not available for this

[2] In addition to the difficulties with separation of the 2009–2010 NHANES dataset, this period spanned the change in food packages. It was therefore not considered appropriate for either the pre- or post-food package change assessments.

[3] Prevalence of inadequacy is presented for nutrients with an EAR. For nutrients with an AI only, interpretation of intake comparisons differs. If mean usual intake meets or exceeds the AI, it can only be said that the prevalence of inadequacy in the population group is likely to be low (IOM, 2000a). Therefore, for nutrients with an AI, the mean intake data are presented.

[4] As described in Chapter 3, a concerning level of inadequate or excessive intake of any nutrient is usually defined as less than 2.5 percent of the population of interest (IOM, 2003). This percentage should translate to an equivalent percentage of impaired function or adverse effect. For this report, a 5 percent threshold was applied. This is a slightly relaxed standard, which accounts for some of the uncertainty in setting the EARs, as well as some of the generally accepted errors associated with dietary assessment.

age group. Vitamin D intake data are not presented for other age groups because of the limited utility of intake information for the assessment of adequacy (Taylor et al., 2013). In phase II, the effects of potential food package changes on vitamin D content of the packages will be assessed in the sensitivity analysis.

For several population subgroups, the sample size is small (i.e., for eligible non-WIC infants 0 to less than 6 months of age, n = 21). Although the mean is adequately precise with small sample sizes in these NHANES datasets (except for the women's subgroup in 2011–2012), intake estimates falling at the ends of the distributions are less precise. For the small subgroup of women, a variance adjustment was applied to reduce the effect of variability in within-person variance (described below and in Chapter 3). WIC participant and eligible non-WIC participant subgroups were compared by t-test. One consequence of the small sample sizes is that the standard error values are large and thus only large differences between means can be detected.

Nutrient Intake of Pregnant, Breastfeeding, and Postpartum Women, Ages 19 to 50 Years

As described in Chapter 3, the sample sizes for pregnant, lactating, and postpartum women were small; therefore respondents of all physiological stages were combined into one analytical subgroup. In addition, the external variances were adjusted by the method of Jahns et al. (2005) to produce estimates that were less subject to the large degree of variability in the within-person variance estimate that can be introduced by a small sample size (described in Chapter 3). The re-scaling method was applied to accommodate differences in nutrient requirements for these various physiological states. There were no statistically significant differences among WIC-participant and eligible nonparticipant subgroups.

Micronutrient Adequacy

For pregnant, breastfeeding, and postpartum women, the prevalence of inadequacy was greater than 5 percent for most nutrients across all subgroups: calcium, copper, iron, magnesium, zinc, thiamin, folate, and vitamins A, E, C, and B6 (see Table 4-1). Low riboflavin and niacin intakes were present in a smaller percentage of women (6 to 9 percent) in the 2005–2008 dataset, but not in the most recent dataset. Micronutrients with the highest prevalences of inadequacy were vitamin E (88 to 98 percent across groups), vitamin A (58 to 60 percent), iron (39 to 66 percent), and magnesium (47 to 65 percent). Vitamin C inadequacy was also present in at least 30 percent of each subgroup analyzed.

TABLE 4-1 Estimated Prevalence of Inadequacy of Selected Nutrients Compared to the Estimated Average Requirement (EAR), Pregnant, Breastfeeding, and Postpartum Women, 19 to 50 Years of Age, NHANES 2005–2008 and 2011–2012

		% Inadequacy (SE)[a]		
Nutrient	EAR (NPNL/P/BF)[b] (per day)	WIC,[c] 2005–2008 (N = 260)	Eligible Non-WIC,[d] 2005–2008 (N = 90)	All Low-Income,[e] 2011–2012 (N = 34)
Calcium	800 mg	31.1 (4.57)	32.2 (9.50)	18.0 (19.88)
Copper	0.7/0.8/1.0 mg	19.4 (5.06)	12.6 (8.08)	7.2 (14.23)
Iron	8.1/22.0/6.5 mg	66.2 (3.55)	53.3 (6.01)	38.5 (12.09)
Magnesium	255/290/255[f] mg	65.3 (3.86)	55.0 (6.07)	46.7 (10.29)
Phosphorus	580 mg	1.7 (1.51)	2.5 (3.49)	0.0 (0.34)
Selenium	45/49/59 μg	1.0 (1.47)	0.9 (2.09)	0
Zinc	6.8/9.5/10.4 mg	37.3 (4.30)	30.5 (9.35)	28.8 (19.98)
Vitamin A	500/550/900 μg RAE	60.1 (4.43)	58.0 (7.34)	59.8 (12.01)
Vitamin E	12/12/16 mg αTOC	98.0 (1.69)	98.3 (3.71)	88.4 (14.46)
Vitamin C	60/70/100 mg	39.1 (4.57)	32.0 (10.22)	35.5 (13.44)
Thiamin	0.9/1.2/1.2 mg	22.0 (5.41)	15.9 (11.06)	5.4 (13.43)
Riboflavin	0.9/1.2/1.2 mg	7.9 (4.07)	7.1 (8.18)	1.7 (6.39)
Niacin	11/14/13 mg	8.9 (4.24)	6.0 (6.10)	0.1 (0.54)
Vitamin B6	1.1[g]/1.6/1.7 mg	41.7 (3.70)	34.3 (8.20)	18.9 (18.17)
Folate	320/520/450 μg DFE	50.1 (4.27)	41.7 (7.85)	15.1 (21.09)
Vitamin B12	2.0/2.2/2.4 mg	4.7 (3.60)	1.1 (3.67)	0.6 (3.86)

NOTES: αTOC = α-tocopherol; DFE = dietary folate equivalent; EAR = Estimated Average Requirement; N = sample size; NPNL/P/BF = Nonpregnant, nonlactating/pregnant/breastfeeding; RAE = retinol activity equivalent; SE = standard error. There were no statistically significant differences between WIC and eligible non-WIC subgroups.

[a] % Inadequacy = percentage of individuals with usual intake below the EAR.

[b] The approach of IOM (2000) was applied in which, when combining groups with different EARs, intakes in one of the groups are rescaled so they can be compared to the EAR of the other group. Values represent the NPNL/P/BF groups. One value indicates that the EAR is the same across groups.

Subgroup definitions are as follows:

[c] WIC = All individuals reporting participation in WIC regardless of income level. Some women reporting WIC participation did not report being pregnant, breastfeeding, or postpartum.

[d] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

[e] All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.

TABLE 4-1 Continued

[f] The EAR for NPNL women 19–30 years is 255 and for women 31–50 years it is 265. The EAR for P women 19–30 years is 290 and for the EAR for P women 31–50 years is 300; The EAR for BF women 19–30 years is 255 and for BF women 31–50 years the EAR is 265.
[g] The EAR for NPNL women 19-30 years is 1.1 and for women 31-50 years is 1.3.
SOURCES: Intake data were obtained from NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012). EARs are from Dietary Reference Intake reports (IOM, 1997, 1998, 2000, 2001, 2002/2005, 2005, 2011).

Intakes of Nutrients with an AI

Among nutrients with AIs, mean usual intakes of potassium and choline were below the AI across all subgroups (see Table 4-2).

Macronutrient and Energy Intake

Protein intakes for women were low, with the prevalence of inadequacy ranging from 24 to 38 percent across subgroups (see Table 4-3). Total fat intakes expressed as a percentage of calories, however, were high across all groups, with 49 percent of 2011–2012 low-income women having intakes above the AMDR. Excessive energy from total fat was more prevalent for WIC participating (39 percent) compared to WIC-eligible nonparticipating women (18 percent). Approximately 11 percent of women across all subgroups had excessive energy from saturated fat. The prevalence of low percentage of energy from carbohydrate was high only for WIC participants (11 percent), compared to 3 percent for eligible nonparticipants. Given that lowering or raising the percent of energy from one dietary macronutrient affects the contribution of the others, it is possible that the prevalence of excessive energy intakes from total fat is related to the prevalence of low energy intakes from carbohydrate. However, as recommended in the *Scientific Report of the 2015 Dietary Guidelines Advisory Committee* (2015 DGAC report) the focus for this age group should be ensuring that the intake of energy from saturated fat is below 10 percent (USDA/HHS, 2015). The 2015 DGAC report did not include any recommendations on energy from total fat or from carbohydrates. As shown in Table 4-3, all three of the subgroups examined here reported a mean energy intake from saturated fat that was slightly above the recommended 10 percent.

Mean fiber intakes for women were below the AI, and mean intakes of added sugars were excessive across all subgroups. Reported energy intake data are presented in Table 4-4. Mean usual intakes were higher than the calculated Estimated Energy Requirements (EERs) for WIC-eligible non-participating women and 2011–2012 low-income women, but not for WIC

TABLE 4-2 Estimated Mean Usual Intakes of Selected Nutrients Compared to the Adequate Intake (AI) Value, Pregnant, Breastfeeding, and Postpartum Women, 19 to 50 Years of Age, NHANES 2005–2008 and 2011–2012

		Mean Intakes, mg/d (SE)		
Nutrient	AI (NPNL/P/BF)[a] (mg/d)	WIC,[b] 2005–2008 (N = 260)	Eligible Non-WIC,[c] 2005–2008 (N = 90)	All Low-Income,[d] 2011–2012 (N = 34)
Potassium	4,700/4,700/5,100	2,402 (50.89)	2,540 (92.33)	2,544 (94.93)
Sodium	1,500	3,197 (50.54)	3,249 (101.20)	3,676 (169.13)
Choline	425/450/550	290 (5.25)	320 (12.22)	302 (12.00)

NOTES: AI = Adequate Intake; N = sample size; NPNL/P/BF = Non-pregnant, non-lactating pregnant/breastfeeding; SE = standard error. There were no statistically significant differences between WIC and eligible non-WIC subgroups.

[a] Values represent the AI for NPNL/P/BF groups. One value indicates that the AI is the same across groups.

Subgroup definitions are as follows:

[b] WIC = All individuals reporting participation in WIC regardless of income level. Some women reporting WIC participation did not report being pregnant, breastfeeding, or postpartum.

[c] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

[d] All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.

SOURCES: Intake data were obtained from NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012). AIs are from Dietary Reference Intake reports (IOM, 1998, 2005).

TABLE 4-3 Estimated Intakes of Macronutrients Compared to Recommended Intakes, Pregnant, Breastfeeding, and Postpartum Women, 19 to 50 Years of Age, NHANES 2005–2008 and 2011–2012

		Comparison to DRI or Recommended Limit (SE)		
Nutrient and DRI or Recommended Daily Limits[a]	Units for Comparison to DRI or Recommended Limit per Day	WIC,[b] 2005–2008 (N = 260)	Eligible Non-WIC,[c] 2005–2008 (N = 90)	All Low-Income,[d] 2011–2012 (N = 34)
Protein (EAR)				
0.66/0.88/1.05 g/kg[e]	% below EAR	38.0 (3.79)	24.1 (6.92)	31.6 (11.18)

TABLE 4-3 Continued

Nutrient and DRI or Recommended Daily Limits[a]	Units for Comparison to DRI or Recommended Limit per Day	Comparison to DRI or Recommended Limit (SE)		
		WIC,[b] 2005–2008 (N = 260)	Eligible Non-WIC,[c] 2005–2008 (N = 90)	All Low-Income,[d] 2011–2012 (N = 34)
Carbohydrate, total (AMDR)				
< 45% of kcal	% below AMDR	11.4 (5.79)	2.8 (7.14)	6.2 (15.75)
> 65% of kcal	% above AMDR	1.3 (1.73)	1.1 (3.80)	0
Fiber (AI)				
25/28/29 g[f]	Mean, g	14.5 (0.40)	15.4 (0.67)	14.6 (1.00)
Added sugars (limit)				
7.6 tsp-eq	Mean tsp-eq	23.0 (4.65)	22.2 (7.06)	20.1 (8.78)
Fat, total (AMDR)				
< 20% of kcal	% below AMDR	0.3 (0.48)	0.1 (0.31)	0
> 35% of kcal	% above AMDR	38.7 (4.72)	18.0 (13.18)	49.1 (14.34)
Fat, saturated (limit)				
< 10% of kcal	Mean, % of kcal	11.1 (0.10)	10.8 (0.19)	11.3 (0.33)

NOTES: AI = Adequate Intake; AMDR = Acceptable Macronutrient Distribution Range; DRI = Dietary Reference Intake; EAR = Estimated Average Requirement; g/d = grams per day; g/kg/d = grams per kilogram of body weight per day; kcal = kilocalories; N = sample size; SE = standard error. There were no statistically significant differences between WIC and eligible non-WIC subgroups.

[a] Values represent a DRI except for added sugars and saturated fat, for which values represent the recommended upper limit of daily intake for a 2,200 kcal diet.

Subgroup definitions are as follows:

[b] WIC = All individuals reporting participation in WIC regardless of income level. Some women reporting WIC participation did not report being pregnant, breastfeeding, or postpartum.

[c] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

[d] All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.

[e] The protein EAR for adults is 0.66 g/kg/d,0.88 g/kg/d for pregnancy, and 1.05 g/kg/d for breastfeeding. The approach of IOM (2000) was applied in which, when combining groups with different DRIs, intakes in one of the groups are rescaled so they can be compared to the DRI of the other group.

[f] Values represent the AI for nonpregnant, nonlactating/pregnant/breastfeeding women.

SOURCES: Intake data were obtained from NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012). Reference intakes for protein, total carbohydrate, total fat, and fiber are from the Dietary Reference Intake report (IOM, 2002/2005). Reference intakes for saturated fat and added sugars are from the *Scientific Report of the 2015 Dietary Guidelines Advisory Committee* (USDA/HHS, 2015).

TABLE 4-4 Estimated Usual Energy Intake and Estimated Energy Requirements, Pregnant, Breastfeeding, and Postpartum Women, 19 to 50 Years of Age, NHANES 2005–2008 and 2011–2012

	kcal/d (SE)		
Energy Intake and Estimated Requirements	WIC,[a] 2005–2008 (N = 260)	Eligible Non-WIC,[b] 2005–2008 (N = 90)	All Low-Income,[c] 2011–2012 (N = 34)
Estimated Energy Requirement[d]			
Median	2,211 (27.9)	2,062 (40.0)	2,165 (91.6)
Mean	2,262 (22.3)	2,080 (31.9)	2,206 (73.1)
Usual Energy Intakes			
Median	1,992 (47.3)	2,170 (97.6)	2,346 (152.0)
Mean	2,044 (33.4)	2,220 (71.5)	2,361 (98.8)

NOTES: EER = Estimated Energy Requirement; kcal = kilocalories; N = sample size; SE = standard error.

Subgroup definitions are as follows:

[a] WIC = All individuals reporting participation in WIC regardless of income level. Some women reporting WIC participation did not report being pregnant, breastfeeding, or postpartum.

[b] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

[c] All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.

[d] EERs were calculated assuming a low-active physical activity level. For pregnant women, EER calculations assumed the second trimester. For lactating women, EER calculations assumed the first 6-month period postpartum.

SOURCES: Intake data were obtained from NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012). EERs were calculated according to Dietary Reference Intake report (IOM, 2002/2005).

participating women. These findings should be interpreted with caution because reported energy intakes are known to be inaccurate (Subar et al., 2015) and mean intakes could also be affected by differing proportions of pregnant, lactation, and postpartum women within each subgroup.

Micronutrient Excess

The prevalence of excessive sodium intakes was high (84 to 92 percent) in all subgroups of women (see Table 4-5). Excess iron intakes were evident in only slightly more than 5 percent of subgroups, except for low-income women in the most recent dataset in which 13 percent of women exceeded the UL.

TABLE 4-5 Estimated Prevalence of Micronutrient Excess Compared to Tolerable Upper Intake Level (UL), Pregnant, Breastfeeding, and Postpartum Women, 19 to 50 Years of Age, NHANES 2005–2008 and 2011–2012

		% of Population Above the UL (SE)		
Nutrient	UL (per day)	WIC,[a] 2005–2008 (N = 260)	Eligible Non-WIC,[b] 2005–2008 (N = 90)	All Low-Income,[c] 2011–2012 (N = 34)
Calcium	2,500 mg	0.1 (0.17)	0.1 (0.36)	0
Iron	45 mg	5.5 (2.44)	5.8 (4.97)	13.3 (14.16)
Sodium	2,300 mg	87.1 (5.53)	83.6 (9.09)	91.9 (9.93)

NOTES: N = sample size; SE = standard error; UL = Tolerable Upper Intake Level. Not included in table: percentages above the UL for these nutrients were < 0.01%: copper, phosphorus, selenium, zinc, retinol, vitamin C, vitamin B6, folic acid, and choline. There were no statistically significant differences between WIC and eligible non-WIC subgroups.

Subgroup definitions are as follows:

[a] WIC = All individuals reporting participation in WIC regardless of income level. Some women reporting WIC participation did not report being pregnant, breastfeeding, or postpartum.

[b] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

[c] All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.

SOURCES: Intake data are from NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012). ULs from Dietary Reference Intake reports (IOM, 1998, 2001, 2005, 2011).

Nutrient Intakes of Formula-Fed Infants

No data on the nutrient intakes of breastfed infants are presented because their intake of human milk was not measured in NHANES, and information on intake of other foods is available for very few of them. As a result, this section applies exclusively to infants who were coded as "formula-fed" in the NHANES dataset (intake of human milk may be occurring in these infants, but is unknown). The nutrient intakes of formula-fed infants were analyzed in two age groups: (1) from birth to less than 6 months of age, and (2) from 6 to less than 12 months of age. These groups align with the recommended age for introduction of complementary feeding (about 6 months [AAP, 2014]) and also the current age categories for the WIC food packages for infants (see Appendix D, Table D-1). Intakes for each age group are summarized separately below. Intake distributions for both age groups are presented in Appendix P. For infants, differences between WIC participants and WIC-eligible nonparticipants were not significant.

Formula-Fed Infants 0 to Less Than 6 Months of Age

Micronutrient intake compared to AIs Only AI levels (and not EARs) apply to infants from birth to less than 6 months of age (i.e., EARs were not available). These AIs are presented in Table 4-6 along with mean usual intakes for each nutrient. Mean usual intakes for all nutrients exceeded these AIs, except for choline. Intakes of choline were below the AI in all subgroups.

Macronutrient and energy intake Macronutrient and energy intake of infants up to 6 months of age are presented in Table 4-7. Mean intake of carbohydrates, fat, and protein were similar across subgroups. Mean intakes of protein, carbohydrate, and total fat exceed the AI for these nutrients. The mean usual energy intake of WIC participating infants less than 6 months of age was 705 kcal per day, which is 19 percent higher than the EER of 594 kcal per day for these individuals (see Table 4-8).

Micronutrient excess The prevalence of excessive micronutrient intakes compared to the UL for infants in this age subgroup are presented in Table 4-9. UL values have been defined only for calcium, iron, selenium, retinol, and zinc. Excess zinc intakes occur in more than 90 percent of the formula-fed infants in this analysis. As described in Chapter 3, zinc and retinol intakes above the established ULs are not considered of concern because the method used to set the UL resulted in a narrow margin between the Recommended Dietary Allowance (RDA) and the UL (IOM, 2001). There is no evidence for adverse effects from zinc naturally occurring in food, and retinol toxicity unless from supplemental sources is rare (IOM, 2001). The committee considers infant formula (and zinc provided therein) to be tightly regulated for safety by the U.S. Food and Drug Administration (FDA). Calcium intakes exceeded the UL for 10 percent of young infants only in the 2011–2012 low-income group.

Formula-Fed Infants 6 to Less Than 12 Months of Age

Micronutrient adequacy For micronutrients with EARs, inadequacy is defined as having an intake below the EAR. Micronutrient EARs for this age group have been established only for zinc and iron (see Table 4-10). The prevalence of inadequate zinc intake was low across all subgroups. Differences between WIC participants and eligible nonparticipants in this age group were not statistically significant.

Intake of nutrients with an AI Mean usual intakes of micronutrients without EARs fell close to the AI for choline and above their respective AIs for all other nutrients (see Table 4-11).

TABLE 4-6 Estimated Mean Usual Intakes of Selected Micronutrients Compared to Adequate Intake (AI) Values, Formula-Fed Infants Less Than 6 Months of Age, NHANES 2005–2008 and 2011–2012

			Mean Usual Intake (SE)		
Nutrient	Units (per day)	AI	WIC,[a] 2005–2008 (N = 204)	Eligible Non-WIC,[b] 2005–2008 (N = 21)	All Low-Income,[c] 2011–2012 (N = 86)
Calcium	mg	200	625 (11.36)	582 (41.15)	693 (27.01)
Copper	mg	0.2	0.67 (0.01)	0.62 (0.03)	0.65 (0.02)
Iron	mg	0.27	15.52 (0.45)	14.14 (1.02)	14.31 (0.54)
Magnesium	mg	30	77 (2.240)	68 (7.02)	78 (3.07)
Phosphorus	mg	100	388 (9.32)	365 (34.91)	394 (20.59)
Selenium	µg	15	18 (0.40)	16 (0.63)	17 (0.54)
Zinc	mg	2	6 (0.12)	6 (0.26)	6 (0.18)
Potassium	mg	400	821 (17.36)	754 (46.40)	835 (26.40)
Sodium	mg	120	236 (5.66)	215 (13.12)	240 (7.99)
Vitamin A	µg RAE	400	625 (9.68)	584 (36.87)	654 (18.81)
Vitamin E	mg αTOC	4	8 (0.16)	8 (0.72)	8 (0.25)
Vitamin C	mg	40	83 (1.99)	82 (4.79)	78 (3.09)
Thiamin	mg	0.2	0.8 (0.03)	0.7 (0.07)	0.7 (0.03)
Riboflavin	mg	0.3	1.1 (0.03)	1 (0.04)	1.1 (0.04)
Niacin	mg	2	10 (0.30)	9 (1.03)	9 (0.37)
Vitamin B6	mg	0.1	0.5 (0.01)	0.4 (0.03)	0.5 (0.02)
Folate	µg DFE	65	180 (3.10)	166 (10.42)	181 (4.82)
Vitamin B12	mg	0.4	1.9 (0.03)	1.8 (0.14)	1.9 (0.06)
Choline	mg	125	97 (2.23)	86 (3.42)	113 (4.12)

NOTES: αTOC = α-tocopherol; AI = Adequate Intake; DFE = dietary folate equivalent; N = sample size; RAE = retinol activity equivalent; SE = standard error. There were no statistically significant differences between WIC and eligible non-WIC subgroups.

Subgroup definitions are as follows:

[a] WIC = All individuals reporting participation in WIC regardless of income level.

[b] Eligible Non-WIC = Low-income individuals that did not report participation in WIC.

[c] All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.

SOURCES: Intake data are from NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012). AIs are from Dietary Reference Intake reports (IOM, 1997, 1998, 2000, 2001, 2002/2005, 2005, 2011).

TABLE 4-7 Estimated Mean Intakes of Macronutrients, Formula-Fed Infants Less Than 6 Months of Age, NHANES 2005–2008 and 2011–2012

Nutrient	AI (per day)	Units (per day)	Mean Intake (SE) WIC,[a] 2005–2008 (N = 204)	Eligible Non-WIC,[b] 2005–2008 (N = 21)	All Low-Income,[c] 2011–2012 (N = 86)
Protein	1.52 g/kg	g/kg	2.4 (0.05)	2.5 (0.19)	2.5 (0.09)
Carbohydrate, total	60 g/d	g/d	82.4 (0.62)	75.6 (1.14)	81.4 (0.61)
Carbohydrate, total	NR	% of kcal	46.8 (0.35)	45.9 (0.69)	45.5 (0.34)
Added sugars	NR	tsp-eq	0.2 (0.30)	NA[d]	NA
Fat, total	31 g	g	44.5 (0.32)	45.1 (0.85)	45.7 (0.34)
Fat, saturated	NR	g	13.9 (0.15)	13.0 (0.29)	15.4 (0.28)
Fat, saturated	NR	% of kcal	17.6 (0.19)	17.7 (0.40)	19.3 (0.35)

NOTES: AI = Adequate Intake level; g/kg/d = grams per kilogram of body weight per day; kcal = kilocalories; N = sample size; NA = data not available; NR = no recommendation; SE = standard error; tsp-eq/d = teaspoon-equivalents per day. Intake data were insufficient to calculate reliable estimates for fiber intakes. There were no statistically significant differences between the WIC and eligible non-WIC subgroups.

Subgroup definitions are as follows:

[a] WIC = All individuals reporting participation in WIC regardless of income level.

[b] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

[c] All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.

[d] All NA notations indicate that data are not available because Statistical Program for Age-adjusted Dietary Assessment (SPADE) requires more than two observations per group with two non-zero intakes in order to estimate a within-person variance.

SOURCES: Intake data were obtained from NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012). Reference intakes for protein, total carbohydrate, and total fat are per the Dietary Reference Intake report (IOM, 2002/2005).

Macronutrient and energy intake As was the case for younger infants, intakes of carbohydrate, fat, and protein were similar across all subgroups (see Table 4-12) ($p > 0.1$). For children 6 to less than 12 months of age, there is a DRI only for protein (11 g per day, as the RDA or 1.0 g/kg per day as the EAR). Nearly 100 percent of the infants in this age group exceeded the DRI for protein, with usual mean intake of 24 g per day (see Appendix P, Tables P-22 to P-24). Reported mean usual energy intake exceeded the calculated EER for all subgroups and was similar among the subgroups (see Table 4-13).

TABLE 4-8 Estimated Usual Energy Intake and Estimated Energy Requirement, Formula-Fed Infants Less Than 6 Months of Age, NHANES 2005–2008 and 2011–2012

	kcal/d (SE)		
Energy Intake and Estimated Requirements	WIC,[a] 2005–2008 (N = 204)	Eligible Non-WIC,[b] 2005–2008 (N = 21)	All Low-Income,[c] 2011–2012 (N = 86)
Estimated Energy Requirement			
Median	603 (10.8)	497 (41.0)	630 (16.0)
Mean	594 (8.6)	547 (32.7)	618 (12.8)
Usual Energy Intakes			
Median	693 (15.0)	629 (37.1)	702 (21.7)
Mean	705 (11.9)	659 (34.0)	716 (17.6)

NOTES: EER = Estimated Energy Requirement; kcal = kilocalories; N = sample size; SE = standard error. There were no statistically significant differences between WIC and eligible non-WIC subgroups.

Subgroup definitions are as follows:

[a] WIC = All individuals reporting participation in WIC regardless of income level.

[b] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

[c] All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.

SOURCES: Intake data were obtained from NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012). EERs were calculated according to Dietary Reference Intake report (IOM, 2002/2005).

Micronutrient excess Across all subgroups, 86 to 89 percent of infants ages 6 to less than 12 months exceeded the UL for zinc, 29 to 36 percent exceeded the UL for retinol, and approximately 7 percent exceeded the UL for selenium (see Table 4-14). As noted for infants 0 to less than 6 months of age, zinc and retinol intakes above the UL are not considered of concern for this age group. Although 9 percent of WIC-eligible nonparticipating infants exceeded the UL for calcium, few WIC participating infants had intakes that were too high.

Evaluation of iron and energy provided in the WIC food packages for fully formula-feeding infants WIC formula is required to contain a minimum of 1.5 mg iron per 100 kilocalories at standard dilution[5] (USDA/FNS, 2014). Participating formula-fed WIC participating infants ages 0 to 3 months old

[5] The FDA regulatory requirements for iron range from 0.15 to 3 mg per 100 mL (21 CFR § 107.100).

TABLE 4-9 Estimated Prevalence of Micronutrient Excess Compared to the Tolerable Upper Intake Level (UL), Formula-Fed Infants Less Than 6 Months of Age, NHANES 2005–2008 and 2011–2012

		% of Population Above the UL (SE)		
Nutrient	UL (per day)	WIC,[a] 2005–2008 (N = 204)	Eligible Non-WIC,[b] 2005–2008 (N = 21)	All Low-Income,[c] 2011–2012 (N = 86)
Calcium	1,000 mg	2.2 (1.8)	3.4 (5.8)	10.6 (4.9)
Zinc	4 mg	92.2 (3.5)	92.8 (10.0)	91.0 (4.5)
Retinol	600 μg	39.2 (2.9)	30.4 (9.8)	49.1 (5.5)

NOTES: N = sample size; SE = standard error; UL = Tolerable Upper Intake Level. Less than 0.01 percent of all population subgroups had iron, or selenium intakes exceeding the UL. There were no statistically significant differences between WIC and eligible non-WIC subgroups.

Subgroup definitions are as follows:

[a] WIC = All individuals reporting participation in WIC regardless of income level.

[b] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

[c] All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.

SOURCES: Intake data are from NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012). ULs from Dietary Reference Intake reports (IOM, 1998, 2001, 2011).

TABLE 4-10 Estimated Prevalence of Inadequacy of Selected Micronutrients Compared to Estimated Average Requirement (EAR) Values, Formula-Fed Infants 6 to Less Than 12 Months of Age, NHANES 2005–2008 and 2011–2012

		% Inadequacy (SE)[a]		
Nutrient	EAR (per day)	WIC,[b] 2005–2008 (N = 252)	Eligible Non-WIC,[c] 2005–2008 (N = 35)	All Low-Income,[d] 2011–2012 (N = 82)
Iron	6.9 mg	5.0 (2.0)	7.0 (6.0)	9.0 (8.0)
Zinc	2.5 mg	0.3 (0.4)	0	0.2 (0.2)

NOTES: EAR = Estimated Average Requirement; N = sample size; SE = standard error. There were no statistically significant differences between WIC and eligible non-WIC subgroups.

[a] % Inadequacy = percentage of individuals with usual intake below the EAR.

Subgroup definitions are as follows:

[b] WIC = All individuals reporting participation in WIC regardless of income level.

[c] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

[d] All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.

SOURCES: Intake data are from NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012). EARs are from Dietary Reference Intake reports (IOM, 1998, 2001).

TABLE 4-11 Estimated Mean Usual Intakes of Selected Micronutrients Compared to Adequate Intake (AI) Values, Formula-Fed Infants 6 to Less Than 12 Months of Age, NHANES 2005–2008 and 2011–2012

		Mean Usual Intake (SE)		
Nutrient	AI (per day)	WIC,[a] 2005–2008 (N = 252)	Eligible Non-WIC,[b] 2005–2008 (N = 35)	All Low-Income,[c] 2011–2012 (N = 82)
Calcium	260 mg	752 (14.15)	858 (83.28)	832 (25.68)
Copper	0.22 mg	0.76 (0.01)	0.63 (0.02)	0.72 (0.02)
Magnesium	75 mg	122 (2.58)	124 (7.91)	124 (3.56)
Phosphorus	275 mg	618 (14.87)	690 (67.20)	607 (26.76)
Selenium	20 µg	35 (0.95)	34 (2.94)	33 (1.85)
Potassium	700 mg	1,353 (28.72)	1,389 (90.43)	1,286 (43.11)
Sodium	370 mg	780 (36.41)	667 (84.51)	698 (48.93)
Vitamin A	500 µg RAE	676 (12.27)	764 (34.34)	725 (30.68)
Vitamin E	5.0 mg αTOC	8.0 (0.18)	5.9 (0.44)	8.6 (0.33)
Vitamin C	50 mg	119 (2.74)	92 (8.12)	97 (3.33)
Thiamin	0.3 mg	1.0 (0.02)	0.9 (0.05)	1.0 (0.04)
Riboflavin	0.4 mg	1.5 (0.03)	1.7 (0.13)	1.5 (0.05)
Niacin	4.0 mg	12.3 (0.28)	9.9 (0.44)	12.5 (0.54)
Vitamin B6	0.3 mg	0.8 (0.02)	0.8 (0.03)	0.8 (0.03)
Folate	80 µg DFE	239 (5.29)	189 (7.44)	224 (7.70)
Vitamin B12	0.5 mg	2.6 (0.07)	3.1 (0.38)	2.5 (0.11)
Choline	150 mg	149 (3.31)	151 (10.98)	138 (5.80)

NOTES: αTOC = α-tocopherol equivalents; AI = Adequate Intake; DFE = dietary folate equivalent; N = sample size; SE = standard error. There were no statistically significant differences between WIC and eligible non-WIC subgroups.

Subgroup definitions are as follows:

[a] WIC = All individuals reporting participation in WIC regardless of income level.

[b] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

[c] All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.

SOURCES: Intake data are from NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012). AIs are from Dietary Reference Intake reports (IOM, 1997, 1998, 2000, 2001, 2002/2005, 2005, 2011).

TABLE 4-12 Estimated Usual Intakes of Macronutrients, Formula-Fed Infants 6 to Less Than 12 Months of Age, NHANES 2005–2008 and 2011–2012

			Mean Usual Intake (SE)		
Nutrient	DRI (per day)	Units (per day)	WIC,[a] 2005–2008 (N = 252)	Eligible Non-WIC,[b] 2005–2008 (N = 35)	All Low-Income,[c] 2011–2012 (N = 82)
Protein	1.0 g/kg (EAR)	g/kg	2.9 (0.08)	3.2 (0.28)	2.9 (0.13)
Carbohydrate, total	95 g (AI)	g	129 (0.93)	124 (2.40)	123 (1.31)
Carbohydrate, total	NR	% of kcal	52.8 (0.38)	52.6 (1.02)	52.6 (0.56)
Fiber	NR	g	5.1 (0.19)	4.5 (0.43)	5.0 (0.31)
Added sugars	NR	tsp-eq	2.7 (1.40)	3.2 (2.19)	3.1 (2.74)
Fat, total	30 g (AI)	g	40.2 (0.35)	37.5 (0.74)	38.7 (0.56)
Fat, total	NR	% of kcal	37.0 (0.32)	35.9 (0.71)	37.2 (0.54)
Fat, saturated	NR	g	16.0 (0.17)	15.8 (0.50)	15.4 (0.27)
Fat, saturated	NR	% of kcal	14.7 (0.16)	15.1 (0.48)	14.9 (0.26)

NOTES: AI = Adequate Intake; EAR = Estimated Average Requirement; g/d = grams per day; g/kg/d = grams per kilogram of body weight per day; kcal = kilocalories; N = sample size; NR = no recommendation; SE = standard error. There were no statistically significant differences between WIC and eligible non-WIC subgroups.

Subgroup definitions are as follows:

[a] WIC = All individuals reporting participation in WIC regardless of income level.

[b] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

[c] All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.

SOURCES: Intake data were obtained from NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012). Reference intakes for protein, total carbohydrate, and total fat are per the Dietary Reference Intake report (IOM, 2002/2005).

receive 806 fl oz per month (537 kcal per day), and infants 4 to less than 6 months of age receive 884 fl oz per month (589 kcal per day). These quantities of formula provide slightly less energy than the calculated EER for the WIC subgroup in this report, 594 kcal per day. Infants participating in WIC who consume infant formula as their sole source of nutrition would be provided with 8.1 to 8.8 mg of iron per day at this range of energy intakes. This quantity of iron is above the AI (0.27 mg per day), but below the UL (40 mg per day) for infants in this age category (see Table 4-15). In this analysis, WIC formula provided to infants ages 6 to less than 12 months

TABLE 4-13 Estimated Usual Energy Intake and Estimated Energy Requirement, Formula-Fed Infants 6 to Less Than 12 Months of Age, NHANES 2005–2008 and 2011–2012

	Mean kcal/d (SE)		
Energy Intake and Estimated Requirements	WIC,[a] 2005–2008 (N = 252)	Eligible Non-WIC,[b] 2005–2008 (N = 35)	All Low-Income,[c] 2011–2012 (N = 82)
Estimated Energy Requirement			
Median	750 (9.0)	687 (19.3)	705 (16.8)
Mean	744 (7.2)	713 (15.4)	717 (13.4)
Usual Energy Intakes			
Median	941 (19.9)	914 (48.0)	911 (37.9)
Mean	978 (17.1)	941 (36.7)	936 (26.6)

NOTES: EER = Estimated Energy Requirement; kcal = kilocalories; N = sample size; SE = standard error.

Subgroup definitions are as follows:

[a] WIC = All individuals reporting participation in WIC regardless of income level.

[b] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

[c] All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.

SOURCES: Intake data were obtained from NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012). EERs were calculated according to Dietary Reference Intake report (IOM, 2002/2005).

provides approximately half of energy needs, based on the EER for WIC-participating children, and slightly less than the AI for iron. It is presumed that infants begin to receive complementary foods between 4 and 6 months of age to meet their increased needs for energy and nutrients.

Nutrient Intakes of Children, Ages 1 to Less Than 2 Years

For this age group, there were no statistically significant differences between WIC participants and eligible non-WIC subgroups.

Micronutrient Adequacy

For children 1 to less than 2 years of age, estimated mean usual intakes of all nutrients with EARs were adequate across all subgroups, with the exception of vitamin E (see Table 4-16).

TABLE 4-14 Estimated Prevalence of Micronutrient Excess Compared to the Tolerable Upper Intake Level (UL), Formula-Fed Infants 6 to Less Than 12 Months of Age, NHANES 2005–2008 and 2011–2012

		% of Population Above the UL (SE)		
Nutrient	UL (per day)	WIC,[a] 2005–2008 (N = 252)	Eligible Non-WIC,[b] 2005–2008 (N = 35)	All Low-Income,[c] 2011–2012 (N = 82)
Calcium	1,500 mg	0.4 (0.4)	9.2 (6.9)	0.7 (1.5)
Selenium	60 µg	7.6 (2.9)	7.5 (7.3)	6.9 (5.2)
Iron	40 mg	0.4 (0.4)	0.1 (0.3)	1.3 (1.6)
Zinc	5 mg	86.1 (3.9)	88.5 (11.5)	86.7 (8.5)
Retinol	600 µg	29.2 (4.2)	36.1 (8.9)	32.3 (7.4)

NOTES: N = sample size; SE = standard error; UL = Tolerable Upper Intake Level. Less than 0.01% of all subgroups had folic acid intakes above the UL. There were no statistically significant differences between WIC and eligible non-WIC subgroups.

Subgroup definitions are as follows:

[a] WIC = All individuals reporting participation in WIC regardless of income level.

[b] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

[c] All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.

SOURCES: Intake data are from NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012). ULs are from Dietary Reference Intake reports (IOM, 2000b, 2001, 2011).

Intakes of Nutrients with an AI

Among nutrients with AIs, mean potassium intakes were below the AI for all subgroups (see Table 4-17). Mean intakes of other nutrients fell above the AI values.

Macronutrient and Energy Intake

The macronutrient intakes for this age group are summarized in Table 4-18. Although the 2015 DGAC report's recommendations were for children aged 2 years and older, the recommended limits on percentage of energy from saturated fat and grams of sugar are applied here as well. Mean saturated fat intakes were high across all subgroups (more than 10 percent of energy), and fiber intakes were low. For WIC participating children, intake of added sugars was approximately twice the recommended

TABLE 4-15 Energy and Iron Provided to Fully Formula-Feeding WIC Infants Compared to the EER and DRI

Formula Volume, Energy, or Iron Provided to Infants	Units	Infant Age (months)		
		0–3	4–5	6–11
FNB[a]	fl oz/month	806	884	624
FNB	kcal/d	537	589	416
EER for WIC subgroup	kcal/d	594[b]	594[b]	744[c]
FNB	% of EER	90.5	99.2	55.9
Iron provided in FNB[d]	mg/d	8.1	8.8	6.2
AI or EAR for iron	mg/d	0.27[e]	0.27[e]	6.9[f]
UL for iron	mg/d	40	40	40

NOTE: AI = adequate intake; DRI = Dietary Reference Intake; EAR = Estimated Average Requirement; EER = Estimated Energy Requirement; FNB = full nutrition benefit; UL = Tolerable Upper Intake Level.

[a] Based on the USDA-FNS final rule.

[b] Based on formula-fed infants ages 0 to less than 6 months in NHANES 2005–2008, n = 204. This information has been updated since the initial release of this report.

[c] Based on formula-fed infants ages 6 to less than 12 months in NHANES 2005–2008, n = 252.

[d] Based on the WIC minimum requirement of 1.5 mg iron/100 kilocalories) at standard dilution.

[e] An AI value (mean intakes exceeding this value are likely to be adequate).

[f] An EAR value (mean intakes below this value are likely to be inadequate).

SOURCES: USDA/FNS, 2014; NHANES data from USDA/ARS, 2005–2008; EERs were calculated according to Dietary Reference Intake report (IOM, 2002/2005).

limit (3.2 tsp-eq per day) for the 1,000–1,300 kcal weighted diet pattern[6] applied to children in this report. If a lower energy intake level, closer to the mean EER for WIC participants in this age group was considered (925 kcal), intakes of these macronutrients are of even greater concern. As noted for women who also had low intakes of carbohydrate, the focus for this age group is the excessive intake of saturated fat as opposed to low carbohydrate intake.

Usual energy intake estimates and the corresponding EER values are presented in Table 4-19. Estimated mean intakes exceeded the EERs across subgroups. For example, energy intake of WIC participating children (1,314 kcal per day) was 42 percent higher than the EER for this subgroup (925 kcal per day).

[6] To evaluate the diets of all children 1 to less than 5 years of age, the committee applied a weighted food pattern (a 1,000 kcal pattern weighted 1:3 with the average of 1,200- and 1,400-kcal patterns) as described in Chapter 3.

TABLE 4-16 Estimated Prevalence of Inadequacy of Selected Micronutrients Compared to Estimated Average Requirement (EAR) Values, Children 1 to Less Than 2 Years of Age, NHANES 2005–2008 and 2011–2012

		% Inadequacy (SE)[a]		
Nutrient	EAR (per day)	WIC,[b] 2005–2008 (N = 311)	Eligible Non-WIC,[c] 2005–2008 (N = 106)	All Low-Income,[d] 2011–2012 (N = 112)
Calcium	500 mg	2.2 (1.58)	1.6 (2.94)	2.6 (4.02)
Iron	3 mg	0	1.0 (1.0)	0
Magnesium	65 mg	0	0	0.1 (0.33)
Phosphorus	380 mg	0.2 (0.22)	0.1 (0.31)	0.1 (0.26)
Selenium	17 μg	0	0.1 (0.23)	0
Vitamin A	210 μg RAE	0.5 (0.74)	1.1 (1.99)	0.5 (1.38)
Vitamin E	5 mg αTOC	91.2 (4.36)	85.1 (8.88)	72.9 (6.51)
Vitamin C	13 mg	0.6 (0.60)	0.02 (0.08)	0.2 (0.55)
Thiamin	0.4 mg	0	0	0.4 (0.70)
Niacin	5 mg	0.3 (0.52)	0.8 (1.32)	0.7 (1.60)
Vitamin B6	0.4 mg	0	0	0.1 (0.34)
Folate	120 μg DFE	0.4 (0.57)	0.1 (0.45)	0.6 (1.31)
Vitamin B12	0.7 mg	0	0	0.04 (0.15)

NOTES: αTOC = α-tocopherol; DFE = dietary folate equivalent; EAR = Estimated Average Requirement; N = sample size; RAE = retinol activity equivalent; SE = standard error. Inadequacy was < 0.15 for copper, zinc, and riboflavin. There were no statistically significant differences between WIC and eligible non-WIC subgroups.

[a] % Inadequacy = percentage of individuals with usual intake below the EAR.

Subgroup definitions are as follows:

[b] WIC = All individuals reporting participation in WIC regardless of income level.

[c] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

[d] All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the “All Low-Income 2011–2012” group serves as a proxy for current intakes of this population.

SOURCES: Intake data were obtained from NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012). EARs are from Dietary Reference Intake reports (IOM, 1997, 1998, 2000, 2001, 2002/2005, 2005, 2011).

Micronutrient Excess

Among all subgroups of children ages 1 to less than 2 years of age, the prevalence of nutrient intakes exceeding the UL was more than 5 percent (see Table 4-20) for zinc, selenium, and retinol. Although there was a high prevalence of zinc and retinol intakes above the UL, this is not of concern

TABLE 4-17 Estimated Mean Usual Intakes of Selected Micronutrients with an Adequate Intake (AI) Value, Children 1 to Less Than 2 Years of Age, NHANES 2005–2008 and 2011–2012

		Mean Usual Intake, mg/d (SE)		
Nutrient	AI (per day)	WIC,[a] 2005–2008 (N = 311)	Eligible Non-WIC,[b] 2005–2008 (N = 106)	All Low-Income,[c] 2011–2012 (N = 112)
Potassium	3,000 mg	2,021 (25.67)	2,032 (43.45)	1,869 (42.84)
Sodium	1,000 mg	1,756 (31.02)	1,820 (63.30)	1,701 (48.21)
Choline	200 mg	215 (3.49)	208 (5.43)	218 (5.84)

NOTES: AI = Adequate Intake; N = sample size; SE = standard error. There were no statistically significant differences between WIC and eligible non-WIC subgroups.

Subgroup definitions are as follows:

[a] WIC = All individuals reporting participation in WIC regardless of income level.

[b] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

[c] All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.

SOURCES: Intake data are from NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012). AIs are from Dietary Reference Intake reports (IOM, 1998, 2005).

for children ages 1 to less than 2 because of the derivation of these values, as described in Chapter 3. The largest difference in excessive intake between WIC-participating children and WIC-eligible nonparticipating children was for selenium (5 percent in WIC participants, compared to 12 percent in non-WIC participants). Even though apparently large, this difference was not statistically significant. The prevalence of excess sodium intake was 62 to 66 percent for all children in this age category.

Nutrient Intakes of Children, Ages 2 to Less Than 5 Years

Micronutrient Adequacy

For children ages 2 to less than 5 years of age, there was a high prevalence of inadequate intake of calcium and vitamin E across all subgroups (see Table 4-21). There were no statistically significant differences between WIC-participant and eligible non-WIC subgroups.

Intakes of Nutrients with an AI

For nutrients with AIs, mean potassium intakes were below the AI for all subgroups (see Table 4-22), while mean choline intakes appear to be

TABLE 4-18 Estimated Intakes of Macronutrients Compared to Recommended Intakes, Children 1 to Less Than 2 Years of Age, NHANES 2005–2008 and 2011–2012

Nutrient and DRI or Recommended Daily Limits[a]	Units for Comparison to DRI or Recommended Limit per Day	Comparison to DRI or Recommended Limit (SE)		
		WIC,[b] 2005–2008 (N = 311)	Eligible Non-WIC,[c] 2005–2008 (N = 106)	All Low-Income,[d] 2011–2012 (N = 112)
Protein (EAR)				
0.87 g/kg	% below EAR	0	0	0
Carbohydrate, total (AMDR)				
< 45% of kcal	% below AMDR	7.8 (4.23)	2.3 (4.26)	6.9 (7.64)
> 65% of kcal	% above AMDR	1.8 (1.81)	0.6 (1.59)	0.5 (1.43)
Fiber (AI)				
19 g	Mean g (AI)	7.8 (0.14)	9.2 (0.33)	8.6 (0.29)
Added sugars (limit)				
3.2 tsp-eq	Mean tsp-eq	8.3 (1.48)	10.3 (3.18)	9 (2.25)
Fat, total (AMDR)				
< 30% of kcal	% below AMDR	26.8 (4.79)	28.1 (6.97)	17.7 (9.93)
> 40% of kcal	% above AMDR	6.1 (3.51)	8.4 (5.88)	4.6 (6.18)
Fat, saturated (limit)				
< 10% of kcal	Mean % of kcal	13.6 (0.16)	13.2 (0.28)	13.1 (0.22)

NOTES: AI = Adequate Intake; AMDR = Acceptable Macronutrient Distribution Range; g/d = grams per day; g/kg/d = grams per kilogram of body weight per day; kcal = kilocalories; N = sample size; SE = standard error; tsp-eq/d = teaspoon equivalents per day. There were no statistically significant differences between WIC and eligible non-WIC subgroups.

[a] Values represent a DRI except for added sugars and saturated fat, for which values represent the recommended upper limit of daily intake for the 1,300 kcal "weighted" food pattern as described in Chapter 3. The resulting calorie level (1,225) may be slightly high for children in this age group.

Subgroup definitions are as follows:

[b] WIC = All individuals reporting participation in WIC regardless of income level.

[c] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

[d] All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.

SOURCES: Intake data were obtained from NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012). Reference intakes for protein, total carbohydrate, total fat, and fiber are per the Dietary Reference Intake report (IOM, 2002/2005). Reference intakes for saturated fat and added sugars are per the *Scientific Report of the 2015 Dietary Guidelines Advisory Committee* (USDA/HHS, 2015).

TABLE 4-19 Estimated Usual Energy Intake and Estimated Energy Requirement, Children 1 to Less Than 2 Years of Age, NHANES 2005–2008 and 2011–2012

Energy Intake and Estimated Requirements	Mean kcal/d (SE) WIC,[a] 2005–2008 (N = 311)	Eligible Non-WIC,[b] 2005–2008 (N = 106)	All Low-Income,[c] 2011–2012 (N = 112)
Estimated Energy Requirement			
Median	917 (11.0)	944 (17.9)	961 (16.0)
Mean	925 (8.8)	945 (14.3)	967 (12.8)
Usual Energy Intakes			
Median	1,284 (25.7)	1,367 (48.6)	1,220 (42.0)
Mean	1,314 (17.2)	1,395 (33.3)	1,242 (27.0)

NOTES: EER = Estimated Energy Requirement; kcal = kilocalories; N = sample size; SE = standard error. There were no statistically significant differences between WIC and eligible non-WIC subgroups.

Subgroup definitions are as follows:

[a] WIC = All individuals reporting participation in WIC regardless of income level.

[b] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

[c] All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.

SOURCES: Intake data were obtained from NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012). EERs were calculated according to Dietary Reference Intake report (IOM, 2002/2005).

adequate and mean sodium intakes were well above the AI. There were no statistically significant differences between WIC and eligible non-WIC subgroups. As for the other age groups, nutrient intake distributions for this age group are presented in Appendix P.

Macronutrient and Energy Intake

Protein intakes were adequate for all children in this age group, and mean carbohydrate intake fell within the AMDR across all subgroups (see Table 4-23). The prevalence of low total fat intakes ranged from 9 to 15 percent, with the greatest difference between WIC participating children (15 percent) and WIC-eligible nonparticipating children (9 percent). The prevalence of excessive total fat intakes ranged from 6 to 9 percent across the subgroups. Mean saturated fat intakes were only slightly above the recommended 10 percent of energy intakes across all subgroups, although

TABLE 4-20 Estimated Prevalence of Micronutrient Excess Compared to the Tolerable Upper Intake Level (UL), Children 1 to Less Than 2 Years of Age, NHANES 2005–2008 and 2011–2012

		% of Population Above the UL (SE)		
Nutrient	UL (per day)	WIC,[a] 2005–2008 (N = 311)	Eligible Non-WIC,[b] 2005–2008 (N = 106)	All Low-Income,[c] 2011–2012 (N = 112)
Calcium	2,500 mg	0.1 (0.11)	0.03 (0.12)	0
Selenium	90 µg	5.0 (3.25)	11.6 (5.59)	5.3 (6.08)
Zinc	7 mg	53.3 (3.66)	56.5 (8.37)	41.6 (7.15)
Sodium	1,500 mg	65.0 (4.01)	66.4 (5.71)	62.1 (5.79)
Retinol	600 µg	16.3(4.89)	12.2 (7.79)	14.7 (7.87)
Vitamin C	400 mg	0.1 (0.20)	0	0

NOTES: DFE = dietary folate equivalent; N = sample size; SE = standard error; UL = Tolerable Upper Intake Level. Not included in table: percentages above the UL for these nutrients were < 0.01 percent: copper, iron, phosphorus, vitamin B6, folic acid, and choline. There were no statistically significant differences between WIC and eligible non-WIC subgroups.

Subgroup definitions are as follows:

[a] WIC = All individuals reporting participation in WIC regardless of income level.

[b] Eligible Non-WIC = Low-income individuals that did not report participation in WIC.

[c] All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.

SOURCES: Intake data are from NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012). ULs are from Dietary Reference Intake reports (IOM, 1997, 1998, 2000, 2001, 2002/2005, 2005, 2011).

as noted in the next paragraph, reported energy intake appeared to be excessive. Fiber intakes were approximately half the AI. Mean added sugars intakes (15 tsp-eq per day; see Appendix P) were approximately five-fold of the recommended limit for a weighted 1,300 kcal diet.

Usual mean energy intakes and the corresponding EER values are presented in Table 4-24. As for younger children, reported energy intakes exceeded the calculated EERs for all subgroups, although the difference among the subgroups was smaller than it was for the younger children. Among WIC-participating children, mean energy intakes (1,534 kcal per day) were approximately 18 percent higher than the predicted requirements (1,295 kcal per day). There were no statistically significant differences between WIC and eligible non-WIC subgroups.

TABLE 4-21 Estimated Prevalence of Inadequacy of Selected Nutrients Compared to the Estimated Average Requirement (EAR) Value, Children 2 to Less Than 5 Years of Age, NHANES 2005–2008 and 2011–2012

		% Inadequacy (SE)[a]		
Nutrient	EAR (Ages 1–3/ Age 4)[b] (per day)	WIC,[c] 2005–2008 (N = 474)	Eligible Non-WIC,[d] 2005–2008 (N = 397)	All Low-Income,[e] 2011–2012 (N = 406)
Calcium	500/800 mg	16.7 (2.99)	21.9 (3.04)	13.8 (3.05)
Copper	0.26/0.34 mg	0.1 (0.1)	0.3 (0.3)	0.0 (0.07)
Magnesium	65/110 mg	0.6 (0.45)	2.5 (1.20)	0.1 (0.16)
Phosphorus	380/405 mg	0.1 (0.18)	0.3 (0.27)	0
Zinc	2.5/4.0 mg	0.1 (0.10)	0.7 (0.60)	0.1 (0.11)
Vitamin A	210/275 μg RAE	1.6 (1.37)	2.5 (1.93)	2.1 (1.70)
Vitamin E	5/6 mg αTOC	79.2 (3.62)	87.6 (5.42)	52.1 (3.60)
Vitamin C	13/22 mg	0.6 (0.46)	1.0 (1.00)	0.1 (0.24)
Thiamin	0.4/0.5 mg	0	0.2 (0.27)	0
Niacin	5/6 mg	0	0.1 (0.20)	0
Vitamin B6	0.4/0.5 mg	0	0.2 (0.25)	0

NOTES: αTOC = α-tocopherol; DFE = dietary folate equivalent; EAR = Estimated Average Requirement; N = sample size; RAE = retinol activity equivalent; SE = standard error. Inadequacy across all subgroups was < 0.01 for iron, selenium, riboflavin, folate, and vitamin B12. There were no statistically significant differences between WIC and eligible non-WIC subgroups.

[a] % Inadequacy = percentage of individuals with usual intake below the EAR.

[b] The approach of IOM (2000) was applied in which, when combining groups with different EARs, intakes in one of the groups are rescaled so they can be compared to the EAR of the other group.

Subgroup definitions are as follows:

[c] WIC = All individuals reporting participation in WIC regardless of income level.

[d] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

[e] All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.

SOURCES: Intake data were obtained from NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012). EARs are from Dietary Reference Intake reports (IOM, 1997, 1998, 2000, 2001, 2002/2005, 2005, 2011).

TABLE 4-22 Estimated Mean Usual Intakes of Selected Micronutrients Compared to the Adequate Intake (AI) Value, Children 2 to Less Than 5 Years of Age, NHANES 2005–2008 and 2011–2012

Nutrient	AI (Ages 1–3/Age 4) (mg/d)	Mean Intake, mg/d (SE) WIC,[a] 2005–2008 (N = 474)	Eligible Non-WIC,[b] 2005–2008 (N = 397)	All Low-Income,[c] 2011–2012 (N = 406)
Potassium	3,000/3,800	2,114 (27.91)	1,847 (26.89)	2,050 (21.81)
Sodium	1,000/1,200	2,168 (29.32)	2,191 (30.19)	2,229 (26.40)
Choline	200/250	223 (3.15)	210 (2.94)	221 (3.00)

NOTES: AI = Adequate Intake; N = sample size; SE = standard error. There were no statistically significant differences between WIC and eligible non-WIC subgroups.

Subgroup definitions are as follows:

[a] WIC = All individuals reporting participation in WIC regardless of income level.

[b] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

[c] All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.

SOURCES: Intake data were obtained from NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012). AIs are from Dietary Reference Intake reports (IOM, 1998, 2005).

Micronutrient Excess

For a number of micronutrients, more than 5 percent of children in this age category exceeded the UL across all subgroups: copper, zinc, sodium, and retinol (see Table 4-25). For most micronutrients consumed in excess, WIC-participating children and WIC-eligible nonparticipating subgroups had similar proportions of excess intake. The largest difference was for zinc, with 54 percent of WIC participants exceeding the UL, compared to 45 percent of nonparticipants, a statistically significant difference ($p < 0.05$). The highest prevalence of excess intake was for sodium (up to 91 percent).

Special Case: Vitamin D Status Across Age Categories

Vitamin D Status

As explained in Chapter 3, serum 25(OH)D concentrations are considered a more accurate indicator of vitamin D status than dietary intake because an individual's vitamin D status is determined by both dietary intake and sun exposure. Thus, instead of relying on dietary intake, serum

TABLE 4-23 Estimated Intakes of Macronutrients Compared to Recommended Intakes, Children 2 to Less Than 5 Years of Age, NHANES 2005–2008 and 2011–2012

Nutrient and DRI or Recommended Daily Limit[a] Age 1–3/Age 4[b]	Units for Comparison to DRI or Recommended Limit per day	Comparison to DRI or Recommended Limit		
		WIC,[c] 2005–2008 (N = 474)	Eligible Non-WIC,[d] 2005–2008 (N = 397)	Low-Income,[e] 2011–2012 (N = 406)
Protein (EAR)				
0.87/0.76 g/kg[e]	% below EAR	0	0	0
Carbohydrate, total (AMDR)				
< 45% of kcal	% below AMDR	1.8 (1.57)	1.8 (2.04)	0.6 (1.01)
> 65% of kcal	% above AMDR	2.7 (2.05)	1.2 (1.55)	1.2 (1.60)
Fiber (AI)				
19/25 g	Mean g (AI)	10.5 (0.18)	9.8 (0.17)	11.6 (0.17)
Added sugars (limit)				
3.2 tsp-eq	Mean tsp-eq	14.1 (1.98)	15.7 (1.74)	13.9 (1.97)
Fat, total (AMDR)				
< 30, 25% of kcal	% below AMDR	15.1 (4.09)	8.5 (4.88)	11.5 (4.88)
> 40, 35% of kcal	% above AMDR	8.4 (3.44)	8.9 (4.97)	6.1 (3.80)
Fat, saturated (limit)				
< 10% of kcal	Mean % of kcal	11.7 (0.09)	12.1 (0.08)	11.2 (0.09)

NOTES: AI = Adequate Intake; AMDR = Acceptable Macronutrient Distribution Range; DRI = Dietary Reference Intake; g/d = grams per day; g/kg/d = grams per kilogram of body weight per day; kcal = kilocalories; N = sample size; tsp-eq/d = teaspoon equivalents per day. There were no statistically significant differences between WIC and eligible non-WIC subgroups.

[a] Values represent a DRI except for added sugars and saturated fat, for which values represent the recommended upper limit of daily intake for the 1,300 kcal "weighted" food pattern as described in Chapter 3. The resulting calorie level (1,225) may be low for children in this age group.

[b] Where two values are presented, the approach of IOM (2000) was applied in which, when combining groups with different DRIs, intakes in one of the groups are rescaled so they can be compared to the DRI of the other group.

Subgroup definitions are as follows:

[c] WIC = All individuals reporting participation in WIC regardless of income level.

[d] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

[e] All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.

SOURCES: Intake data were obtained from NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012). Reference intakes for protein, total carbohydrate, total fat, and fiber are per Dietary Reference Intake report (IOM, 2002/2005). Reference intakes for saturated fat and added sugars are per the *Scientific Report of the 2015 Dietary Guidelines Advisory Committee* (USDA/HHS, 2015).

TABLE 4-24 Estimated Usual Energy Intake and Estimated Energy Requirement, Children 2 to Less Than 5 Years of Age, NHANES 2005–2008 and 2011–2012

	kcal/d (SE)		
Energy Intake and Estimated Requirements	WIC,[a] 2005–2008 (N = 474)	Eligible Non-WIC,[b] 2005–2008 (N = 397)	All Low-Income,[c] 2011–2012 (N = 406)
Estimated Energy Requirement			
Median	1,314 (10.0)	1,350 (12.3)	1,371 (11.8)
Mean	1,295 (8.0)	1,326 (9.8)	1,341 (9.4)
Usual Energy Intakes			
Median	1,495 (23.6)	1,471 (23.4)	1,546 (25.1)
Mean	1,534 (16.8)	1,493 (16.6)	1,569 (16.4)

NOTES: EER = Estimated Energy Requirement; kcal = kilocalories; N = sample size; SE = standard error. There were no statistically significant differences between WIC and eligible non-WIC subgroups.

Subgroup definitions are as follows:

[a] WIC = All individuals reporting participation in WIC regardless of income level.

[b] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

[c] All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.

SOURCES: Intake data were obtained from NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012). EERs were calculated according to Dietary Reference Intake report assuming a low-active physical activity level (IOM, 2002/2005).

25(OH)D concentrations were analyzed to assess vitamin D status among all subgroups and across all age categories. The serum distributions presented in Table 4-26 indicate a low prevalence of inadequacy (no more than 5 percent) for the subgroups of children when compared to the serum value that is linked to the EAR, 40 nmol/L (IOM, 2011). However, the prevalence of inadequacy was undesirably high (21 percent) among pregnant, breastfeeding, and postpartum women. There were no statistically significant differences between WIC and eligible non-WIC subgroups.

Vitamin D Intakes

Infants less than 12 months of age Dietary vitamin D intakes of infants are presented in Table 4-27 because serum vitamin D data are not available for this age group. The AI for vitamin D in this age group is 10 μg per day. As described in Chapter 3, however, these values establish baseline vitamin D

TABLE 4-25 Estimated Prevalence of Micronutrient Excess Compared to the Upper Tolerable Intake Level (UL), Children 2 to Less Than 5 Years of Age, NHANES 2005–2008 and 2011–2012

		% of Population Above the UL (SE)		
Nutrient	UL (Ages 1–3/Age 4)[a] (per day)	WIC,[b] 2005–2008 (N = 474)	Eligible Non-WIC,[c] 2005–2008 (N = 397)	Low-Income,[d] 2011–2012 (N = 406)
Calcium	2,500/2,500 mg	0.1 (0.7)	0	0.1 (0.09)
Copper	1/3 mg	15.5 (3.13)	11.5 (3.21)	9.8 (3.32)
Selenium	90/150 µg	6.6 (2.77)	5.9 (2.94)	4.7 (3.28)
Zinc	7/12 mg	54.3 (2.96)[e]	45.4 (2.98)	47.0 (3.29)
Sodium	1,500/1,900 mg	82.4 (3.59)	83.7 (3.75)	90.9 (3.77)
Retinol	600/900 µg	12.2 (4.51)	9.4 (4.29)	19.7 (5.03)
Vitamin C	400/650 mg	0.4 (0.37)	0	0

NOTES: DFE = dietary folate equivalent; N = sample size; SE = standard error; UL = Tolerable Upper Intake Level. Not included in table: percentages above the UL for these nutrients were < 0.01 percent: iron, phosphorus, vitamin B6, folic acid, and choline.

[a] The approach of IOM (2000) was applied in which, when combining groups with different EARs, intakes in one of the groups are rescaled so they can be compared to the EAR of the other group.

Subgroup definitions are as follows:

[b] WIC = All individuals reporting participation in WIC regardless of income level.

[c] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

[d] All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.

[e] Significantly different from eligible non-WIC participants ($p < 0.05$) by t-test.

SOURCES: Intake data are from NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012). ULs are from Dietary Reference Intake reports (IOM, 1997, 1998, 2000, 2001, 2002/2005, 2005, 2011).

intake to use for the assessment of the effect of potential food package changes on intakes of this nutrient and provide little information about the vitamin D adequacy of infants.

Other age groups relevant to the WIC food packages As described in Chapter 3, dietary intake of vitamin D is not well correlated with status of this nutrient. Vitamin D intakes of other relevant WIC subgroups will be presented in the phase II report to evaluate the potential effect of food package modifications on intake of vitamin D.

TABLE 4-26 Distributions of Serum 25-Hydroxy Vitamin D, NHANES 2005–2006[a]

		25(OH)D Percentiles and Means (nmol/L)						
Participant Category	N	10th	25th	Median	Mean (SE)	75th	90th	% < 40 nmol/L[f]
Children 1 to < 2 Years, WIC[b]	101	57.5	62.5	70.0	72.3 (1.7)	82.5	97.5	2
Children 1 to < 2 Years, Eligible Non-WIC[c]	47	42.5	55.0	67.5	68.2 (2.7)	80.0	95.0	2
Children 1 to < 2 Years, All Low-Income[d]	135	47.5	60.0	67.5	69.5 (1.5)	80.0	95.0	2
Children 2 to < 5 Years, WIC	201	45.0	55.0	65.0	66.4 (1.3)	75.0	92.5	5
Children 2 to < 5 Years, Eligible Non-WIC	161	47.5	55.0	65.0	67.1 (1.4)	75.0	95.0	5
Children 2 to < 5 Years, All Low-Income	340	47.5	55.0	65.0	66.5 (1.0)	75.0	92.5	5
P/BF/PP Women 19 to 50 Years, WIC[e]	195	27.5	42.5	62.5	61.7 (2.1)	75.0	87.5	21
P/BF/PP Women 19 to 50 Years, Eligible Non-WIC	55	25.0	42.5	60.0	61.3 (3.7)	80.0	115.0	21
P/BF/PP Women 19 to 50 Years, All Low-Income	167	27.5	42.5	60.0	60.8 (2.0)	77.5	97.5	21

NOTES: 25(OH)D = 25-hydroxy vitamin D; N = sample size; P/BF/PP = pregnant, breastfeeding, or postpartum; SE = standard error. There were no statistically significant differences between WIC and eligible non-WIC subgroups.

[a] Serum data for 25-hydroxy vitamin D are only available in NHANES 2005–2006.

Subgroup definitions are as follows:

[b] WIC = All individuals reporting participation in WIC regardless of income level.

[c] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

[d] All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.

[e] Some women reporting WIC participation did not report being pregnant, breastfeeding, or postpartum.

[f] A serum 25(OH)D level of 40 nmol/L was established by IOM (2011) as an average requirement that meets the needs of approximately half the population, used to establish EARs for dietary intake of vitamin D.

SOURCES: NHANES 2005–2006 (USDA/ARS, 2005–2006).

TABLE 4-27 Mean Vitamin D Intakes of Formula-Fed Infants Less Than 12 Months, NHANES 2007–2008 and 2011–2012

		Mean Vitamin D Intake (µg/d) (SE)					
		2007–2008			2011–2012		
Participant Age	AI (per day)	WIC[a]	Eligible Non-WIC[b]	All Low-Income[c]	WIC[a]	Eligible Non-WIC[b]	All Low-Income[c]
Infants 0 to < 6 months	10 µg	9.2 (0.20)	8.9 (0.65)	9.2 (0.21)	9.5 (0.23)	9.9 (0.72)	9.9 (0.23)
N		121	19	105	110	15	104
Infants 6 to < 12 months	10 µg	8.4 (0.21)	11.1 (0.41)	8.8 (0.30)	8.5 (0.29)	9.6 (0.28)	9.2 (0.32)
N		108	19	90	78	13	64

NOTES: AI = Adequate Intake; N = sample size; SE = standard error. Vitamin D intake was not reported in 2005–2006 for this age group. There were no statistically significant differences between WIC and eligible non-WIC subgroups.

Subgroup definitions:

[a] WIC = All individuals reporting participation in WIC regardless of income level.

[b] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

[c] All Low-Income = All individuals at ≤ 185 percent of poverty.

SOURCES: Intake data are from NHANES 2007–2008 and 2011–2012 (USDA/ARS, 2007–2008, 2011–2012). AIs from Dietary Reference Intake report (IOM, 2011).

Special Case: Vitamin E

As was the case with the subgroups included in the committee's NHANES analyses, low vitamin E intake appears to be ubiquitous in the general U.S. population. However, because clinical vitamin E deficiency is uncommon (IOM, 2000), neither the 2015 DGAC report nor the 2010 DGA considered it to be a nutrient of public health concern (USDA/HHS, 2010, 2015). Given the high prevalence of vitamin E inadequacy identified in this analysis, the committee sees vitamin E intake as requiring further attention.

EVALUATION OF DIET QUALITY

Two indexes of diet quality were applied to all three NHANES subgroups and across all age groups: (1) the Healthy Eating Index-2010 (HEI-2010), as requested by USDA-FNS (results are presented in Chapter 5), and (2) a nutrient-based diet quality (NBDQ) index, which was created by the committee. The NBDQ index has a maximum score of 100 and is based on the probability of adequacy of the shortfall nutrients, as defined by the 2015 DGAC report (see details of the methodology in Appendix K, document K-1). The NBDQ values for women, children 1 to less than 2 years of age, and children 2 to less than 5 years of age, are presented in Tables 4-28

TABLE 4-28 NBDQ Index Distributions for Pregnant, Postpartum, or Breastfeeding Women, 19 to 50 Years of Age

	N	10th	25th	Median	Mean	75th	90th
WIC,[a] 2005–2008	387	35	44	50	49	55	61
Eligible Non-WIC,[b] 2005–2008	90	37	43	49	48	54	60
All Low-Income,[c] 2011–2012	63	39	42	52	50	56	59

NOTES: N = number of observations; NBDQ = Nutrient-Based Diet Quality index designed by the committee. Numbers represent probability of adequacy for the nine shortfall nutrients outlined in the *Scientific Report of the 2015 Dietary Guidelines Advisory Committee* (potassium; calcium; iron; vitamins A, E, and C; folate; magnesium; and fiber; iron for adolescent and premenopausal females) (USDA/HHS, 2015).

Subgroup definitions are as follows:

[a] WIC = All individuals reporting participation in WIC regardless of income level. Some women reporting WIC participation did not report being pregnant, breastfeeding, or postpartum.

[b] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

[c] All Low-Income = All individuals at ≤ 185 percent of poverty.

SOURCES: NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012).

TABLE 4-29 NBDQ Index Distributions for Children, 1 to Less Than 2 Years of Age

	N	10th	25th	Median	Mean	75th	90th
WIC,[a] 2005–2008	311	63	64	66	66	68	70
Eligible Non-WIC,[b] 2005–2008	106	64	65	67	67	69	71
All Low-Income,[c] 2011–2012	112	63	65	67	67	70	72

NOTES: N = number of observations; NBDQ = Nutrient-Based Diet Quality index designed by the committee. Numbers represent probability of adequacy for the nine shortfall nutrients outlined in the *Scientific Report of the 2015 Dietary Guidelines Advisory Committee* (potassium; calcium; iron; vitamins A, E, and C; folate; magnesium; and fiber; iron for adolescent and premenopausal females) (USDA/HHS, 2015).

Subgroup definitions are as follows:

[a] WIC = All individuals reporting participation in WIC regardless of income level.

[b] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

[c] All Low-Income = All individuals at ≤ 185 percent of poverty.

SOURCES: NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012).

TABLE 4-30 NBDQ Index Distributions for Children, 2 to Less Than 5 Years of Age

	N	10th	25th	Median	Mean	75th	90th
WIC,[a] 2005–2008	474	57	63	66	66	70	74
Eligible Non-WIC,[b] 2005–2008	397	54	61	65	64	68	71
All Low-Income,[c] 2011–2012	406	61	65	69	69	72	75

NOTES: N = number of observations; NBDQ = Nutrient-Based Diet Quality index designed by the committee. Numbers represent probability of adequacy for the nine shortfall nutrients outlined in the *Scientific Report of the 2015 Dietary Guidelines Advisory Committee* (potassium; calcium; iron; vitamins A, E, and C; folate; magnesium; and fiber; iron for adolescent and premenopausal females) (USDA/HHS, 2015).

Subgroup definitions are as follows:

[a] WIC = All individuals reporting participation in WIC regardless of income level.

[b] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

[c] All Low-Income = All individuals at ≤ 185 percent of poverty.

SOURCES: NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012).

through 4-30. The NBDQ could not be calculated for infants because there are so few nutrient EARs for the two infant age groups. Mean scores on the NBDQ were lower for women (48–50) than for children (64–69); this indicates that women were more likely than children to have inadequate intakes of the shortfall nutrients. Within population subgroups, mean scores were similar for WIC participants and nonparticipants.

CONSIDERATIONS FOR DATA INTERPRETATION

The analyses described in this chapter were designed to address the committee's task as closely as possible given what was available at the time the analyses were conducted. Although the accuracy of data reported in NHANES has been questioned (Archer et al., 2013), it remains the best available source of nationally representative food and nutrient intake data. In their recent commentary, Subar et al. (2015) provide a detailed review of the strengths and limitations of the NHANES data. They acknowledge the weakness of NHANES for some purposes but also note the utility of these data for developing population-level policies related to nutrition. Nonetheless, use of NHANES data had limitations relative to the committee's task, as previously noted in the Letter Report issued for this study (IOM, 2015).

First, the WIC to non-WIC comparisons were made using data from 2005–2008, which were not the most recent NHANES datasets available. Although these analyses update the prior Institute of Medicine (IOM) report (2006), a more recent and WIC-focused comparison (using NHANES 2011–2012) is desirable. The indicator of WIC participation was not available for the most recent NHANES dataset in time for this report, but it will be available for phase II.

Second, using NHANES data to capture data from WIC participants specifically depends on accurate self-identification by WIC recipients in NHANES, and determination of "eligibility" among other, low-income individuals. The committee's comparison of the weighted total number of recipients reporting WIC participation, as well as extensive experience reporting on social assistance programs like WIC, suggest that WIC use is underreported in NHANES (Bitler et al., 2003; Celhay et al., 2015; Meyer et al., 2015). In addition, there are challenges to determining individuals who are "eligible" but do not participate accurately. In addition to determination of demographic or physiological eligibility (i.e., age, pregnancy, postpartum, and breastfeeding status), some WIC-eligible individuals may not be captured in the NHANES low-income (≤ 185 percent poverty-to-income ratio [PIR]) groups because they are of higher income levels. Applying the income criterion of ≤ 185 percent of the PIR does not necessarily correspond to state-level income requirements for WIC eligibility. Individuals may still legitimately participate in the program if adjunctively or automatically eligible due to participation in Medicaid, Temporary Assistance for Needy Families (TANF), or the Supplemental Nutrition Assistance Program (SNAP). For these reasons, there may be more individuals eligible for WIC than would be included in a screen of ≤ 185 percent of the PIR. Finally, even if NHANES were to capture WIC participation exactly, the number of participants who are enrolled in WIC would still be very small.

Estimating Micronutrient Adequacy

To estimate the adequacy of micronutrient intake, adjustments were made to calculate nutrient adequacy in analytical subgroups in which more than one EAR was applicable. Using this method may conceal a relatively high prevalence among pregnant women and a much lower prevalence among lactating women, as described in Chapter 3. This case is applicable to the assessment of iron adequacy in children and iron and folate adequacy in women. In addition, iron inadequacy in women may be incorrectly estimated because a normal distribution of requirements was used, which assumes that women who are pregnant, lactating, or postpartum do not skew requirements due to menstrual losses. As noted previously, for nutrients with an AI value only, no inference can be made about nutrient adequacy.

Several of the micronutrient intake estimates should be interpreted with caution because of small sample sizes (see Chapter 3, Table 3-2). The committee calculated that a mean usual nutrient intake can be calculated within 3 percent of the true value (95 percent confidence interval) with a minimum of 18–20 individuals, depending on nutrient and on age group. This minimum may not apply to calculation of population-level intake adequacy. At the same time, the statistical method applied gives relatively reliable numbers around the median and mean even with small sample sizes, but with less reliability at the tails of distributions. Sample sizes for women remained small despite combining all pregnant, breastfeeding, and postpartum individuals, but the estimates were stabilized by weighting the external variance, and therefore, should be reliable (Jahns et al., 2005).

Finally, because all women were combined to generate more robust sample sizes, it was not possible to determine differences in the prevalence of inadequacy among these three reproductive categories. Furthermore, mean intakes and prevalences of inadequacies for these subpopulations may be affected by differing proportions of pregnant, lactating, and postpartum women within each subpopulation. As a result, comparison across the subpopulations (such as WIC versus WIC-eligible) should be interpreted with extra caution.

Estimating Macronutrient and Energy Intake

Although the EERs have been published, an individual's requirements depend on many factors and cannot be precisely estimated. The EERs used in this report were calculated based on established equations developed by the IOM (2002/2005). Recently, Butte et al. (2014) proposed that the IOM (2002/2005) equations overestimate energy expenditure for toddlers because they are based on incorrect physical activity assumptions. The committee is aware of this finding and will consider it when developing its final recommendations.

The mean energy intake of infants was at least 30 percent higher than the EER used in this report and, for children, 42 percent (children 1 to less than 2 years) and 18 percent (children 2 to less than 5 years) higher. This suggests that caretakers of children in these subgroups may be over-reporting energy intakes, as has been proposed in other studies (Eck et al., 1989; Devaney et al., 2004) as well as in the previous IOM review of WIC food packages (IOM, 2006). Assessing dietary intake in people of any age is challenging, but measuring the diet of infants and very young children can be particularly problematic. Multiple people may be responsible for the care of the child, and collecting an accurate picture of intake often requires combining parental reports with observations from other caretakers (Foster and Adamson, 2014). Should over-reporting be the case, nutrients identified in the NHANES analyses as under-consumed become more significant concerns.

In contrast to infants and children, reported mean energy intakes of women in this report were 10 percent lower than estimated average needs. There is robust evidence that adults tend to underreport energy intakes if they are overweight (Macdiarmid and Blundell, 1998), and the Centers for Disease Control and Prevention data indicate higher levels of obesity in lower-income women (CDC, 2010). A recent evaluation of reporting accuracy in NHANES 2002–2012 indicated that 25 percent of adults ages 20 and older were likely to underreport energy intake. Respondents were more likely to underreport if female, non-Hispanic black, having lower education or income, and if overweight or obese (Murakami and Livingstone, 2015). Archer et al. (2013) and Subar et al. (2015) agree that self-reported energy intake is of limited value as a measure of true energy intake. Under-reporting could exaggerate the estimated micronutrient inadequacies for women identified in this report, however, as noted in Subar et al. (2015), if the discrepancy between reported and recommended intakes is large enough, concern may be warranted even considering a degree of error. In general, underreporting is more pervasive than over-reporting (Murakami and Livingstone, 2015), especially among overweight and obese women (Briefel et al. 1995; McKenzie et al., 2002).

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5

Food Intake of WIC-Eligible Populations

In phase I, the committee was tasked with assessing food intake of the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC)-eligible populations. This chapter summarizes the committee's findings. The approaches applied included an evaluation of findings from published surveys on dietary intake (for individuals younger than 2 years of age), National Health and Nutrition Examination Survey (NHANES) analyses similar to the nutrient intake analyses described in Chapter 4, and a literature search for supplemental information. The information summarized in this chapter, in combination with the nutrient intake information presented in Chapter 4, support identification of nutrient and food group priorities for the WIC food packages.

LITERATURE AND REPORT FINDINGS: FOOD INTAKE OF WIC PARTICIPANTS

The committee reviewed the literature for information on food intakes of WIC participants, with a particular focus on complementary feeding practices. A summary of the committee's findings is presented here.

Food Intake of WIC Participants Compared to Nonparticipants

The committee identified five cross-sectional studies that compared food intakes of WIC participants to nonparticipants. Three conducted crude analysis on food intake data: (1) a small regional study in South Carolina (McElligott et al., 2012), (2) an analysis of data from the Feeding

Infants and Toddlers Study (FITS) (Deming et al., 2014), and (3) a study of NHANES 2005–2010 (Watowicz and Taylor, 2014). Ages ranged from 6 months to 4 years. All three studies found higher intakes of juice among WIC participants compared to nonparticipants. Other notable findings were lower intakes of whole fruit among 1- to 4-year-old WIC participants (Deming et al., 2014) and higher milk intakes among 2- to 4-year-old WIC participants compared to nonparticipants, although the latter finding was not statistically significant (Watowicz and Taylor, 2014). Additional detail on findings from the FITS study is presented later in this chapter.

The U.S. Department of Agriculture's Food and Nutrition Service (USDA-FNS) *Diet Quality of American Young Children* study (see Chapter 4 for a description of the methodology) examined food intakes of WIC-participating and non-WIC children using NHANES 2005–2008. Their analysis indicated that compared to income-eligible nonparticipants, WIC participating children were more likely to consume WIC juice, cow's milk, whole milk, regular soda, beans, and WIC cereals, and less likely to consume fruit (excluding juice) and fats and oils added to foods (USDA/FNS, 2015).

Food Intake and the Revised Food Packages

Except for studies on breastfeeding, data characterizing the effect of the 2009 WIC food package changes on children's food intake or health are sparse. The data that do exist are regional. Two prospective cohort studies were conducted using the same population sample, a group of Hispanic and African American mother–child pairs from 12 Chicago WIC clinics (Kong et al. 2014; Odoms-Young et al., 2014). Baseline data were collected in summer 2009 before the WIC food package revisions were implemented. Odoms-Young et al. (2014) reported that, 6 months postrevision, fruit consumption increased among Hispanic mothers; low-fat dairy consumption increased among Hispanic mothers, Hispanic children and African American children; and whole milk consumption decreased among all groups. Additionally, home food availability of low-fat dairy and whole grains increased. No significant changes in diet quality were observed for any other group. Kong et al. (2014) reported that, 18 months postrevision, low-fat milk intake increased for African American and Hispanic children and that whole milk intake decreased for all groups.

Four pre-post studies compared food intake before and after the 2009 WIC food package revisions. Again, as with the two Chicago studies, all four were regional. One was conducted in New York State (Chiasson et al., 2013), one among Indian Tribal Organizations across multiple states (Ishdorj and Capps, 2013), the third in California (Whaley et al., 2012), and the fourth in Georgia (Meiquari, 2015). Despite numerous differences among the populations sampled, including varying cultural food preferences, the studies consistently suggest that the 2009 WIC food package changes were associated with increased consumption of fruits, vegetables, whole grains, and low-fat/fat-free milk and decreased consumption of whole milk. Specifically, Chiasson et al. (2013) reported that food intake and healthy behaviors of more than 3.5 million children ages 0 to 4 years participating in the New York State WIC program showed an improvement between 2008 and 2011. In particular, these improvements included delayed introduction of solids and increased consumption of fruits, vegetables, and whole grains and reduced-fat milk. In a study of 1,642 Native American children ages 2 to 4 years who participated in WIC, Ishdorj and Capps (2013) found increases in lower-fat milk, fruit, vegetable, and whole grain intake following revisions of the food packages. Whaley et al. (2012) conducted a random telephone survey of California WIC families before and after the 2009 changes to the WIC packages. Based on their assessment of 3,004 (in 2009) and 2,996 (in 2010) households, they found significant increases in consumption of fruits, vegetables, and whole grains and decreases in consumption of whole milk. Their findings were for families, but the increased consumption of reduced fat milk was specifically identified in children. In their recent systematic review, Schultz et al. (2015) reported that there was an overall improvement in dietary intake after the 2009 food package changes, although the body of evidence was limited. The committee came to the same conclusion after its own independent review.

Finally, Meiquari et al. (2015) conducted a pre-post study that surveyed African American WIC participant mothers and their eldest child at two WIC clinics in Atlanta, Georgia, specifically to examine the impact of the 2009 food package changes on milk intake. The authors reported that children significantly increased their intake of low-fat milk after the food package changes, although "low-fat" was defined as all forms other than whole, including 2% milk. There was no change in intake of "low-fat" milk (as defined in this study) by women. Importantly, this study was conducted prior to issuance of the final rule eliminating 2% milk from most food packages and allowing only skim or 1% (USDA/FNS, 2014).

Racial and Ethnic Differences in Intake of WIC and Other Foods

Many findings suggest that food purchasing and consumption patterns may be strongly connected to culture, race, or ethnicity (Dubowitz et al., 2007, 2008; Bermúdez-Millán et al., 2009; Kong et al., 2013; Pooler and Gleason, 2014; Chaparro et al., 2015). This is evident in the WIC population, for example, Kong et al. (2013) compared the diets of African American and Hispanic mothers and their 2- to 3-year-old children who were enrolled in WIC prior to the 2009 food package revisions. Although the dietary intake of all groups fell short of national recommendations, the diets of Hispanic mothers and children were lower in percentage of calories from fat, added sugars, sodium, and sweetened beverages and higher in vitamin A, calcium, whole grains, fruits, and dairy foods, compared to their African American counterparts. Reported differences in intake among and between racial and ethnic groups, however, are not always consistent (Faith et al., 2006; Odoms-Young et al., 2014; Chaparro et al., 2015; Cho et al., 2015). Chapter 2 contains additional information on racial and ethnic differences and the impact of the 2009 revisions on intake and acceptability of WIC package food items.

Geographical Differences in Food Intakes

The committee identified one cross-sectional study on geographic differences in food intake. In a comparison of fruit and vegetable consumption between urban and rural African American Texas WIC participants, Ettienne-Gittens et al. (2013) found urban African American women consumed a wider variety of fruits than their rural counterparts. Compared to rural children, urban children were provided with a wider variety of vegetables and consumed them more frequently. Additional information on the effect of rural versus urban settings on food accessibility is presented in Chapter 2.

Complementary Food Intake of Individuals Younger Than 2 Years of Age

Complementary feeding is broadly defined as the addition of any foods other than human milk or formula to an infant's diet. This transition to table foods typically starts when the nutritional needs of the infant surpass what can be provided through human milk, usually occurring at around 6 months of age and lasting until a child is around 24 months of age (AAP, 2014). Although several large-scale surveys have asked parents and guardians to report when complementary foods were first introduced in their children's diets, infant dietary intake has not been a primary focus for most of these studies (NIS-Child Hard Copy Questionnaire, 2015; ECLS-B 9-Month Questionnaire; SLAITS-National Survey of Early Childhood Health, 2000). The WIC Infant and Toddler Feeding Practices Study, a longitudinal, nationally representative study of infants in low-income families, is currently underway, and the committee anticipates results for review in phase II (Harrison et al., 2014).

For this report, the committee relied on food intake data from three large contemporary datasets: (1) Infant Feeding Practices Study II (IFPS II), (2) 2008 Feeding Infants and Toddlers Study (FITS 2008), and (3) NHANES. Findings from IFPS II and FITS 2008 are summarized and supplemented with relevant findings from a recently released analysis of the 2005–2012

NHANES on foods that contribute to energy and nutrient intake in infants 0–24 months old (Grimes et al., 2015). Findings from the committee's own analyses of NHANES data are summarized later in this chapter. A comparison of the designs of IFPS II and FITS 2008 is outlined in Table 5-1. It should be noted that the data from these two studies were collected before the October 1, 2009, deadline for states to implement revisions to the WIC food packages. The IFPS II analysis detailed below combined WIC with non-WIC infants, and the results reflect all consumption in the 7 days before the survey. The FITS 2008 analysis described in this section, in contrast, compared WIC and non-WIC participants, and the data collected were for food intake only during the 24 hours before the interview.

Food group intake findings from IFPS II (Grummer-Strawn et al., 2008) and FITS 2008 (Deming et al., 2014) are summarized in Table 5-2. Findings from a recent NHANES analysis evaluating food group contributions to energy and nutrient intake (Grimes et al., 2015) are summarized in Table 5-3. Highlights of the three selected reports are discussed below.

TABLE 5-1 Study Designs and Characteristics of Selected Reports, IFPS II, FITS 2008, and NHANES 2005–2012

	IFPS II[a]	FITS 2008[b]	NHANES, 2005–2012[c]
Design	Longitudinal data collected from the last trimester of pregnancy through infant's first year of life[d]	Cross-sectional evaluation of dietary intake of U.S. children, birth to 4 years of age	Cross-sectional
Data Collection Dates	May 2005–June 2007; 6-year follow-up in 2012[d]	June 2008–January 2009	2005–2012
Recruitment	Pregnant women who were part of a nationally distributed consumer opinion panel	Sample frame came from the New Parent Database and the Consumer Database from the Experian, Inc.	Complex, multistage, probability sampling

continued

TABLE 5-1 Continued

	IFPS II[a]	FITS 2008[b]	NHANES, 2005–2012[c]
Eligibility	Women ≥ 18 years of age Delivered a singleton infant who was at least 35 week, gestation and weighed at least 5 pounds at birth Both mother and child were free from conditions that could affect feeding	Household had child 0–47 months old	Non-institutionalized U.S. population
Sample Size	4,902 qualified in prenatal period 3,033 qualified in neonatal period 1,807 remained by end of study	3,273 infants and children	2,857 children enrolled[e] 2,791 completed the first 24-hour dietary recall 2,740 had reliable dietary recall data 765 infants, 0–5.9 months 854 infants, 6–11.9 months 1,121 toddlers, 12–23.9 months
WIC Participants in Sample	1,112 (36.7 percent) of enrolled households (mother and/or infant) participated in WIC in the neonatal period 912 (30.1 percent) of enrolled households (mother and/or infants) participated in WIC any time from month 1 to 12	794 WIC infants and children 117 infants, 0–5.9 months 84 infants, 6–8.9 months 76 infants 9–11.9 months 238 toddlers, 12–23.9 months 279 preschoolers, 24–47.9 months	Not identified in this analysis

TABLE 5-1 Continued

	IFPS II[a]	FITS 2008[b]	NHANES, 2005–2012[c]
Data Collection	Mail-based survey Sent monthly approximately 2–7 months postpartum, then approximately every 7 weeks thereafter through 12 months postpartum	Phone-based	Face-to-face interview
Dietary Assessment[f]	Food frequency table of liquids and solids the infant consumed in previous 7 days Quantities consumed not captured	24-hour recall and brief questionnaire Second 24-hour recall performed in a subsample, 7–10 days after first (n = 701)[h] Descriptive findings of unadjusted prevalence are presented for WIC versus non-WIC participants; analyses used sample weights and groups were compared using t-tests[g]	24-hour proxy-recall[i] Evaluated contributions of foods to energy and nutrient intake

NOTES: FITS = 2008 Feeding Infants and Toddlers Study; IFPS II = Infant Feeding Practices Study II.
[a] Overall study design, Fein et al., 2008a; CDC, 2014.
[b] Overall study design, Briefel et al., 2010.
[c] Grimes et al., 2015.
[d] A year 6 follow-up study of children initially assessed in the IFPS II has been conducted, evaluating links between early feeding practices and various health outcomes (Fein, 2014).
[e] Number represents sample included in the analysis, not entire NHANES sample.
[f] Information about dietary supplement use was collected in each of the overall study designs, but the three reports on food group intakes did not evaluate supplement use.
[g] Report-specific analysis, Deming et al., 2014.
[h] Two days of dietary intake per sampled child was used to calculate usual nutrient intake distributions, Briefel et al., 2010.
[i] While two 24-hour recalls are part of the NHANES procedures, Grimes et al. (2015) only evaluated intake reported on the first day of recall.
SOURCE: As indicated by the referenced publications.

TABLE 5-2 Complementary Food Intake of Infants, Ages 0 to 2 Years of Age, from IFPS II and FITS 2008

	IFPS II[a]		FITS 2008[b]		
				Percent Consuming on a Given Day	
Food Group	Age in Months	Percent Consuming in the Previous Week	Age in Months	WIC	Non-WIC
Fruit (Excluding Juice)	3	2.8	0–5.9	8.6[c]	6.4[c]
	6	71.3	6–11.9	69.1	75.6
	9	97.0	12–23.9	62.3	83.6[d]
	12	98.4			
100% Juice	3	5.0	0–5.9	8.2[c]	3.8[c]
	6	33.4	6–11.9	46.1	28.3[e]
	9	62.8	12–23.9	61.9	52.4
	12	76.9			
Vegetables, total	3	1.4	0–5.9	11.2[c]	8.4
	6	73.1	6–11.9	57.7	75.6[e]
	9	97.2	12–23.9	73.5	69.5
	12	98.7			
Grains and Grain Products, total	3	18.3	0–5.9	26.7	22.7
	6	86.1	6–11.9	91.5[c]	90.3
	9	96.3	12–23.9	99.5[c]	98.4[c]
	12	97.0			
Infant Cereal	3	18.2	0–5.9	26.7	21.9
	6	83.7	6–11.9	61.8	66.9
	9	83.4	12–23.9	6.9[c]	11.4
	12	46.6			
Meats and Meat Substitutes[f]	3	0.7	0–5.9	2.8[c]	0.0[c]
	6	22.0	6–11.9	64.1	53.6
	9	78.4	12–23.9	93.9[c]	94.1
	12	96.6			
Cow's Milk, total	3	0.3	0–5.9	0.0	0.0
	6	1.2	6–11.9	13.3	9.4
	9	5.3	12–23.9	86.5	81.0
	12	81.2			
Cow's Milk, Whole	NR		6–11.9	10.0[c]	7.8
			12–23.9	59.2	64.2

TABLE 5-2 Continued

	IFPS II[a]		FITS 2008[b]		
				Percent Consuming on a Given Day	
Food Group	Age in Months	Percent Consuming in the Previous Week	Age in Months	WIC	Non-WIC
Cow's Milk, Reduced- or Low-Fat	NR		6–11.9	2.7[c]	1.1[c]
			12–23.9	31.8	19.7[e]
Cow's Milk, Nonfat	NR		6–11.9	0.5	0.1[c]
			12–23.9	1.0[c]	1.0
Sweetened Beverages	3	1.1	0–5.9	0.0[c]	0.3[c]
	6	3.1	6–11.9	12.3[c]	4.5[c]
	9	6.2	12–23.9	39.6	22.0
	12	14.6			
Desserts and Candy	3	0.2	0–5.9	1.7[c]	1.1[c]
	6	1.5	6–11.9	22.7	24.8
	9	12.3	12–23.9	63.6	55.5
	12	52.2			

NOTE: NR = not reported.
[a] Grummer-Strawn et al., 2008.
[b] Deming et al., 2014 (Data reprinted with permission).
[c] Point estimate imprecise due to small sample size and it being an uncommon or very common response.
[d] Significantly different from WIC group at 0.01 level by t-test.
[e] Significantly different from WIC group at 0.05 level by t-test.
[f] FITS 2008 classified this category as "Meat and other protein sources" and included cheese and yogurt in this category while IFPS II has a separate "Other Dairy" category.
SOURCES: Grummer-Strawn et al., 2008; Deming et al., 2014.

Fruit, Excluding Juice

Fruits were introduced to IFPS II infants at a median age of 5–6 months, and the proportion of infants consuming fruit in the week prior to the survey increased with age (Grummer-Strawn et al., 2008). The FITS 2008 data showed that fruit consumption on a given day was less common in WIC participants 12–23.9 months old than in their nonparticipant counterparts (Deming et al., 2014). For NHANES infants, fruit composed a greater proportion of energy intake of children aged 12–23.9 month scompared to infants 6–11.9 months old (4.8 percent versus 2.3 percent, respectively; Grimes et al., 2015).

TABLE 5-3 Percentage of Daily Energy Intake of Complementary Food Groups by Infants 6 to 23.9 Months of Age, NHANES 2005–2012[a,b]

Food Group	Percent of Daily Energy Intake 6–11.9 months	Percent of Daily Energy Intake 12–23.9 months
Fruit (Excluding Juice)	2.3	4.8
100% Juice	1.5	5.9
Vegetables	NA[c]	3.2[d]
Grains and Grain Products		
Mixed Dishes—Grain-based	2.3	5.5
Bread, Rolls, Tortillas	1.1	3.8
Crackers	NA	2.4
Ready-to-Eat Cereal	NA	2.3
Quick Breads and Bread Products	NA	1.6
Cooked Cereals	NA	1.4
Meats and Meat Substitutes		
Poultry	NA	3.6
Cured Meats and Poultry	NA	2.5
Eggs	NA	2.2
Mixed Dishes—Meat, Poultry, Seafood	NA	2.0
Plant-based Protein Foods	NA	1.6
Dairy		
Cow's Milk, All Fat Levels	3.1	22.4
Cheese	NA	2.6
Yogurt	NA	1.7
Flavored Milk	NA	1.3
Desserts, Sweetened Beverages, and Savory Snacks		
Sweet Bakery Products	1.8	4.6
Sweetened Beverages	NA	3.1
Savory Snacks	NA	2.4
Candy	NA	1.3
Other Desserts	NA	1.2

NOTE: NA = data not available.

[a] Grimes et al., 2015.

[b] Intake of human milk and infant formulas not represented in this table.

[c] All NA notations indicate that data were not presented in Grimes et al. (2015), as intake contributed to less than 1 percent of total energy intake.

[d] Sum of "White Potatoes" group and "Vegetables, excluding potatoes" group.

100% Juice

The proportion of IFPS II infants who consumed 100% juice in the week prior to the survey increased as they aged (Grummer-Strawn et al., 2008). In the FITS 2008 study, a greater proportion of WIC infants 6–11.9 months old consumed 100% juice compared to their non-WIC counterparts, but a significant difference was not seen in the 12–23.9 month groups (Deming et al., 2014). The 2005–2012 NHANES analysis showed 100% juice contributed to 1.5 percent and 5.9 percent of total energy intake of infants 6–11.9 months and 12–23.9 months of age, respectively (Grimes et al., 2015).

Vegetables

Vegetables were introduced to the IFPS II infants at a median age of 5–6 months (Grummer-Strawn et al., 2008). FITS 2008 data suggest that a lower percentage of WIC infants 6–11.9 months old consumed any vegetable on a given day compared to non-participants, a difference not seen 12–23.9 month groups (Deming et al., 2014). Due to small sample sizes and the infrequency of the responses, point estimates for intake of specific types of vegetables (e.g., dark green, deep yellow) were largely imprecise for infants less than 1 year of age. On a given day, a portion of WIC participants 12–23.9 months old in the FITS 2008 study reportedly consumed white potatoes (41.5 percent), other starchy vegetables (17.0 percent), deep yellow vegetables (16.0 percent), dark green vegetables (12.0 percent), and other vegetables (28.7 percent) (Deming et al., 2014). Vegetable intake contributed to less than 1 percent of energy intake of 2005–2012 NHANES 6–11.9-month-old infants (Grimes et al., 2015). For 12–23.9 month olds, total vegetable intake contributed to 3.2 percent of energy (Grimes et al., 2015).

Grains and Grain Products

Grains were present in the diets of 18.3 percent of 3-month-old IFPS II infants, primarily in the form of infant cereal (Grummer-Strawn et al., 2008). Similarly, infant cereals were the primary grain contributors in the diets of FITS 2008 infants 0–5.9 months old (Deming et al., 2014). In later infancy (6–11.9 months), non-infant cereals were present in the diets of 26.4 percent of infants, and crackers, pretzels, or rice cakes were being eaten by 39.4 percent of WIC-participating infants (Deming et al., 2014). In the 12–23.9 month group, 56.2 and 63 percent WIC participants were consuming grains in mixed dishes and non-infant cereals, respectively (Deming et al., 2014). For NHANES 2005–2012 infants 6–11.9 months of age, mixed grain-based dishes and breads, rolls, and tortillas each contributed to 2.3 and 1.1 percent of total energy intake, respectively (Grimes et al., 2015). For 12–23.9-month-olds, mixed grain-based dishes; bread, rolls, and tortillas; crackers; ready-to-eat cereal; quick breads and bread products; and cooked cereals each contributed more than 1 percent of total energy intake (Grimes et al., 2015).

Meats and Meat Substitutes

Meat and meat substitutes were introduced to IFPS II infants at a median age of approximately 8 months (Grummer-Strawn et al., 2008). By 1 year of age, most IFPS II individuals were consuming meat, chicken, or combination dishes (93.8 percent) and eggs (59.2 percent), with fewer eating peanuts or peanut butter (25.1 percent), fish and shellfish (17.7 percent), and soy foods (5.8 percent). Point estimates of meat and meat substitute consumption among FITS 2008 WIC participants ages 0 to less than 6 months are imprecise due to sample size and because consumption of meats and meat substitutes was an uncommon event for this age group (Deming et al., 2014). In general, baby food meat was not commonly consumed (< 10 percent in any age group). On a given day, 23.5 percent of older WIC infants (6–11.9 months) and 71.9 percent of WIC children (12–23.9 months) consumed non-baby-food meat. Only 28.3 percent of children 12–23.9 months reportedly ate eggs on a given day. Among 2005–2012 NHANES 6–11.9-month-olds, meat and meat substitute food groups (e.g., poultry, plant-based protein foods) each contributed to less than 1 percent of total energy intake (Grimes et al., 2015). In contrast, 2005–2012 NHANES 12–23.9-month-olds reportedly consumed poultry, cured meats and poultry, eggs, mixed meat/poultry/seafood dishes, and plant-based protein foods (Grimes et al., 2015).

Dairy

For the majority of IFPS II infants, cow's milk and milk products (excluding breast milk and infant formulas) were not present in their diets until late infancy, with the median age of introduction being approximately 10 months (Grummer-Strawn et al., 2008). By approximately 10.5 months of age, 17.3 percent of IFPS II infants were consuming cow's milk. FITS 2008 found that approximately 13 percent of WIC participants 6–11.9 months old consumed cow's milk on a given day (Deming et al., 2014). Cow's milk was consumed on a daily basis by more than 80 percent of WIC participants 12–23.9-months-old, with the majority (59.2 percent) reportedly consumed whole milk. A greater proportion of WIC participants consumed reduced- or low-fat milk on a given day, compared to their non-WIC counterparts (31.8 versus 19.7 percent). Cow's milk contributed to

3.1 percent and 22.4 percent of total energy intake of 2005–2012 NHANES infants aged 6–11.9 months and 12–23.9 months, respectively (Grimes et al., 2015). Among 12–23.9-month-olds, cheese, yogurt, and flavored milk contributed another 2.6, 1.7, and 1.3 percent of total energy, respectively (Grimes et al., 2015).

Desserts, Sweetened Beverages, and Savory Snacks

In the IFPS II cohort, fatty and sugared foods were present in the diet of nearly one-quarter of 9-month old infants (Grummer-Strawn et al., 2008). By 1 year of age, 14.6 percent were consuming sweetened drinks, and 52.2 percent were consuming candy, cookies, and cake. In the FITS 2008 sample, 22.7 percent of older WIC participants 6–11.9 months and 63.6 percent of WIC participants 12–23.9 months old consumed desserts and candy on a given day, but their consumption of these foods did not differ from that of nonparticipants (Deming, 2014). Differences did emerge for consumption of sweetened beverages and fruit-flavored drinks, however, with more WIC participants 12–23.9 months old consuming these on a daily basis (39.6 percent and 31.1 percent, respectively) compared to nonparticipants (22.0 percent and 16.6 percent, respectively). Consumption of carbonated sodas (sweetened or non-caloric was not specified) also appears to have been more common among WIC participants 12–23.9 months old, but the point estimate for nonparticipants was imprecise due to small sample sizes and low frequency of consumption (10.3 percent of WIC versus 1.8 percent of non-WIC). Approximately 18 percent of WIC participants 12–23.9 months old consumed salty snacks on a given day, which was comparable to nonparticipants. The 2005–2012 NHANES analysis found that sweet bakery products contributed 1.8 percent of the total energy intake of 6–11.9-month-olds (Grimes et al., 2015). Among 12–23.9-month-olds, sweet bakery products, sugar-sweetened beverages, savory snacks (e.g., potato chips, tortilla chips, popcorn, pretzels, snack mixes), candy, and other desserts each contributed more than 1 percent of total energy intake (Grimes et al., 2015).

Areas of Concern for Complementary Feeding

Based on the findings from IFPS II, FITS 2008, and the 2005–2012 NHANES analysis, the committee identified four areas of concern with respect to complementary feeding: (1) early introduction of complementary foods, (2) insufficient intake of iron-fortified foods and supplements among older infants, (3) early introduction of cow's milk, and (4) consumption of foods of poor nutritional value. The committee's reasons for concern are explained below.

It should be reiterated that data collection for IFPS II, FITS 2008, and most of the presented NHANES analysis occurred prior to the full implementation of the WIC food package revisions. Some of the changes, such as not issuing complementary foods prior to an infant reaching 6 months of age, have the potential to affect the areas of concerns described below. Large datasets exploring the postrevision status of infants, however, do not currently exist.

Early Introduction of Complementary Foods

Of the 1,334 IFPS II mothers who provided complete data, 40.4 percent reported introducing solid food before their infant was 4 months of age (before 17 weeks; Clayton et al., 2013). This early introduction of complementary foods was half as common among breastfed infants (24.3 percent) compared to infants who were formula fed or mixed fed (52.7 percent and 50.2 percent, respectively). Women who introduced complementary foods early were more likely to be participating in the WIC program, according to Clayton et al. (2013). In another analysis of the IFPS II data that used different criteria and cutoffs, the estimated proportion of early introducers (before 15 weeks) was 21 percent, and early introduction of complementary foods was associated with lower maternal education (Fein et al., 2008b). The reported differences in proportion of early introducers may be due to differences in the cutoff ages of infants included in the respective studies. The FITS 2008 data also suggested that a portion of infants were receiving complementary foods before 4–6 months of age. Introduction of these foods appears to be delayed compared to FITS 2002 infants (Siega-Riz et al., 2010).

The early introduction of complementary foods may reflect early cessation of exclusive breastfeeding and has implications for infant weight gain. Gaffney et al. (2012) reported that the weight-for-age z-score of 691 IFPS II infants (primarily white) at 1 year of age was significantly higher in infants who received complementary foods before 6 months of age compared to those who received them at or after 6 months of age. Chapter 6 provides a summary of health outcomes associated with inappropriate infant weight gain.

Iron-Fortified Foods and Supplements

Healthy, full-term infants are typically born with sufficient iron stores for at least the first 4 months of life (AAP, 2014). The iron concentration of human milk, however, is relatively low and, although readily absorbed by the infant, can be insufficient to meet iron needs in the latter half of infancy. Inasmuch as iron deficiency can have potentially long-lasting neurocognitive effects (see Chapter 6 for a summary of health outcomes associated with iron deficiency in infants), the American Academy of Pediatrics (AAP) recommends that infants who consume at least half of their daily feedings from human milk receive a 1 mg/kg/day iron supplement starting at 4 months of age, with the supplement eventually being displaced by iron-rich complementary foods (Baker and Greer, 2010; AAP, 2014).

Using IFPS II data, Dee et al. (2008) compared the intake of iron-rich foods among exclusively breastfed versus mix-fed, full-term infants and found that, by 6 months of age, 80 percent of mix-fed infants were consuming infant cereal and 14 percent were consuming meat. In contrast, nearly one-quarter of exclusively breastfed, full-term infants (23 percent) did not have a regular iron-rich food source in their diets. Iron supplementation among both exclusively breastfed and mix-fed infants was fairly uncommon, with less than 10 percent reporting using iron supplements at any given time during the survey.

Among FITS 2008 infants, which included infants of all breastfeeding intensities, Butte et al. (2010) found mean iron intake among 6–11-month-olds to be 15.8 mg/day, with 12 percent consuming inadequate iron (relative to the EAR of 6.9 mg/day). Among 12–23-month-olds inadequate iron uptake was not apparent. Based on the 2005–2012 NHANES analysis (Grimes et al., 2015), which did not include supplement use in the evaluation, the top foods that contributed to iron intake among 6–11.9-month-olds were infant formulas (44.8 percent), baby foods (43.1 percent), ready-to-eat cereals (3.1 percent), and grain-based mixed dishes (1.0 percent).

Early Introduction of Cow's Milk

The early introduction of cow's milk can affect the health of an infant. For example, a portion of infants experience significant increases in occult fecal blood loss when fed cow's milk, with the response diminishing with age (Ziegler et al., 1990, 1999; Jiang et al., 2000). Furthermore, cow's milk has a high protein, but low iron content. As such, it may displace foods with higher iron content in the early months of complementary feeding and thereby compromise an infant's iron status. Some international guidelines for the introduction of cow's milk into the diets of infants and young children suggest that a limited amount is permissible (usually 500 mL/day after 6 or 9 months of age), especially if accompanied by an iron supplement (Agostoni and Turck, 2011; FAO, 2013). The AAP, however, recommends that whole milk should not be introduced before 12 months of age (Baker and Greer, 2010; AAP, 2014).

Estimates from IFPS II, FITS 2008, and the 2005–2012 NHANES indicate that infants are being fed cow's milk prior to 12 months of age. IFPS II results found that, at 10.5 months, 17.3 percent of infants had consumed cow's milk in the previous week (Grummer-Strawn et al., 2008). Overall, 25.9 percent of IFPS II infants had consumed cow's milk prior to 10.5 months of age, a practice more common among mothers with lower education levels (Fein et al., 2008b). FITS 2008 data indicate that an estimated 13.3 percent of WIC infants aged 6–11.9 months consumed cow's milk on a given day (Deming et al., 2014). For infants 6–11.9 months of age included in the 2005–2012 NHANES analysis, cow's milk contributed 3.1 percent of total energy intake (Grimes et al., 2015).

Foods of Poor Nutritional Value

Results from IFPS II, FITS 2008, and the 2005–2012 NHANES indicate that desserts, sweetened beverages, and salty snacks are parts of the diets of children less than 24 months of age. These foods are typically energy-dense and nutrient-poor, and have little nutritive role in the diets of young children. Higher consumption of energy-dense, nutrient-poor foods has been associated with lower micronutrient intake in young children (Webb, 2006) and can help to establish taste preferences, which has implications for dietary patterns later in life (Beauchamp and Mennella, 2009; Mennella, 2014).

NHANES ANALYSIS: FOOD GROUP AND SUBGROUP INTAKES

In addition to evaluating NHANES findings reported in the literature (i.e., Grimes et al. 2015), the committee conducted its own analyses of NHANES data. The committee examined food intake data from the three analytical subgroups described in Chapter 3, namely 2005–2008 WIC participants, 2005–2008 income-eligible nonparticipants, and 2011–2012 low-income individuals, across relevant WIC age categories (pregnant, breastfeeding, and postpartum women, 19 to 50 years; formula-fed infants 0 to less than 6 months; formula-fed infants 6 to less than 12 months; children 1 to less than 2 years; and children 2 to less than 5 years). Too few breastfeeding infants with reported food intake were included in NHANES to estimate their usual intakes of foods for any survey years of interest. Mean usual intakes and intake distributions for the population subgroups analyzed here are presented in Appendix Q.

As mentioned in Chapter 4, the WIC identifier for the 2011–2012 NHANES dataset became available only after completion of these analyses. Therefore, it was not possible to compare food intakes among WIC participants before the 2009 food package changes occured to those after the changes were implemented. Moreover, only the 2005–2008 NHANES data were considered appropriate for comparison of WIC participants to WIC-eligible nonparticipants.[1] All individuals who were income-eligible for WIC from NHANES 2011–2012 were analyzed as a proxy for WIC participants. In phase II, the WIC indicator will be applied to the NHANES 2011–2012 dataset so that, depending on the sample sizes in 2011–2012, intakes of WIC participants in 2011–2012 can be compared to those of income-eligible nonparticipants. With adequate sample sizes, WIC participant intakes can also be compared before and after the 2009 food package changes.

Food group and subgroup intakes among WIC participating women, infants, and children were evaluated relative to the *Scientific Report of the 2015 Dietary Guidelines Advisory Committee* (2015 DGAC report) recommended intakes or other dietary guidance as appropriate. To estimate the distribution of dietary components consumed episodically (food groups and subgroups), the Statistical Program for Age-adjusted Dietary Assessment (SPADE), a method similar to the National Cancer Institute (NCI), was implemented. For all population subgroups for which the percentage below recommended food intakes could be calculated with reasonable precision, a population level prevalence of low intakes of 50 percent or more was considered of concern (see detailed explanation of these methods in Chapter 3).

WIC participant and eligible non-WIC participant subgroups were compared by t-test. One consequence of the small sample sizes is that the standard error values are large and thus only large differences among means can be detected.

Food Group Intakes of Pregnant, Breastfeeding, and Postpartum Women, 19 to 50 Years of Age

Food group and subgroup intakes for women compared to recommendations are presented in Table 5-4, with mean usual intakes and intake distributions presented in Appendix Q. No statistically significant differences between WIC participant and WIC-eligible nonparticipant subgroups were identified. For low-income women in the 2011–2012 NHANES dataset, the estimated percentage below recommendations data are not reliable because the population subgroup size was small and the variance was large.[2] Therefore, mean usual intake data are presented so comparisons can be made

[1] The 2009–2010 NHANES dataset spanned the period of time over which the 2009 food package changes were implemented. It was therefore not considered appropriate for either the pre- or post-food package change assessments. As noted in Chapter 3, separation of a 2-year dataset requires re-computation of population weights, which was beyond the scope of this study.

[2] For the analysis of episodically consumed foods, small samples add enormous challenges. Consequently, with the small sample sizes that were available for women, estimates of the proportion of usual intakes of foods below recommendations are less reliable. Estimates of mean food intake are, however, adequately precise and only these are presented for women.

TABLE 5-4 Food Group Intakes Compared to the DGAC 2015 Report Recommendations, Pregnant, Breastfeeding, or Postpartum Women 19 to 50 Years, NHANES 2005–2008 and 2011–2012

		Mean Usual Intake (SE)			% of Population Below Recommended Intake (SE)	
Food Group	Recommended Intake[a]	WIC,[b] 2005–2008 (N = 222)	Eligible Non-WIC,[c] 2005–2008 (N = 76)	All Low-Income,[d] 2011–2012 (N = 29)[e]	WIC,[b] 2005–2008 (N = 222)	Eligible Non-WIC,[c] 2005–2008 (N = 76)
Total Fruit	2 c-eq/d	1.47 (0.12)	1.36 (0.15)	2.19 (0.45)	77 (3.19)	79 (11.17)
Total Vegetables	3 c-eq/d	1.33 (0.06)	1.46 (0.12)	1.48 (0.17)	99 (4.41)	96 (8.24)
Dark Green Vegetables	2 c-eq/wk	NA	0.71 (NA)	1.29 (NA)	NA[f]	99 (NA)
Total Red and Orange Vegetables[g]	6 c-eq/wk	2.63 (0.18)	2.47 (0.24)	3.24 (0.53)	95 (3.73)	98 (5.84)
Beans and Peas Computed as Vegetables	2 c-eq/wk	0.94 (0.13)	0.85 (0.16)	NA	84 (6.95)	87 (15.99)
Total Starchy Vegetables	6 c-eq/wk	2.91 (0.98)	3.40 (0.47)	1.99 (0.74)	98 (4.96)	84 (7.21)
Other Vegetables	5 c-eq/wk	3.31 (0.32)	3.84 (0.51)	3.55 (0.69)	80 (5.09)	75 (12.85)
Total Grains	7 oz-eq/d	6.96 (0.29)	7.60 (0.38)	7.38 (0.59)	55 (2.76)	40 (1.36)
Whole Grains	3.5 oz-eq/d	0.56 (0.06)	0.64 (0.13)	1.13 (0.30)	100 (1.00)	100 (2.32)
Refined Grains	3.5 oz-eq/d	6.38 (0.26)	6.99 (0.34)	6.53 (0.58)	6 (0.38)	0 (8.57)
Total Protein Foods	6 oz-eq/d	5.10 (0.23)	5.67 (0.37)	5.76 (0.39)	71 (3.34)	61 (12.00)
Meat, Poultry, and Eggs (Not Seafood)	28 oz-eq/wk	30.58 (1.59)	31.22 (1.86)	34.02 (2.74)	45 (2.49)	46 (3.90)
Seafood	9 oz-eq/wk	3.32 (0.58)	7.16 (NA)	NA	91 (6.93)	75 (NA)
Nuts, Seeds, and Soy	5 oz-eq/wk	1.93 (0.39)	2.87 (1.19)	4.62 (1.30)	89 (5.90)	84 (13.54)
Total Dairy	3 c-eq/d	1.88 (0.08)	1.91 (0.18)	2.15 (0.21)	87 (3.05)	92 (6.07)
Oils	29 g-eq/d	20.87 (1.14)	21.32 (1.76)	25.06 (2.75)	80 (4.50)	84 (10.40)

					% of Population Above Recommended Intake (SE)[b]	
Solid Fats	< 18 g-eq/d	36.98 (1.34)	40.84 (1.66)	43.36 (3.85)	91 (0.13)	96 (0.01)
Added Sugars	< 8 tsp-eq/d	23.00 (5.06)	25.66 (7.06)	20.07 (8.78)	93 (0.17)	97 (4.99)

NOTES: c-eq = cup-equivalents; d = day; g-eq = gram-equivalents; N = sample size; NA = data not available; oz-eq = ounce-equivalents; SE = standard error; wk = week. Percentage of population below recommended intake not provided for the "All Low-Income 2011–2012" group because the sample size is too small to produce statistically reliable estimates. There were no statistically significant differences between WIC and eligible non-WIC subgroups.

[a] For women, the reference food intake pattern used was 2,200 kcals, which was the calculated Estimated Energy Requirement for WIC women in NHANES 2005–2008.

Population subgroup definitions are as follows:

[b] WIC = All individuals reporting participation in WIC regardless of income level.

[c] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

[d] All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.

[e] The sample size of this group is too small to produce statistically reliable estimates in these units.

[f] For all NA notations, estimate could not be obtained because the Statistical Program for Age-adjusted Dietary Assessment (SPADE) requires more than two observations per group with two non-zero intakes in order to estimate a within-person variance.

[g] Although all data here are compared to values presented in the *Scientific Report of the 2015 Dietary Guidelines Advisory Committee* (2015 DGAC report), the *Dietary Guidelines for Americans* (DGA) in place at the time of the 2005–2008 NHANES survey (the 2005 DGA) did not include a red and orange vegetables subgroup.

[h] For solid fats and added sugars, Recommended Intakes indicate an upper limit.

SOURCES: Intake data are from NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012). Reference values are the USDA food patterns from the 2015 DGAC report (USDA/HHS, 2015).

across subgroups of women. Estimates of "% below recommendations" was adequately precise for women in the 2005–2008 dataset; therefore these data are presented.

More than 50 percent of WIC participating women and WIC-eligible nonparticipating women in the 2005–2008 NHANES survey had low intakes of all food groups, with the exception of refined grains (0 to 6 percent) and meat, poultry, and eggs (45 to 46 percent). Nearly 100 percent of these women had low intakes of total vegetables and whole grains. Likewise, nearly all women in the 2005–2008 NHANES survey had low intakes of dark green vegetables (for WIC-participating women, not enough consumed foods from this group to generate reliable estimates), red and orange vegetables (95 to 98 percent), and starchy vegetables (84 to 98 percent). Very low intakes (i.e., 80–95 percent of the population subgroup below recommendations) were also evident for beans and peas, nuts, seeds and soy, total dairy, and oils.

Mean usual intake data were also compared across subgroups of women. There were small differences across these groups in food intake, but women in the 2011–2012 NHANES dataset consumed more total fruit, total vegetables (as well as dark green and red and orange), whole grains, total protein foods (including meat, poultry, and eggs; nuts, seeds, and soy), and total dairy compared to women in the 2005–2008 NHANES survey. Too few women in the most recent survey consumed beans and peas or seafood to generate estimates. Intake of WIC-eligible nonparticipating women was generally greater than that of WIC participating women, except for total fruit, red and orange vegetables, and beans and peas.

For WIC participating women from the 2005–2008 population subgroup, mean intake of solid fats was 37 g-eq per day, or more than twice the recommended limit of 18 g-eq per day. Their intake of added sugars was 23 tsp-eq per day (see Appendix Q, Table Q-2), which was approximately triple the recommended limit of 8 tsp-eq per day.

Food Group Intakes of Formula-Fed Infants Ages 0 to Less Than 6 Months

Mean food group and subgroup intakes for infants ages 0 to less than 6 months are presented in Table 5-5. Because the 2015 DGAC report recommendations do not apply to infants, adequacy of food intake could not be evaluated for this age group. Intakes are anticipated to be low, given that the AAP advises complementary feeding to begin between 4 and 6 months of age. No statistically significant differences between WIC participant and WIC-eligible nonparticipant subgroups were identified.

Comparing mean usual intakes across population subgroups of these children, differences were small with a few exceptions. Low-income chil-

TABLE 5-5 Mean Usual Food Group Intakes of Formula-Fed Infants 0 to Less Than 6 Months, NHANES 2005–2008 and 2011–2012

		Mean Usual Intake (SE)		
Food Group	Units	WIC,[a] 2005–2008 (N = 12)	Eligible Non-WIC,[b] 2005–2008 (N = 19)	All Low-Income,[c] 2011–2012 (N = 71)
Total Fruit	c-eq/d	0.19 (0.02)	0.20	0.10 (0.04)
Total Vegetables	c-eq/d	0.09 (0.01)	0.09	0.06 (0.01)
Dark Green Vegetables	c-eq/wk	NA[d]	NA	NA
Red and Orange Vegetables	c-eq/wk	0.40 (0.07)	NA	0.31
Beans and Peas Computed as Vegetables	c-eq/wk	NA	NA	NA
Starchy Vegetables	c-eq/wk	0.18 (0.04)	NA	NA
Other Vegetables	c-eq/wk	NA	NA	NA
Total Grains	oz-eq/d	0.35 (0.06)	0.26	0.10 (0.03)
Whole Grains	oz-eq/d	0.11 (0.02)	NA	0.04 (NA)
Refined Grains	oz-eq/d	0.24 (0.05)	0.16	0.09 (0.02)
Total Protein Foods	oz-eq/d	0.03 (0.01)	NA	NA
Meat, Poultry, and Eggs	oz-eq/wk	0.20 (0.05)	NA	NA
Seafood	oz-eq/wk	NA	NA	NA
Nuts, Seeds, and Soy	oz-eq/wk	NA	NA	NA
Total Dairy	c-eq/d	0.01 (NA)	NA	NA
Oils	g-eq/d	0.06 (0.01)	NA	NA
Food groups to limit				
Fats, solid[e]	g-eq/d	0.21 (0.05)	NA	NA
Added Sugars	tsp-eq/d	0.63 (0.30)	NA	NA

NOTES: c-eq = cup-equivalents; d = day; g-eq = gram-equivalents; N = sample size; NA = data not available; oz-eq = ounce-equivalents; SE = standard error; wk = week. There were no statistically significant differences between WIC and eligible non-WIC subgroups.

Population subgroup definitions are as follows:

[a] WIC = All individuals reporting participation in WIC regardless of income level.

[b] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

[c] All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.

[d] For all NA notations, the estimate could not be obtained because the Statistical Program for Age-adjusted Dietary Assessment (SPADE) requires more than two observations per group with two non-zero intakes in order to estimate a within-person variance.

[e] Solid fat was considered equivalent to saturated fat in this analysis.

SOURCES: Intake data are from NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012). Reference values are the USDA food patterns from the *Scientific Report of the 2015 Dietary Guidelines Advisory Committee* (USDA/HHS, 2015).

dren in the most recent survey consumed fewer total vegetables and total grains (whole grains and refined grains), and total fruit. For many food groups, estimates could not be generated because the minimum amount of data required for SPADE was not reached.

Food Group Intakes of Formula-Fed Infants Ages 6 to Less Than 12 Months

Mean usual intakes for older infants (ages 6 to less than 12 months) are presented in Table 5-6. As with the younger infants, there exists no recommended food group pattern on which to assess adequacy. Mean usual intake of infants based on NHANES 2011–2012 was higher compared to other infants for red and orange vegetables and oils. Intakes of WIC participating infants were comparable to those of WIC-eligible nonparticipating infants when data were available.

Food Group Intakes of Children 1 to Less Than 2 Years of Age

As was the case for infants, the 2015 DGAC report does not include recommended food patterns for children 1 to less than 2 years of age. For this reason, mean usual food group and subgroup intakes for children of these ages are presented in Table 5-7 (intake distributions are presented in Appendix Q). Across population subgroups, intakes of vegetables, whole grains, and seafood are among the smallest (although seafood intake could be estimated for only one group). Intakes of total fruit, total vegetables (including all vegetable subgroups except "other"), total grains (including whole and refined), total protein (including nuts, seeds, and soy) were higher for WIC-eligible nonparticipating children compared to WIC participants. WIC participants consumed slightly more total dairy than non-WIC children. Other differences between these two subgroups of children were even smaller.

Children ages 1 to less than 2 years consumed similar amounts of solid fats. Intake of added sugars was greater for nonparticipating, low-income infants than both WIC participants and low-income children in the most recent survey (NHANES 2011–2012).

Food Group Intakes of Children 2 to Less Than 5 Years of Age

The percentage of food group and subgroup intakes for children ages 2 to less than 5 years compared to the 2015 DGAC report recommendations are presented in Table 5-8. (As with the other age groups, mean usual intakes and intake distributions are presented in Appendix Q.) Overall differences across subgroups of children were small, and no differences

TABLE 5-6 Mean Usual Food Group Intakes of Infants 6 to Less Than 12 Months, NHANES 2005–2008 and 2011–2012

		Mean Usual Intake (SE)		
Food Group	Units	WIC,[a] 2005–2008 (N = 136)	Eligible Non-WIC,[b] 2005–2008 (N = 31)	All Low-Income,[c] 2011–2012 (N = 73)
Total Fruit	c-eq/d	0.86 (0.04)	0.90 (0.09)	0.73 (0.06)
Total Vegetables	c-eq/d	0.40 (0.02)	0.45 (0.06)	0.45 (0.04)
Dark Green Vegetables	c-eq/wk	0.05 (NA)	NA[d]	NA
Red and Orange Vegetables	c-eq/wk	2.13 (0.27)	1.91 (0.29)	3.40 (0.63)
Beans and Peas Computed as Vegetables	c-eq/wk	0.16 (0.05)	NA	NA
Starchy Vegetables	c-eq/wk	1.02 (0.12)	0.90 (0.24)	0.79 (0.14)
Other Vegetables	c-eq/wk	0.40 (0.06)	NA	0.60 (0.13)
Total Grains	oz-eq/d	1.49 (0.07)	1.85 (0.19)	1.61 (0.12)
Whole Grains	oz-eq/d	0.26 (0.03)	0.87 (0.29)	0.32 (0.05)
Refined Grains	oz-eq/d	1.22 (0.07)	1.51 (0.20)	1.30 (0.13)
Total Protein Foods	oz-eq/d	0.80 (0.15)	0.86 (0.14)	0.73 (0.13)
Meat, Poultry, and Eggs (not Seafood)	oz-eq/wk	5.22 (0.83)	5.05 (0.75)	4.57 (0.94)
Seafood	oz-eq/wk	NA	NA	NA
Nuts, Seeds, and Soy	oz-eq/wk	0.12	NA	NA
Total Dairy	c-eq/d	0.58 (0.57)	1.76 (0.77)	0.56 (0.16)
Oils	g-eq/d	2.80 (0.27)	3.01 (0.64)	5.20 (1.23)
Food groups to limit				
Fat, solid[e]	g-eq/d	9.11 (0.84)	14.26 (2.99)	5.48 (1.25)
Added Sugars	tsp-eq/d	11.44 (1.40)	13.78 (2.19)	13.16 (2.74)

NOTES: c-eq = cup-equivalents; d = day; g-eq = gram-equivalents; N = sample size; NA = data not available; oz-eq = ounce-equivalents; SE = standard error; wk = week. There were no statistically significant differences between WIC and eligible non-WIC subgroups.

Population subgroup definitions are as follows:

[a] WIC = All individuals reporting participation in WIC regardless of income level.

[b] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

[c] All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.

[d] For all NA notations, the estimate could not be obtained because the Statistical Program for Age-adjusted Dietary Assessment (SPADE) requires more than two observations per group with two non-zero intakes in order to estimate a within-person variance.

[e] Solid fat was considered equivalent to saturated fat in this analysis.

SOURCES: Intake data are from NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012). Reference values are the USDA food patterns from the *Scientific Report of the 2015 Dietary Guidelines Advisory Committee* (USDA/HHS, 2015).

TABLE 5-7 Mean Usual Food Group Intakes of Children 1 to Less Than 2 Years, NHANES 2005–2008 and 2011–2012

Food Group	Units	Mean Usual Intake (SE)		
		WIC,[a] 2005–2008 (N = 254)	Eligible Non-WIC,[b] 2005–2008 (N = 82)	All Low-Income,[c] 2011–2012 (N = 93)
Total Fruit	c-eq/d	1.39 (0.06)	1.43 (0.10)	1.29 (0.10)
Total Vegetables	c-eq/d	0.52 (0.02)	0.61 (0.05)	0.52 (0.04)
Dark Green Vegetables	c-eq/wk	0.13 (0.02)	0.27 (NA)	0.23 (NA)
Red and Orange Vegetables	c-eq/wk	1.33 (0.11)	1.38 (0.14)	1.56 (0.26)
Beans and Peas Computed as Vegetables	c-eq/wk	0.35 (0.04)	0.37 (NA)	0.38 (0.07)
Starchy Vegetables	c-eq/wk	1.53 (0.20)	2.57 (0.39)	1.32 (0.16)
Other Vegetables	c-eq/wk	1.37 (0.25)	0.71 (0.59)	0.80 (0.14)
Total Grains	oz-eq/d	3.02 (0.10)	3.38 (0.21)	3.31 (0.16)
Whole Grains	oz-eq/d	0.39 (0.03)	0.41 (0.07)	0.69 (0.11)
Refined Grains	oz-eq/d	2.62 (0.09)	2.95 (0.18)	2.78 (0.16)
Total Protein Foods	oz-eq/d	2.13 (0.08)	2.15 (0.14)	2.12 (0.16)
Meat, Poultry, and Eggs (not Seafood)	oz-eq/wk	13.72 (0.53)	13.31 (0.77)	12.99 (1.02)
Seafood	oz-eq/wk	NA[d]	NA	0.64 (NA)
Nuts, Seeds, and Soy	oz-eq/wk	0.84 (0.15)	1.29 (0.30)	1.24 (0.29)
Total Dairy	c-eq/d	2.67 (0.08)	2.53 (0.14)	2.33 (0.11)
Oils	g-eq/d	8.27 (0.41)	9.20 (0.82)	8.89 (0.48)
Food groups to limit				
Fats, solid[e]	g-eq/d	27.25 (0.77)	27.63 (1.28)	25.30 (1.53)
Added Sugars	tsp-eq/d	8.30 (1.48)	10.25 (3.18)	8.98 (2.25)

NOTES: c-eq = cup-equivalents; d = day; g-eq = gram-equivalents; N = sample size; NA = data not available; oz-eq = ounce-equivalents; SE = standard error; wk = week. There were no statistically significant differences between WIC and eligible non-WIC subgroups.

Population subgroup definitions are as follows:

[a] WIC = All individuals reporting participation in WIC regardless of income level.

[b] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

[c] All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.

[d] For all NA notations, the estimate could not be obtained because the Statistical Program for Age-adjusted Dietary Assessment (SPADE) requires more than two observations per group with two non-zero intakes in order to estimate a within-person variance.

[e] Solid fat was considered equivalent to saturated fat in this analysis.

SOURCES: Intake data are from NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012). Reference values are the USDA food patterns from the *Scientific Report of the 2015 Dietary Guidelines Advisory Committee* (USDA/HHS, 2015).

TABLE 5-8 Food Group Intakes Compared to the DGAC 2015 Report Recommendations, Children 2 to Less Than 5 Years, NHANES 2005–2008 and 2011–2012

Food Group	Recommended Intake[a]	% of Population Below Recommended Intake (SE) WIC,[b] 2005–2008 (N = 398)	Eligible Non-WIC,[c] 2005–2008 (N = 329)	All Low-Income,[d] 2011–2012 (N = 340)
Total Fruit	1.19 c-eq/d	43 (5.59)	53 (11.17)	45 (3.04)
Total Vegetables	1.38 c-eq/d	94 (1.41)	97 (8.24)	98 (0.19)
Dark Green Vegetables	0.88 c-eq/wk	98 (1.85)	96 (NA)	92 (2.27)
Red and Orange Vegetables[e]	2.88 c-eq/wk	86 (2.83)	87 (5.84)	91 (1.55)
Beans and Peas Computed as Vegetables	0.50 c-eq/wk	65 (3.55)	79 (15.99)	65 (2.18)
Starchy Vegetables	3.13 c-eq/wk	81 (5.47)	85 (7.21)	67 (1.11)
Other Vegetables	2.25 c-eq/wk	73 (3.65)	95 (12.85)	55 (3.37)
Total Grains	4.13 oz-eq/d	48 (4.36)	40 (1.36)	31 (2.72)
Whole Grains	2.06 oz-eq/d	100 (0.02)	100 (2.32)	93 (0.14)
Refined Grains	2.06 oz-eq/d	8 (1.03)	5 (8.57)	2 (2.82)
Total Protein Foods	3.13 oz-eq/d	57 (4.87)	58 (12.00)	54 (4.19)
Meat, Poultr,y and Eggs	14.88 oz-eq/wk	32 (6.19)	34 (3.90)	37 (3.48)
Seafood	4.50 oz-eq/wk	100 (1.06)	97 (NA)	96 (3.04)
Nuts, Seeds, and Soy	2.38 oz-eq/wk	76 (5.13)	71 (13.54)	66 (3.68)
Total Dairy	2.38 c-eq/d	66 (10.84)	68 (6.07)	68 (0.69)
Oils	16.50 g-eq/d	78 (5.53)	84 (10.40)	65 (2.63)
		% of Population Above Recommended Intake (SE)[f]		
Fats, solid[g]	< 7.75 g-eq/d	100 (0.00)	100 (1.66)	100 (2.06)
Added Sugars	< 3.24 tsp-eq/d	99 (0.04)	100 (7.06)	99 (0.69)

NOTES: c-eq = cup-equivalents; d = day; g-eq = gram-equivalents; N = sample size; NA = data not available; oz-eq = ounce-equivalents; SE = standard error; wk = week. There were no statistically significant differences between WIC and eligible, non-WIC subgroups.

[a] For all children 1 to less than 5 years of age, recommended intakes were generated by weighting the 1,000 and 1,300 (averaged from 1,200 and 1,400 kcal patterns) kcal food patterns in a 1:3 ratio following the methodology applied in IOM (2011). This results in a food pattern equivalent to approximately 1,225 kcals, slightly under the Estimated Equivalent Requirement for children 2 to 5 years of age of approximately 1,300 kcals. Therefore, the "% below recommendations" may be similarly underestimated.

continued

TABLE 5-8 Continued

Population subgroup definitions are as follows:
[b] WIC = All individuals reporting participation in WIC regardless of income level.
[c] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.
[d] All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.
[e] Although all data here are compared to values presented in the *Scientific Report of the 2015 Dietary Guidelines Advisory Committee* (2015 DGAC report), the *Dietary Guidelines for Americans* (DGA) in place at the time of the 2005–2008 NHANES survey (the 2005 DGA) did not include a red and orange vegetables subgroup.
[f] For solid fats and added sugars, Recommended Intakes indicate an upper limit.
[g] Solid fat was considered equivalent to saturated fat in this analysis.
SOURCES: Intake data are from NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012). Reference values are the USDA food patterns from the report of the 2015 DGAC report (USDA/HHS, 2015).

were statistically significant. Intakes were particularly poor (80 percent or more below recommended intakes across all three subgroups of children) for total vegetables (and, within total vegetables, dark green vegetables and red and orange vegetables), whole grains, and seafood. For all other food groups, with the exception of refined grains, 30 to 40 percent or more of children had intakes below recommended amounts. Intakes of added sugars and solid fats exceeded the recommendations across subgroups of children. Mean added sugars intake among WIC participating children was 14 tsp-eq per day, approximately five times the recommended limit for the 1,000–1,300 kcal weighted diet[3] (approximately 3 tsp-eq per day). Mean solid fat intake for this group was 29 g-eq per day, or approximately 7 times that recommended for this calorie level.

EVALUATION OF DIET QUALITY

Two indexes of diet quality were estimated for all three NHANES subgroups: the Healthy Eating Index-2010 (HEI-2010) as requested by USDA-FNS, and a second index, the Nutrient-Based Dietary Quality (NBDQ) index, created by the committee. The basis for the NBDQ is described in Chapter 3 and, because the NDBQ is nutrient based, the results are described in Chapter 4. HEI-2010 values were generated following the method described in Guenther et al. (2014) and as described in Box 3-2 and Appendix K. As

[3] To evaluate the diets of all children 1 to less than 5 years of age, the committee applied a weighted food pattern (a 1,000 kcal pattern weighted 1:3 with the average of 1,200- and 1,400-kcal patterns [see Chapter 3 for details]).

noted in Chapter 3, because it is based on the *Dietary Guidelines for Americans* (DGA) food patterns, which apply only to individuals ages 2 and older, the HEI-2010 was applied only to individuals in this age range.

Mean scores for the HEI-2010 are presented in Tables 5-9 and 5-10. Mean scores are presented for each of the 12 components that make up the HEI-2010 as well for the overall index (total score). To provide context, maximum potential scores are presented in the second column. The maximum score for the index as a whole is 100, and maximum scores for the various components range from 5 to 20. In all cases, including dietary components that should be consumed in moderation (i.e., sodium, refined grains, and empty calories), a higher score reflects better diet quality.

Mean HEI-2010 Scores of Pregnant, Breastfeeding, and Postpartum Women

Mean total scores for all subgroups of women were well below the maximum possible score of 100. There were no statistically significant differences between WIC participant and eligible non-WIC participant subgroups (see Table 5-9). Overall, scores were lowest, relative to the maximum possible score, for greens and beans, whole grains, fatty acids (healthy fats), and empty calories. These results are consistent with the analysis of food group intakes reported earlier in this chapter and with findings from the USDA-FNS (2015) *Diet Quality of Young American Children* report (which also included an analysis of the HEI-2010 for women).

Mean HEI-2010 Scores of Children 2 to Less Than 5 Years of Age

Mean HEI-2010 scores for children 2 to less than 5 years of age are presented in Table 5-10. On average, children had higher total scores for the HEI-2010 than women (see Table 5-9). Mean total scores for WIC-participating children in the 2005–2008 NHANES surveys were 8 points higher than the scores observed for women (59.8 versus 51.9), although still well below the maximum score of 100. WIC participating children and income-eligible nonparticipant children in the NHANES 2005–2008 surveys had virtually identical mean scores for the HEI-2010 overall (total score) and for its 12 components. Scores were lowest, relative to the maximum possible score, for greens and beans, whole grains, fatty acids (healthy fats), total vegetables, and seafood and plant proteins. Differences in scores between WIC-participating children and eligible nonparticipating children were not significant.

These results are consistent with the analysis of food group intakes reported earlier in this chapter. The results are also generally consistent with findings from the USDA-FNS (2015) *Diet Quality of Young American*

TABLE 5-9 Summary of Mean HEI-2010 Scores for Women Ages 19-50 Years

HEI-2010 Component	Maximum Score	WIC,[a] 2005–2008 (N = 222)	Eligible Non-WIC,[b] 2005–2008 (N = 76)	All Low-Income,[c] 2011–2012 (N = 29)
		Mean Score (SE)		
Adequacy				
Total Vegetables	5	2.7 (0.36)	2.4 (0.32)	2.4 (0.36)
Greens and Beans[d]	5	0.9 (0.46)	2.2 (1.01)	1.7 (0.82)
Total Fruit[e]	5	3.8 (0.43)	4.2 (0.50)	4.1 (1.18)
Whole Fruit[f]	5	3.6 (0.66)	4.4 (0.52)	3.0 (1.19)
Whole Grains	10	2.1 (0.36)	2.1 (0.56)	2.6 (0.74)
Dairy[g]	10	7.0 (0.41)	5.9 (0.86)	5.9 (0.99)
Total Protein Foods[h,i]	5	4.8 (0.23)	5.0 (0.08)	4.4 (0.47)
Seafoods and Plant Proteins	5	2.1 (0.42)	4.3 (0.92)	2.9 (1.15)
Fatty Acids[j]	10	3.8 (0.53)	3.0 (0.80)	5.3 (0.83)
Moderation				
Sodium	10	5.4 (0.59)	6.6 (0.70)	6.5 (0.90)
Refined Grains	10	6.0 (0.46)	4.6 (0.60)	6.4 (0.68)
Empty Calories[k]	20	9.8 (1.36)	10.2 (1.02)	11.4 (2.07)
Total HEI-2010 Score	100	51.9 (3.25)	55.0 (2.12)	56.6 (4.37)

NOTES: HEI = Healthy Eating Index; N = sample size; SE = standard error. There were no statistically significant differences between WIC and eligible non-WIC subgroups.

Population subgroup definitions are as follows:

[a] WIC = All individuals reporting participation in WIC regardless of income level.

[b] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

[c] All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.

[d] Includes any beans and peas not counted as Total Protein Foods.

[e] Includes 100% fruit juice.

[f] Includes all forms except juice.

[g] Includes all milk products, such as fluid milk, yogurt, and cheese, and fortified soy beverages.

[h] Beans and peas are included here (and not with vegetables) when the Total Protein Foods standard is otherwise not met.

[i] Includes seafood, nuts, seeds, and soy products (other than beverages) as well as beans and peas counted as Total Protein Foods.

[j] Ratio of poly- and monounsaturated fatty acids (PUFAs and MUFAs) to saturated fatty acids (SFAs).

[k] Calories from solid fats, alcohol, and added sugars; threshold for counting alcohol is more than 13 grams/1,000 kcal.

SOURCES: USDA/ARS, 2005–2008, 2011–2012, 2014.

TABLE 5-10 Summary of Mean HEI-2010 Scores for Children Ages 2 to Less Than 5 Years

HEI-2010 Component	Maximum Score	WIC,[a] 2005–2008 (N = 398)	Eligible Non-WIC[b] 2005–2008 (N = 329)	All Low-Income,[c] 2011–2012 (N = 340)
		Mean Score (SE)		
Adequacy				
Total Vegetables	5	2.2 (0.10)	2.1 (0.10)	1.9 (0.10)
Greens and Beans[d]	5	0.3 (0.12)	0.7 (0.18)	0.8 (0.35)
Total Fruit[e]	5	5.0 (0.00)	5.0 (0.08)	5.0 (0.01)
Whole Fruit[f]	5	5.0 (0.07)	5.0 (0.03)	5.0 (0.01)
Whole Grains	10	1.8 (0.15)	2.2 (0.29)	2.7 (0.21)
Dairy[g]	10	10.0 (0.01)	9.9 (0.15)	9.9 (0.25)
Total Protein Foods[h,i]	5	4.1 (0.13)	4.3 (0.15)	4.1 (0.26)
Seafoods and Plant Proteins	5	2.2 (0.22)	2.7 (0.37)	2.6 (0.27)
Fatty Acids[j]	10	2.1 (0.22)	2.2 (0.23)	3.2 (0.55)
Moderation				
Sodium	10	6.7 (0.25)	5.9 (0.25)	6.4 (0.25)
Refined Grains	10	7.4 (0.31)	6.6 (0.26)	6.6 (0.31)
Empty Calories[k]	20	13.2 (0.34)	12.0 (0.41)	13.7 (0.46)
Total HEI-2010 Score	100	59.8 (0.66)	58.7 (1.08)	62.0 (1.05)

NOTES: HEI = Healthy Eating Index; N = sample size; SE = standard error. There were no statistically significant differences between WIC and eligible non-WIC subgroups.

Population subgroup definitions are as follows:

[a] WIC = All individuals reporting participation in WIC regardless of income level.

[b] Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

[c] All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the “All Low-Income 2011–2012” group serves as a proxy for current intakes of this population.

[d] Includes any beans and peas not counted as Total Protein Foods.

[e] Includes 100% fruit juice.

[f] Includes all forms except juice.

[g] Includes all milk products, such as fluid milk, yogurt, and cheese, and fortified soy beverages.

[h] Beans and peas are included here (and not with vegetables) when the Total Protein Foods standard is otherwise not met.

[i] Includes seafood, nuts, seeds, and soy products (other than beverages) as well as beans and peas counted as Total Protein Foods.

[j] Ratio of poly- and monounsaturated fatty acids (PUFAs and MUFAs) to saturated fatty acids (SFAs).

[k] Calories from solid fats, alcohol, and added sugars; threshold for counting alcohol is more than 13 grams/1,000 kcal.

SOURCES: USDA/ARS, 2005–2008, 2011–2012, 2014.

Children report. However, there were differences between the committee's analysis and the USDA-FNS (2015) report for some of the component scores. Specifically, the USDA-FNS (2015) analysis found that WIC-participating children had significantly higher scores than WIC-eligible nonparticipant children for all three of the dietary components that should be consumed in moderation: sodium, refined grains, and empty calories. In the committee's analysis, there were no significant differences between WIC children and income-eligible nonparticipant children for these components.[4] One potential reason for the discrepant findings (both analyses are based on 2005–2008 NHANES data) is that the USDA-FNS results were age adjusted to account for differences in the age distribution of WIC participants and nonparticipants. The analysis conducted by the committee was not age adjusted. In addition, the food patterns databases applied were different between the USDA-FNS's and the committee's approach.

Similar to the pattern observed for pregnant, breastfeeding, and postpartum women, low-income children in the 2011–2012 NHANES survey had a notably higher total score on the HEI-2010 than either subgroup of children in the 2005–2008 NHANES surveys (62.0 versus 59.8). Differences for the component scores were mixed (some were higher in 2011–2012 and some were lower), but the main contributors to the higher total score in 2011–2012 were higher scores for fatty acids (healthy fats), whole grains, sodium, and empty calories.

CONSIDERATIONS FOR DATA INTERPRETATION

The committee recognized several potential limitations to interpreting the data presented in this chapter. Since the Institute of Medicine (2006) report, there has been only limited national-level work evaluating the food intake patterns of infants up to 24 months of age. The two nationally representative surveys summarized here (IFPS II and FITS 2008) were completed 8 or more years ago and may not adequately reflect current feeding practices. As noted previously, the committee anticipates that results of the WIC Infant and Toddler Feeding Practices Study will be available in phase II (Harrison, 2014).

Limitations to the nutrient intake analyses that were discussed in Chapter 4 are also applicable to the food intake analyses of NHANES data presented here. In addition, the food intake data include many zeros in a reported day's intake and this feature of the data requires appropriate methods that account for the zero intakes in estimating the intake distributions (see Chapter 3). The sample sizes are smaller across population subgroups

[4] Although not reported in Table 5-10, tests of statistical significance were conducted for these comparisons.

in the food intake analysis compared to those for nutrient intake because (due to software requirements) individuals included in the sample must have 2 days of reported intake to estimate usual intakes of foods (reported intake could be zero on one or both days). In some cases, this results in sample sizes that are quite small. For example, the 2011–2012 low-income population subgroup of women includes only 29 individuals. The only software that does not require equal number of observations per person is the NCI software, but it failed to converge in several cases in these analyses.

In this report, a population-weighted approach was applied using SPADE. An alternative, simplified approach was applied in the Letter Report (IOM, 2015) to compare intake to recommendations. Also, in the Letter Report, PC Software for Intake Distribution (PC-SIDE) and the Iowa State University method were used instead of SPADE, and for different sample years and respondent selection criteria, so mean intakes and the comparisons to recommended intakes differ between the Letter Report and the analyses presented here.

Overall, comparisons to recommended food patterns presented in this report are similar to those in other studies. Most recently, Krebs-Smith et al. (2010) applied an approach similar to that used here to compare intakes to federal dietary recommendations using 2001–2004 NHANES data. Although the food groups were categorized differently then, most individuals in the U.S. population did not meet the recommended intakes for any food group except "total grains" and "meat and beans." As the committee found in its analysis, energy intake from solid (saturated) fats and added sugars was excessive. Similar to the findings in this report and those of Krebs-Smith et al., (2010), the 2015 DGAC report indicated overall poor intakes of food groups that supply important nutrients.

The reliability and consistency of the HEI-2010 has been validated for prediction of diet quality (Guenther et al., 2014); however, the index has a few limitations. Consumers of beans and peas may have lower scores for "seafood and plant proteins" or "total vegetables" because the beans and peas are counted toward other groups first, then any "leftover" is counted as contributing to these groups. The HEI-2010 also does not account for physical activity or the appropriateness of energy intake. Therefore, an individual who consumes too much energy may have higher HEI scores than one consuming an appropriate level of energy but whom, as a result, has difficulty meeting the recommended food pattern. For example, individuals over the age of 8 with energy needs less than 1,600 kcal will have difficulty meeting nutrient requirements (Guenther et al., 2014). Although consuming DGA 2010 food patterns would result in a perfect score, the food patterns do not actually provide the recommended amounts of vitamins D or E, or potassium or choline (Guenther et al., 2014). The HEI-2010 does provide a validated way to compare diet quality across population groups.

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6

Nutrition-Related Health Risks in the WIC Population

INTRODUCTION

Women, infants, and children ages 1 to less than 5 years who meet the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) eligibility criteria for income, life-stage category, and residency status are presumed to be at nutritional risk (IOM, 2002).[1] These nutritional risks include anthropometric; biochemical; dietary; clinical, health, and medical; and other risks (USDA/FNS, 2013). This chapter begins with a summary of the WIC specification of these risks and the most commonly reported risks for WIC participants. Next, the health outcomes associated with these nutritional risks are discussed. For each outcome, its prevalence is described in women, infants, and children from 1 to less than 5 years of age participating in WIC, and the relevant U.S. population based on national and regional evidence. During its evaluations, the committee remained aware of the importance of maternal nutrition on infant health (IOM, 2011a), as well as differences among racial and ethnic groups that are represented in the WIC population. This chapter ends by covering food safety risks relevant to the WIC population and the food packages.

[1] As stated in 7 C.F.R. § 246.2: "Nutritional risk means: (a) Detrimental or abnormal nutritional conditions detectable by biochemical or anthropometric measurements; (b) Other documented nutritionally related medical conditions; (c) Dietary deficiencies that impair or endanger health; (d) Conditions that directly affect the nutritional health of a person, including alcoholism or drug abuse; or (e) Conditions that predispose persons to inadequate nutritional patterns or nutritionally related medical conditions, including, but not limited to, homelessness and migrancy."

Evidence and Data Sources

The committee conducted a literature search to identify evidence for specific health risks of relevance to WIC participants, focusing on recent systematic or comprehensive reviews, highly relevant research studies, and nationally representative data on health risks in either the U.S. or WIC-specific populations. This literature search was separate from the literature search discussed in Chapter 3. The Institute of Medicine (IOM) report *Weight Gain During Pregnancy: Reexamining the Guidelines* (IOM, 2009) was also considered because of its extensive review of several health concerns applicable to the WIC population.

The committee considered three sources of national data specific to the WIC population:

1. The U.S. Department of Agriculture's Food and Nutrition Service (USDA-FNS) biennial Participant and Program Characteristics (PC) report series (USDA/FNS, 2007, 2013);
2. The National Survey of WIC Participants (NSWP)-II report (USDA/FNS, 2012); and
3. The Center for Disease Control and Prevention's (CDC's) Pediatric Nutrition Surveillance System (PedNSS) and Pregnancy Nutrition Surveillance System (PNSS) for which annual data collection was discontinued after 2012 (CDC, 2011a,b).

The committee was not able to evaluate the effect of the 2009 food package change on WIC participants' health because the NSWP-II report data cannot be ascribed to a time period specifically before or after this change.

In addition to WIC-specific data, the committee considered two sources of relevant national data: (1) National Health and Nutrition Examination Survey (NHANES), which is released on a biennial basis (USDA/ARS, 2005–2008, 2011–2012), and (2) the CDC's Pregnancy Risk Assessment Monitoring System (PRAMS), for which data are collected annually (CDC, 2015a). Details of the methodology and survey populations for these sources are available in Appendix R, Table R-1. Nationwide prevalence data (for either the WIC or U.S. population) are reported when available. Otherwise, data from smaller studies published in the peer-reviewed literature are referenced. The committee was aware that WIC-specific data are subject to the selection bias challenges outlined in Chapter 3.

MATERNAL NUTRITION-RELATED HEALTH RISKS

WIC-Reported Nutritional Risks for Participants

The specific criteria for the most relevant nutrition-related risks as reported by WIC programs are summarized in Table 6-1. For some risks, such as inappropriate weight status (high or low weight for height) in children at least 2 years of age and women, the preferred definition is based on body mass index (BMI) cutoff points but, if height and weight cannot be reliably measured, an alternative approach is allowed. For anemia, low hemoglobin or hematocrit is used, which includes all causes, such as genetic, inflammatory, and nutritional deficiency (iron, folate, and vitamin B12). Further, hematocrit or hemoglobin may be directly measured in some states or taken from self-reports or medical records in other states. A state agency may use more, but not less, restrictive criteria (USDA/FNS, 2011).

WIC agencies can report multiple nutritional health risks for a participant (up to 10 in 2012) (USDA/FNS, 2013). In 2012, 40 percent of infants and 60 percent of children had only one reported nutritional risk (USDA/FNS, 2013), whereas 54 percent of breastfeeding women had three or more reported nutritional risks. The committee recognizes the value and importance to USDA-FNS of WIC programs reporting nutritional risk of participants using nationwide criteria. As a result of the multiple risk reporting and the use of multiple approaches for nutritional risk assessment, interpretation of the frequency of reported risks is challenging. Therefore, the committee cites only the five most frequently reported nutritional risks for WIC participants in 2012 (see Table 6-2).

For all women participants, high weight for height (measures of overweight and obesity) (see Table 6-1) were the most common nutritional risk criteria reported. This criterion was reported for 53 to 54 percent participating women at enrollment. Inappropriate nutrition practices are the most commonly reported risk for infants (31 percent) and children (64 percent). Such inappropriate practices include feeding practices that compromise appropriate infant or child growth, health, or safety; risk associated with complementary feeding for those 4 to 23 months of age; failure to meet the *Dietary Guidelines for Americans* (DGA) by those 2 years and older; and dietary supplement practices including inadequate, excessive, or inappropriate usage (see Table 6-1). For children, high weight for height/length (a measure of overweight or obesity) (see Table 6-1) was the second most commonly reported nutritional risk (24 percent).

The committee considered using these reported nutritional risk data as one measure of the prevalence of these conditions in the WIC population but decided against using this approach. This is because of the multiple risk criteria reporting for an individual, the potential variance in actual mea-

TABLE 6-1 Selected WIC-Reported Nutritional and Related Risks and Criteria for WIC Participants

Risk Category	Risk Criteria	WIC Participant Category	Risk Criteria Definition
Anthropometric	Low weight for length/height	Women	BMI < 18.5 (measured height and weight; alternative permitted) (CDC, 2011c)
		Infants and Children	< 2 years: < the fifth percentile low weight for length (CDC, 2009) or weight loss < 1 month
		Children	2 to < 5 years: < the fifth percentile BMI (measured height and weight; alternative permitted) (CDC, 2009)
	High weight for length/height	Women	BMI 25–29.9 (overweight) and ≥ 30 (obese) (measured height and weight; alternative permitted) (CDC, 2011c)
		Infants and Children	< 2 years: ≥ the 97.7th percentile weight for length (USDA/FNS, 2013) or biological mother's BMI at conception or in first trimester for infants
		Children	2 to < 5 years: > the 85th < the 95th percentile (overweight) or ≥ the 95th percentile BMI-for-age (measured height and weight; alternative permitted) (CDC, 2009)
	Short stature	Infants and Children	< 2 years: ≤ 2.3rd percentile or < the fifth percentile (at risk for short stature) (USDA/FNS, 2013)
		Children	2 to < 5 years: < the fifth percentile length or height for age (CDC, 2009)
	Inappropriate growth or weight gain pattern	Pregnant Women	Gestational weight gain < or > IOM Weight Gain Guidelines (2009) or weight loss
		Infants	Low birth weight (< 2,500 g) or small for gestational age (< the 10th percentile birth weight for gestational age) or premature birth (< 37 weeks gestation)
		Infants and Children	Failure to thrive (WIC medical condition): < the fifth percentile of weight for age)

TABLE 6-1 Continued

Risk Category	Risk Criteria	WIC Participant Category	Risk Criteria Definition
Biochemical	Low hematocrit or hemoglobin	Postpartum or Breastfeeding Women	< 12 g/dL hemoglobin or < 37.7% hematocrit for women 18 years or older (CDC, 2011c)
		Pregnant Women	Trimester-specific cutpoints for hemoglobin (g/dL) and hematocrit (%) respectively: 1st: 11.0 and 33.0; 2nd: 10.5 and 32.0; 3rd: 11.0 and 33.0 (CDC, 2009)
		Infants and Children	6 months to < 2 years: < 11 g/dL or < 32.9% for hemoglobin or hematocrit 2 to < 5 years: < 11.1 g/dL or < 33.3% for hemoglobin or hematocrit (CDC, 2009)
Dietary	Failure to meet the *Dietary Guidelines for Americans* (DGA)	Women and Children ≥ 2 Years	Diet intake fails to meet DGA
	Inappropriate feeding or nutritional practices	Women	Behaviors related to dietary supplement consumption (inadequate, excessive, prenatal, iron, etc.), strict diets, consumption of non-food items, food-safety-related practices (CDPH, 2015)
		Infants and Children	Feeding practices that compromise appropriate infant growth, health, or safety (CDPH, 2015); 4–23 months dietary risk associated with complementary feeding (age introduced, intake, quantity, etc.) Dietary supplements (inadequate, excessive, fluoride, vitamin D) (USDA/FNS, 2006)

continued

TABLE 6-1 Continued

Risk Category	Risk Criteria	WIC Participant Category	Risk Criteria Definition
Clinical, Health, and Medical	Pregnancy-induced conditions	Pregnant Women	Hyperemesis, gravidarum, gestational diabetes, history of gestational diabetes, history of preeclampsia (USDA/FNS, 2006)
	General obstetrical risks	Pregnant Women	Multiple fetus births, high parity and young age, closely spaced pregnancies Delivery of low birth weight or premature infant Prior stillbirth, fetal, or neonatal death (USDA/FNS, 2006)
	Nutrition-related risk conditions	Women, Infants, and Children	Any nutrition-related chronic disease, genetic disorder, infectious disease, gastrointestinal disorders, drug-nutrient interactions, prediabetes (USDA/FNS, 2006)
	Substance abuse	Women	Use of drugs, alcohol, or tobacco (USDA/FNS, 2006)
	Other health risks	Women, Infants, and Children	Fetal alcohol syndrome Oral health and dental problems (USDA/FNS, 2006)
Other	Various	Women, Infants, and Children	Regression/transfer (nutrition risk unknown)/presumptive eligibility Breastfeeding mother and infant dyad Homelessness/migrancy Other nutritional risks (USDA/FNS, 2006)

SOURCES: USDA/FNS, 2006, 2013; CDC, 2009, 2011c; IOM, 2009; CDPH, 2015.

sure or alternative approaches for some assessments, and variance among states in the use of directly measured versus self-reported values or values extracted from the medical record. The committee found that the variance introduced by these factors limited the utility of these data for assessment of prevalence. Instead, the committee relied on national and regional (state or smaller WIC specific) evidence determining prevalence of health risks of interest (see Table 6-3).

This section summarizes maternal nutrition-related health risks before pregnancy, during pregnancy, and after pregnancy and the effects of these risks on both maternal and infant health outcomes. Women who are not pregnant or postpartum are not categorically eligible for WIC participa-

TABLE 6-2 Reported Nutritional Risks for WIC Participants from Most Common to Fifth Most Common in 2012

	WIC Participant Category				
	Women			Infants	Children
Rank	Pregnant	Breastfeeding	Postpartum	0 to < 12 months	1 to < 5 years
1	High weight for height	High weight for height	High weight for height	Inappropriate nutrition practices	Inappropriate nutrition practices
2	Inappropriate weight gain	Low hematocrit or hemoglobin	Inappropriate weight gain	Low birth weight or premature birth	High weight for height/length
3	Inappropriate nutritional practices	Inappropriate weight gain	Low hematocrit or hemoglobin	Short stature	Failure to meet the *Dietary Guidelines for Americans*
4	General obstetrical risk	Inappropriate nutritional practices	Inappropriate nutritional practices	Low weight for length	Low hematocrit or hemoglobin
5	Low hematocrit or hemoglobin	General obstetrical risk	General obstetrical risk	Low hematocrit or hemoglobin	Low weight for height/length

SOURCE: USDA/FNS, 2013.

TABLE 6-3 Prevalence (%) of Selected Nutrition-Related Health Risks and Outcomes in WIC Participants and U.S. Women from Nationally Representative Evidence

Nutrition-Related Health Risk/Outcome	2011 PNSS (WIC Women)[a]	NHANES (U.S. Women)	
		Pregnant	All
	Before Pregnancy		
Overweight	26.0	NA	23.9[b]
Obese	27.6	NA	31.9[b]
Combined overweight and obese	53.6	NA	55.8[b]
Underweight	4.5	NA	2.5[c]
Low folate status	NA	NA	0.9[d]
	During Pregnancy: Maternal Risks and Outcomes		
Inappropriate gestational weight gain			
< IOM 2009 Guidelines	21.0	NA	NA
> IOM 2009 Guidelines	48.0	NA	NA
Gestational diabetes	5.7	NA	NA
Pregnancy-induced hypertension	6.7	NA	NA
Anemia	NA	5.4[e]	NA
1st trimester	7.3	NA	NA
2nd trimester	11.6	NA	NA
3rd trimester	33.8	NA	NA
Iron deficiency	NA	18.0[e]	NA
1st trimester	NA	6.9[e]	NA
2nd trimester	NA	14.3[e]	NA
3rd trimester	NA	29.7[e]	NA
	During Pregnancy: Fetal Risks and Outcomes		
Low birth weight	7.9	NA	NA
SGA (full-term low birth weight)	3.4	NA	2.0[f]
Premature birth	10.5	NA	10.0[f]
High birth weight	6.9	NA	NA
	Postpartum		
Excessive weight retention	NA	NA	NA
Anemia	28.3	NA	NA

TABLE 6-3 Continued

Nutrition-Related Health Risk/Outcome	2011 PNSS (WIC Women)[a]	NHANES (U.S. Women)	
		Pregnant	All
		Breastfeeding	
Overweight and obese	NA	NA	NA
Anemia	NA	NA	NA

NOTES: IOM = Institute of Medicine; NA = Data not available; NHANES = National Health and Nutrition Examination Survey; PNSS = Pregnancy Nutrition Surveillance System; SGA = small for gestational age.

[a] PNSS has 100 percent WIC participants (N = 1,005,177).

[b] Overweight calculated by difference of reported combined overweight and obesity prevalence and obesity prevalence in women ages 20 to 39 years based on NHANES 2009–2010 (Flegal et al., 2012).

[c] Age-adjusted prevalence of underweight in women ages 20 to 39 years from NHANES 2011–2012 (CDC, 2014a).

[d] Low serum folate for women 15–44 years in NHANES 1999–2010 (Pfeiffer et al., 2012). Red blood cell folate data were suppressed because the standard error for this estimated was too large.

[e] Anemia and iron status (based on total body iron) from NHANES 1998–2006 (Mei et al., 2011).

[f] Self-reported small for gestational age (< 5.5 birthweight not preterm) and premature (≤ 36 weeks at birth) by a subset of women ages 17 to 35 years in NHANES 1999–2006 who completed the Reproductive Health Questionnaire (Hux et al., 2014).

SOURCES: PNSS data from CDC, 2011a; NHANES analysis sources as listed in the table notes.

tion, but the potential impact of key nutrition-related health risks before pregnancy are discussed, as they relate to pregnancy outcomes. Finally, health risks that can be affected by the composition of the food package are discussed for pregnant women in terms of maternal and fetal outcomes, postpartum women, and breastfeeding women.

Nutrition-Related Health Risks Before Pregnancy

The committee considered two nutrition-related health risks that occur before conception and can affect pregnancy outcomes, namely inappropriate weight status (i.e., overweight and obesity) and folate status. The evidence relating these risks is summarized here.

Inappropriate Weight Status

The 2009 Committee to Reexamine IOM Pregnancy Weight Guidelines recommended that, ideally, women should begin pregnancy with a BMI within the recommended range because abnormal pre-pregnancy BMI is an independent predictor of adverse pregnancy outcomes (IOM, 2009). Pre-pregnancy overweight and obesity are associated with poor birth outcomes, including higher risk of fetal death, stillbirth, and infant death (Aune et al., 2014; Marchi et al., 2015), higher birth weight (IOM, 2009; Shin and Song, 2014; Marchi et al., 2015; Vinturache et al., 2015; Yan, 2015), reduced breastfeeding rates (Marchi et al., 2015), adiposity of offspring into childhood (Tan et al., 2015), and adverse maternal outcomes including gestational hypertension and diabetes (Shin and Song, 2014; Marchi et al., 2015).

The prevalence of overweight and obesity is high among WIC participants and U.S. women of reproductive age (see Table 6-3). PNSS data from 2011 indicated a 26 percent prevalence of overweight and 27.6 percent prevalence of obesity in WIC women (CDC, 2011a). The combined prevalence of obesity and overweight in U.S. reproductive-age women (20 to 39 years) was 55.8 percent in 2011–2012 (Flegal et al., 2012), with black or African American and Hispanic females having higher rates of overweight and obesity compared to other groups (Flegal et al., 2012; Ogden et al., 2014).

Periconceptional Folate Status

A relationship between maternal folate stores and birth defects is well documented. Following the required addition of folic acid to enriched grain products in 1998 (NARA, 1996), the incidence of neural tube defects in the United States dropped by approximately 36 percent from 1996 to 2006 (CDC, 2010) and has subsequently remained stable (Williams et al., 2015). However, also following the fortification rule, the DGA began to emphasize intake of whole grains (USDA/HHS, 2000), for which folic acid fortification is not required. Subsequently, the 2009 changes in the WIC food packages included introduction of whole wheat bread (or allowable substitutions from other whole grain options), and required that WIC vendors ensure that half of cereal choices were made with whole grains. Although 40 percent of adult U.S. females consume folate primarily through mandatorily fortified enriched cereal grain products, another 16.8 percent consume it through voluntarily fortified ready-to-eat cereals as well as mandatorily fortified enriched grains (Yang et al., 2010). The committee noted that no fortification of corn masa flour (used to make tortillas) is required. Williams et al. (2015) reported that the prevalence of neural tube defects across the United States between 1995 and 2011was highest among Hispanics, many of whom commonly consume products made with corn masa flour.

Available data on WIC participants from North Dakota (Watts et al., 2007), California (predominantly Hispanic participants [Leonard et al., 2014]), and Georgia (Dunlop et al., 2013) indicated that folate intakes were below recommendations. In Chapter 4 (see Table 4-20), the committee reports a higher prevalence (50 percent) of folate inadequacy among pregnant, breastfeeding or postpartum WIC participants compared to low-income non-WIC participants in NHANES 2005–2008 or all low-income women in NHANES 2011–2012. However, the prevalence of folate deficiency based on serum folate[2] is very low (0.9 percent, Table 6-3) in reproductive age women in 1999–2010 NHANES (Pfeiffer et al., 2012).

Nutrition-Related Health Risks During Pregnancy

Nutrition-related health risks during pregnancy include inappropriate gestational weight gain, type 2 and gestational diabetes, pregnancy-induced hypertension and preeclampsia, maternal iron deficiency and anemia, low maternal vitamin D, and low maternal choline intake (IOM, 2009). This section covers each of these risks and its maternal and fetal health outcomes. The prevalence of these risks is summarized for WIC participants and the U.S. population as well. The effect of nutrition-related health risks during pregnancy on success of breastfeeding is addressed in a later section.

Gestational Weight Gain

Pregnancy weight gain below or above IOM (2009) weight gain guidelines can affect both the mother (i.e., by increasing the risks of gestational diabetes and pregnancy-induced hypertension and preeclampsia) and the developing fetus (i.e., by increasing the risks of low and high birth weight). All of these effects are discussed below. The effects of gestational weight gain on maternal postpartum weight retention and success of breastfeeding are discussed later in this chapter. Among WIC participants, the frequency of "greater than ideal" or "less than ideal" weight gain based on IOM (2009) guidelines[3] was 48 and 21 percent, respectively, in the 2011 PNSS survey (see Table 6-3; CDC, 2011a).

Type 2 and Gestational Diabetes

Pre-existing type 2 diabetes or the development of gestational diabetes during pregnancy increases the risks of high birth weight,[4] birth defects,

[2] In Pfeiffer et al. (2012), standard error was too large to present estimates of folate deficiency based on red blood cell folate.

[3] Weight gain guidelines as specified in IOM (2009): Underweight pre-pregnancy (ideal weight gain = 28 to 40 pounds); normal weight pre-pregnancy (ideal weight gain = 25 to 35 pounds); overweight prepregnancy (ideal weight gain = 15 to 25 pounds); obese prepregnancy (ideal weight gain = 11 to 20 pounds).

[4] Large for gestational age, meaning birth weight greater than 90th percentile for gestational age.

birth by cesarean delivery, high blood pressure and preeclampsia, preterm birth, hypoglycemia, and miscarriage or stillbirth (IOM, 2009; CDC, 2012a; Dean et al., 2014; Hartling et al., 2014).

Pre-pregnancy obesity greatly increases the risk for development of gestational diabetes. However, emphasizing reduced energy intakes and weight loss may not be appropriate for pregnant women with diabetes because pregnancy requires achieving gestational weight gain goals (IOM, 2009). Instead, current guidelines from the American Diabetes Association (ADA) for pregnant women with type 2 or gestational diabetes focus on tight glycemic control to reduce adverse outcomes. ADA (2014) noted, "substituting low-glycemic load foods for higher-glycemic load foods may modestly improve glycemic control," but graded the evidence as a *C* indicating conflicting evidence supporting the recommendation (ADA, 2014). A recent systematic review reported that a diet with low glycemic index foods reduced maternal insulin and newborn weight, suggesting that a focus on the glycemic load of foods may be useful for pregnant women with diabetes (Viana et al., 2014).

The committee was not able to find data specific to the prevalence of gestational diabetes in the WIC population on a national level. Regional data available from Los Angeles County, California, indicated a prevalence of 12 percent in 2014. This prevalence varied with ethnicity (from 6.6 for African Americans to 17.6 percent for Asian-Pacific Islanders) (Personal communication, S. Whaley, Public Health Foundation WIC Enterprises, January 12, 2015). The national prevalence of gestational diabetes in 2010 was estimated to be as high as 9.2 percent (DeSisto et al., 2014). PNSS data indicate a lower prevalence of 5.7 percent among WIC women (see Table 6-3; CDC, 2011a).

Pregnancy-Induced Hypertension and Preeclampsia

Pregnancy-induced hypertension and preeclampsia are major causes of maternal, fetal, and neonatal morbidity and mortality, including abruptio placentae, maternal vascular events and organ failure, adverse fetal growth, and preterm birth (Kintiraki et al., 2015). Preeclampsia (high blood pressure accompanied by protein in the urine) can result in preterm birth, intrauterine growth restriction, and maternal and fetal morbidity and mortality (Lin et al., 2015). Associated nutritional risk factors for preeclampsia include both pre-pregnancy overweight and obesity (Dean et al., 2014) and low pre-pregnant weight (Savitz et al., 2012). A Cochrane systematic review found that calcium supplementation greater than 1 g per day, especially in women consuming low-calcium diets, was associated with reduced risk of preeclampsia (Hofmeyr et al., 2014). Although low vitamin D status, assessed by serum 25-hydroxy vitamin D, known as 25(OH)D, levels, has been inconsistently associated with the risk for preeclampsia in the past, the Agency for Healthcare Research and Quality (AHRQ) (2014) cited newer studies suggesting a possible relationship between vitamin D and reduced risk for preeclampsia. PNSS data indicate a prevalence of hypertension during pregnancy, including preeclampsia, of 6.7 percent among WIC women (see Table 6-3; CDC, 2011a).

Maternal Iron Deficiency and Anemia

Demand for iron is elevated during pregnancy to meet high maternal and fetal needs. Maternal iron deficiency and iron-deficient anemia are associated with several adverse maternal outcomes, including fatigue, weakness, and tachycardia (AHRQ, 2015). They are less conclusively associated, particularly for anemia in the third trimester (Scholl, 2011), with neonatal outcomes, including lower iron stores, impaired neurocognitive development, developmental programming, low birth weight, and preterm birth (Cao and O'Brien, 2013; AHRQ, 2015).

The varying physiologic changes in iron stores and hemoglobin that occur across pregnancy require the use of multiple biomarkers and trimester-specific cutpoints for evaluating iron deficiency or iron-deficiency anemia. Emerging evidence links obesity-induced inflammation with iron deficiency and anemia through its disturbances of iron absorption and sequestration (Becker et al., 2015). This was of interest to the committee because of the high prevalence of obesity in the WIC population. However, no data could be identified on obesity-induced, iron-deficiency anemia during pregnancy.

PNSS data indicate a prevalence for third trimester anemia from any cause of 34 percent in WIC respondents (CDC, 2011a). NHANES data from 1999–2006 indicated a prevalence of anemia in pregnant women of 5.4 percent (see Table 6-3; Mei et al., 2011).

The committee was also interested in iron deficiency even though it is not a WIC-reported nutritional risk because of the importance of maternal iron status for early infant iron status. NHANES data from 1999–2006 indicate a prevalence for iron deficiency (based on total body iron) in pregnant women of 18 percent. The prevalence of iron deficiency increased across pregnancy from 6.9 percent in the first trimester to 29.7 percent in the third trimester (see Table 6-3; Mei et al., 2011). Iron deficiency was higher in African American and Hispanic women compared to white women.

Low Vitamin D Status

Evidence on the relationship between low vitamin D status and maternal and infant outcomes is conflicting (IOM, 2011b). Low serum 25(OH)D has been inconsistently associated with a number of pregnancy outcomes in the mother, including cesarean delivery, gestational diabetes, preeclampsia (as discussed previously), and bacterial vaginosis (IOM, 2011b; AHRQ, 2014). Potential adverse outcomes of low maternal vitamin D for the neonate include preterm delivery, small for gestational age, and neonatal bone health (IOM, 2011b; AHRQ, 2014). In a recent systematic review of vitamin D supplementation during pregnancy, Harvey et al. (2014) found only modest evidence (limited by its observational nature and lack of concordance with intervention trials) to support a relationship of maternal vitamin D status with birth weight or bone mass and judged the evidence insufficient to support vitamin D supplementation during pregnancy. In its updated review on vitamin D and health outcomes, AHRQ (2014) found no consistent relationship between vitamin D or vitamin D supplementation and birth weight and conflicting observational evidence for relationships with preterm birth and small for gestational age (AHRQ, 2014).

The prevalence of inadequacy of vitamin D specifically in pregnant women from NHANES has not been analyzed to date using valid serum 25(OH)D levels (i.e., corrected for the known assay shifts and drifts).

Choline Deficiency

Choline, like folate, is a methyl donor and therefore also plays an important role in fetal development (IOM, 1998, 2000). Low maternal choline intake has been associated with a greater risk of neural tube defects and orofacial cleft in infants (Zeisel, 2013). In their recent randomized-controlled trial, Yan et al. (2013) found that choline demand was significantly higher in late pregnancy. Although choline appears to have positive effects on cognitive function and risks of chronic diseases later in life, the mechanisms are not fully understood (Jiang et al., 2014).

Choline intakes for women ages 20 years and older in NHANES 2007–2008 were approximately 60 percent of the Adequate Intake (AI) value established by the IOM (USDA/ARS, 2011).

Fetal Outcomes Related to Nutrition-Related Health Risks During Pregnancy

This section summarizes evidence associating low and high birth weight with nutrition-related conditions in women.

Low birth weight Low birth weight is defined as a birth weight less than 2,500 g and includes infants born either small for gestational age (less than 10th percentile birthweight for gestational age) or preterm (less than 37 weeks' gestation) (CDC, 2015). Being small for gestational age increases risks of perinatal mortality and morbidity, including metabolic alterations such as hypoglycemia and hypothermia (Saggese et al., 2013). Both conditions are known risk factors for developmental programming of adult health and disease (Martin-Gronert and Ozanne, 2012).

Both prepregnancy underweight and lower than recommended gestational weight gain increase the risk of the child being born small for gestational age (IOM, 2009). The 2011 PNSS sample of WIC-participating women reports a low prevalence of pre-pregnancy underweight of 4.5 percent (see Table 6-3; CDC, 2011a), but a higher prevalence of "less than ideal" weight gain of 21 percent. As noted previously, preeclampsia also increases the risk of being small for gestational age (via its effect on intrauterine growth restriction) (Lin et al., 2015).

Although specific causes of preterm birth are unknown, undernutrition, pre-pregnancy underweight, and lack of specific nutrients may increase the risk (Bloomfield, 2011; Dean et al., 2014). In an analysis of data from PRAMS, pregnancy underweight was associated with an increased risk of preterm labor (Shin and Song, 2014). Reduced risk of preterm delivery has been associated with consumption of several different protein-rich food sources, fruits, and some whole grains, and increased risk with consumption of primarily discretionary foods (Grieger et al., 2014). In addition, zinc inadequacy specifically may play a role in preterm birth; an evidence-based review of zinc supplementation in pregnancy was associated with a 14 percent relative reduction in preterm births in low-income women (Ota et al., 2015).

The combined prevalence of babies born small for gestational age and preterm birth was 13.9 percent based on PNSS sample of infants born to WIC-participating women (see Table 6-3). Of this, 10.5 percent of infants were born preterm and 3.4 percent were born small for gestational age (full-term, low birth weight) (CDC, 2011a).

High birth weight High birth weight is defined as a birth weight greater than 4,000 g (CDC, 2009), which is greater than the 90th percentile among full-term infants. The term *large for gestational age* is more general and refers to a birth weight greater than the 90th percentile for gestational age. High birth weight increases the risk for morbidity in infants. As discussed previously, maternal pre-pregnancy overweight and obesity, excess weight gain above that recommended, and diabetes (type 2 or gestational) during pregnancy all increase the risk for the neonate to be large for gestational age and have a high birth weight. PNSS data indicate that 6.9 percent of WIC infants had a high birth weight in 2011 (see Table 6-3; CDC, 2011a).

Nutrition-Related Health Risks in Postpartum Women

Excessive Weight Retention

A key nutrition-related health risk among postpartum women is excessive maternal weight retention (IOM, 2009), generally defined as a body weight of more than 5 kg above pre-pregnancy weight at 6 months postpartum. Excessive postpartum weight retention increases the risk of obesity, even in women with normal pre-pregnancy BMI (Endres et al., 2015). Further, it increases the risk of an adverse cardiometabolic profile (Kew et al., 2014). In a national prospective cohort study of American women, nearly one-third who had a normal pre-pregnancy weight were overweight or obese at 1 year postpartum (Endres et al., 2015). Evidence is building on the importance of interconceptional nutrition and health on birth outcomes and long-term maternal health (IOM, 2009). A thorough evaluation of this evidence was beyond the scope of WIC and the scope of the committee's task. Excessive postpartum weight retention, however, could contribute to such interconceptional nutritional risk and adverse birth outcomes or long-term maternal health.

Gestational weight gain above the recommended amounts (IOM, 2009; Endres et al., 2015) is associated with excessive postpartum weight retention and is greater for African American than Hispanic women (IOM, 2009; Endres et al., 2015), white, or other ethnic groups (Endres et al., 2015). In the PRAMS 2002–2003 survey of U.S. women, approximately half of those surveyed had excessive gestational weight gain, with the highest rates in non-Hispanic multiple-race women (54 percent) and lowest rates in non-Hispanic Asian women (33 percent) (IOM, 2009). Based on a national prospective cohort study (Endres et al., 2015), other factors associated with gestational weight gain above the 2009 IOM guidelines include being of lower income, having a high school education, receiving public aid, being less likely to work outside of the home, not being in a relationship with the child's father, and not having planned the pregnancy.

In the study by Endres et al. (2015), 75 percent of participants weighed more at 1 year postpartum than pre-pregnancy, and 47 percent and 24 percent retained more than 10 and 20 pounds, respectively.

Gestational Diabetes and Risk for Subsequent Chronic Disease

Gestational diabetes poses long-term risks to the mother after its resolution at delivery (Bellamy et al., 2009; Noctor and Dunne, 2015; Yuan and Wong, 2015). Gestational diabetes increases the lifetime risk of type 2 diabetes by 60 percent, but there is heterogeneity among the studies in this risk (Noctor and Dunne, 2015). A systematic review reports a pooled risk ratio of 7.4 (based on 20 cohort studies) of developing type 2 diabetes after gestational diabetes (Bellamy et al., 2009). This risk may in part depend on maternal ethnicity. Based on prevalence data, women from South Asia or Southeast Asia appear to have a higher risk of gestational diabetes compared to white, African American, or Hispanic women (Yuen and Wong, 2015). The risk of hypertension after pregnancy may be increased in women who developed gestational diabetes. Hispanic and white women may be more at risk for hypertension following the development of gestational diabetes compared to African American or Asian women (Bentley-Lewis et al., 2014).

Nutrition-Related Health Risks and Breastfeeding

Breastfeeding has well-documented protective health benefits for both the mother and infant, as reviewed in Chapter 7. High weight for height (overweight and obesity) is the most prevalent nutritional risk criterion reported for breastfeeding WIC participants (see Table 6-2) (USDA/FNS, 2013). This section considers how overweight and obesity can adversely impact breastfeeding success. A recent systematic review found that pre-pregnancy obesity is associated with lower intention to breastfeed, lower initiation, and shorter duration of breastfeeding (Turcksin et al., 2014). In addition, evidence has associated obesity with delayed lactogenesis II, the postpartum onset of copious milk production (Rasmussen and Kjolhede, 2004), and a less-adequate milk supply (Turcksin et al., 2014). The mechanisms underlying these adverse effects of obesity on breastfeeding are complex, not well understood, and include biological, sociocultural, and psychological factors (Rasmussen, 2007). In a study published after the systematic review by Turcksin and colleagues, obese women in the IFPS II sample did not differ in intent to breastfeed, but were less likely to ever breastfeed and more likely to cease breastfeeding earlier than normal-weight women (Hauff et al., 2014). Another study published after this review found nearly twice the risk of early cessation of breastfeeding in primaparous, but not multiparous, obese women compared to women of normal weight (Kronborg et al., 2013). The authors suggested that interventions to enhance the duration of breastfeeding among obese women might best target those with “little or no breastfeeding experience” (Kronborg et al., 2013).

NUTRITION-RELATED HEALTH RISKS IN INFANTS

This section summarizes evidence for health outcomes associated with nutrition related-risks for infants. Also summarized is the prevalence of each risk in the WIC and U.S. populations based on national and regional evidence (see Table 6-4).

TABLE 6-4 Prevalence (%) of Selected Nutrition-Related Health Risks in WIC Participants and U.S. Children Ages 1 to Less Than 5 Years

Nutrition-Related Health Risk/ Outcome	2011 PedNSS (Predominantly WIC[a]) 12 to 23 Months		2011 PedNSS (Predominantly WIC[a]) 24 to 59 Months		NHANES (All Children Ages 1 to < 5 Years) Birth to < 2 Years	NHANES (All Children Ages 1 to < 5 Years) 2 to 5 Years
Underweight	0.6		3.6		NA	3.4[b]
Short stature	6.3		3.7		NA	NA
Obesity	14.1		14.4		NA	8.4[c]
Overweight	NA		16.0		NA	14.4[c,d]
Combined obesity and overweight	NA		30.4		8.13	22.83
	12 to 17 Months	18 to 23 Months	24 to 35 Months	36 to 59 Months	1 to 3 Years	
Anemia (all cause)	18.1	15.2	15.6	10.5	NA	
Iron deficiency	NA	NA	NA	NA	8.0[e]	

NOTE: NA = Data not available; NHANES = National Health and Nutrition Examination Survey; PedNSS = Pediatric Nutrition Surveillance System.

[a] Of the 8.2 million infants and children in the study, 86.9 percent were known WIC participants; 21.6 percent of individuals in the study were 12 to 23 months of age, and 44.6 percent were 24 to 59 months of age. The proportion of individuals in each age group participating in WIC was not available (CDC, 2011b).

[b] CDC, 2012b.

[c] Ogden et al., 2014.

[d] Overweight calculated from reported obesity and combined obesity and overweight rates.

[e] Brotanek et al., 2007.

SOURCES: PedNSS data from CDC, 2011b; NHANES analysis sources as listed in notes.

Low and High Birth Weight

Size at birth has significant implications for infant health (IOM, 2009). It also has long-term consequences. Low birth weight at term is associated with the developmental programming of several adult chronic diseases, including obesity, hypertension, and metabolic syndrome (Saggese et al., 2013). Emerging evidence, though controversial, has similarly associated rapid catch-up growth in infants with low birth weight and being small for gestational age, particularly excess weight-for-length gain (Belfort and Gillman, 2013), with obesity, hypertension and metabolic syndrome as well as cardiometabolic risk, later in life (Jain, 2012). Being small for gestational age, but not low birth weight, was found in a systematic review to be modestly associated with childhood, but not adult, morbidity (Malin et al., 2015). High birth weight and being large for gestational age increase the risk for hypoglycemia in the neonate (Rozance, 2014) and the risk for adult chronic diseases, including metabolic syndrome and type 2 diabetes (Martin-Gronert and Ozanne, 2012). The prevalence of high birth weight in 2011 in PNSS (a national sample of WIC respondents) was 6.9 percent (CDC, 2011a).

Inappropriately Slowed or Accelerated Growth Patterns

Normal growth is a complex interplay of genetics, nutrition, and endocrine regulation and proceeds at different rates across the postnatal period (Ismail and Ness, 2013). In the absence of known genetic or endocrine disorders, inappropriately slowed growth (i.e., failure to thrive or short stature) represents inadequate nutrient availability, and inappropriately accelerated growth (i.e., infant obesity) represents excessive nutrient availability. In its review of the evidence, the committee was mindful of the complexity of growth and its implications for interpreting commonly used anthropometric measures of growth.

Failure to Thrive

Failure to thrive represents inappropriately slowed growth of both length and weight (Grissom, 2013). Although failure to thrive is sometimes defined clinically as being less than the 5th percentile of weight for age on multiple occasions or a deceleration of growth that crosses two major percentiles, it is more accurately defined by a combination of anthropometric growth parameters (Cole and Lanham, 2011). Failure to thrive generally presents before 18 months of age. Failure to thrive may result in developmental delays, recurrent severe infections, and cardiac abnormalities, in addition to growth failure. The risk of failure to thrive is increased by low birth weight and can result from inadequate caloric intake, impaired caloric absorption, or excessive caloric expenditure (Cole and Lanham, 2011).

In the PedNSS nationally representative sample (CDC, 2011b), 3.5 percent of infants and children less than 5 years of age were underweight, as defined by being less than the fifth percentile of weight for length or stature, which is another clinical definition of failure to thrive. A prospective cohort study of WIC participants in Louisiana found that about 3.5 percent of infants had low weight for length stature (less than fifth percentile), with no difference between white and African American infants (Wightkin et al., 2007).

Short Stature

Short stature, another representation of inappropriately slowed linear growth, is defined as a child's length for age being less than the fifth percentile (CDC, 2009). In addition to contributing to adult stunting and failure to achieve genetic growth potential, short stature has been associated with structural and functional impairments of the brain and poorer cognitive function (Dewey and Begum, 2011). Short stature can result from genetic or endocrine disorders, feeding and nutritional limitations, and unknown factors (Grissom, 2013).

The prevalence of short stature was 9.8 percent in infants 0–11 months in the 2011 PedNSS national sample (CDC, 2011b) (see Table 6-4). Short stature has been reported to be more prevalent in African American infants (12.2 percent) than in white, Hispanic, or Native American infants (8.9 to 9.9 percent) (CDC, 2011b).

Overweight in Infancy

High weight for length in infants and young children less than 2 years of age is typically defined as a child's weight for length being greater than the 98th percentile when plotted using the World Health Organization (WHO) growth charts (CDC, 2015b). Having high weight for length both at birth and at 6 months has been shown to increase the risk of obesity at 3 years by 4 percent (Taveras et al., 2009). Infant obesity, when defined not just as high weight for length, but also in terms of excess subcutaneous fat, was associated with delayed motor development in low-income African American infants 3–18 months of age (Slining et al., 2010).

Both infant and early childhood obesity and overweight are influenced by early infant feeding practices. In the 2008 Feeding Infants and Toddlers Study (FITS), energy intakes were higher than those generally recommended for infants for both the 0–6 and 6–11 month age ranges (Saavedra et al., 2013). In a systematic review, Weng et al. (2012) reported that breastfeeding reduces the risk of childhood overweight by 15 percent and cited evidence that early childhood overweight is associated with early introduction of complementary foods. Adair (2008) found an association of early childhood obesity with the inappropriate introduction of complementary foods, such as the bottle feeding of infant cereal mixed with formula. Early childhood obesity has not been linked, however, to intakes of any specific complementary foods or food groups (Grote and Theurich, 2014). NHANES 2011–2012 data indicate that 8.1 percent of infants and young children ages 0 to less than 2 years of age in the United States had a high weight for length (Ogden et al., 2014).

Rapid Weight Gain in Infancy

Rapid infant weight gain was identified as a risk factor for obesity in children between 4.5 and 14 years old in a systematic review (Weng et al., 2012). In two of the identified studies, every 100 g of weight gain in the first year of life resulted in increased odds of childhood overweight (Stettler et al., 2002; Reilly et al., 2005). However, these studies examined the absolute rate of weight gain rather than change in weight-for-age (WAZ) or weight-for-length (WLZ) Z-scores. In addition, infant feeding practices may modify the effect of rapid weight gain. Karaolis-Danckert et al. (2007) reported from the DONALD cohort study that infants with rapid weight gain (> 0.67 WAZ) who were fully breastfed for 4 months or more had lower percent body fat at 2 years persisting to 5 years. Further, those with rapid weight gain as infants who had low fat intakes at 12 and 18 to 24 months had lower percent body fat than similar infants with rapid weight gain who had high fat intakes. The American Academy of Pediatrics (AAP) recommends close monitoring of infant and child weight gain to determine and mitigate risk of current and future overweight/obesity (AAP, 2014).

Nutrient Deficiencies in Infants

The committee considered four health-related nutrient deficiencies in infants: iron, zinc, omega-3 fatty acids, and vitamin D. The focus was on these four nutrients because of their likelihoods of deficiency and roles in growth and development.

Iron

Breastfed infants 0 to approximately 6 months of age Even though human milk has a low concentration of iron, it meets most of the iron needs of breastfeed infants in the first 4 to 6 months (IOM, 2001; Baker et al., 2010; Lönnerdal et al., 2015). AAP recommends that iron supplementation (oral 1 mg/kg/day) in exclusively breastfed infants begin at 4 months of age to prevent iron deficiency and iron-deficiency anemia (AAP, 2014).

Older infants 6 to less than 12 months of age Human milk alone provides inadequate quantities of iron for infants older than 6 months (AAP, 2014; Lönnerdal et al., 2015). Recommended iron intakes increase at 7 months to 11 mg per day (a Recommended Dietary Allowance [RDA]) from a low of 0.27 mg per day (an AI) for infants 6 months and younger (IOM, 2006). After 6 months, this additional iron is needed to meet growing iron demands for tissue accretion, increases in tissue and storage iron, increases in hemoglobin, obligatory iron losses, and neurodevelopment (Berglund and Domellöf, 2014). AAP recommends that complementary foods rich in iron (red meats and vegetables rich in iron) be introduced early to help meet this demand (AAP, 2014). Further, the AAP recommends that oral iron supplementation is appropriate for infants 6 to 12 months of age who are not consuming the recommended amount of iron from formula and complementary foods (AAP, 2014). An AHRQ systematic review (AHRQ, 2015) noted that, despite some evidence for improvement of hematological values following iron supplementation, evidence for improved clinical health outcomes was lacking. Low birth weight infants may be at greater risk for iron deficiency because of lower iron stores and more rapid catch-up growth, but the evidence to support iron supplementation specifically in infants with low birth weight is limited (Long et al., 2012). Boys may be at more risk for iron deficiency based on reports of poorer iron status biomarkers (Lönnerdal et al., 2015). Emerging evidence also suggests potential adverse effects of excess iron, particularly from iron supplementation, on linear growth in iron-replete older infants (Lönnerdal et al., 2015). The prevalence of anemia in children 6–11 months old was 18 percent in a 2011 nationally representative sample in PedNSS (CDC, 2011b). The committee was unable to identify any national prevalence data on iron deficiency in infants less than 12 months of age.

Zinc

Breastfed infants 0 to 6 months of age Zinc is important for growth and development (Krebs et al., 2006). Although human milk has a low zinc concentration, it provides the necessary zinc for breastfed infants for approximately the first 6 months (AAP, 2014). After this time, foods containing zinc are emphasized as part of complementary feeding (AAP, 2014).

Older infants 7 to 11 months of age For infants older than 6 months, human milk alone provides inadequate quantities of zinc (AAP, 2014). Older infants obtain approximately 90 percent of their required zinc intake from complementary foods (Krebs, 2007). The AI for infants less than 6 months of age is 2 mg per day. For older infants (6 to less than 12 months), there is an Estimated Average Requirement (EAR) for zinc of 2.5 mg per day (IOM, 2006).

Infants, particularly those with low birth weight, are at risk for zinc deficiency and have limited adaptive homeostatic mechanisms for modest zinc intakes (Krebs, 2007; Krebs et al., 2014). Also at risk are older infants who are breastfed and receive plant-based complementary foods low in zinc or with less bioavailable forms. Complementary meat baby foods provide higher content and bioavailability of zinc than non-fortified plant foods (Krebs, 2007).

USDA-FNS does not report on zinc intake of older infants who are participating in WIC. Relatively few older infants (less than 6 percent) in the 2008 FITS consumed inadequate zinc, with a majority (68 percent) consuming more than the Tolerable Upper Intake Level (UL) (5 mg per day) from foods and beverages, primarily infant formulas and fortified infant cereals (Butte, 2010). Most recently, Grimes et al. (2015) also reported mean zinc intakes above the UL for breastfed and formula-fed infants up to 6 months (4.2 mg per day) and infants 6 to 12 months (6.1 mg per day) in NHANES 2005–2012. Krebs et al. (2006) reported that infants who received complementary zinc-fortified foods or meat had zinc intakes above the RDA, but those fed unfortified complementary foods and no meat had considerably lower (approximately 1 mg per day) intakes, which were also below the EAR (2.5 mg per day). As noted in Chapter 4, zinc intakes above the UL are not considered a concern for infants.

Omega-3 Fatty Acids

Delayed visual development can cause a delay in other early life developmental stages (Judge et al., 2011). Visual acuity may reflect nutritional status early in life. Although some studies suggest a link between essential fatty acids, particularly long-chain omega-3 fatty acids, and measures of visual acuity, this relationship remains unconfirmed (Campoy et al., 2012; Gould et al., 2013). Also unclear is whether either prenatal or postnatal supplementation with omega-3 fatty acids improves visual acuity. A study in primates suggests that prenatal deficiency of omega-3 fatty acids can result in some limitations in visual acuity of offspring at 3 years of age (Anderson et al., 2005). However, in a randomized control study of maternal prenatal supplementation of the long-chain omega-3 fatty acid docosahexaenoic acid, it did not enhance visual acuity in offspring at 4 months of age (Smithers et al., 2011).

No evidence could be identified on the status of omega-3 fatty acids or the visual acuity of the WIC population. A study examining NHANES data over the years 1999–2000 indicates that poor visual health was greater in whites than African Americans (Zhang et al., 2012).

Vitamin D

Although vitamin D is known to be important for calcium homeostasis and bone health in infants, data linking vitamin D status to other health outcomes is conflicting and inconclusive (IOM, 2011b; AHRQ, 2014). According to AAP (2014), vitamin D supplementation of 400 IU per day is recommended for breastfed infants beginning in the first few days of life and continuing until consumption of vitamin D-fortified milk is adequate (AAP, 2014).

NUTRITION-RELATED HEALTH RISKS IN CHILDREN

This section summarizes evidence for health outcomes associated with nutrition related risks for children 1 to less than 5 years of age. Also summarized is the prevalence of each risk in the WIC and U.S. populations based on nationally representative samples (see Table 6-4), or smaller studies of WIC participants in specific states or regions.

Inappropriately Slowed or Accelerated Growth Patterns

As discussed above for infants, inappropriate growth patterns in children indicative of either undernutrition (e.g., underweight, short stature) or overnutrition (e.g., accelerated patterns such as obesity and overweight) are of concern because of both their immediate and long-term adverse health effects. Overall, evidence exists for both slowed and accelerated growth patterns among children participating in WIC.

Underweight

Low weight for height (2 years and older) or length (less than 2 years), including failure to thrive, can result from inadequate nutrient intakes, impaired nutrient absorption, or excessive energy expenditure. The overall prevalence of low weight for height reported in the 2011 PedNSS was 0.6 percent for 12–23-month-old infants. It was higher, at 3.5 percent, for 24 to 59 month olds (see Table 6-4; CDC, 2011b). The prevalence nationally in the 2007–2010 NHANES was similar at 3.4 percent (CDC, 2012b). The 2011 PedNSS revealed a higher prevalence of underweight among African American children compared to other racial and ethnic subgroups in the sample (4.9 percent).

Short Stature

The prevalence of short stature in the 2011 PedNSS was 6.3 percent among 12–23-month-olds, 4 percent among 24–35-month-olds, and 3.7 percent among 36–47-month-olds. Unlike underweight, however, little racial or ethnic disparity was evident in the prevalence of short stature in the 2011 PedNSS (see Table 6-4).

Obesity and Overweight

Childhood obesity and overweight have substantial implications for adult health, increasing the risk of adult obesity, heart disease, and type 2 diabetes (Sabin and Kiess, 2015). Central adiposity in children has been shown to increase cardiometabolic disease risk (Kelishadi et al., 2015).

Obesity and overweight in children have been linked with dietary patterns high in energy-dense, high-fat, and low-fiber foods (Ambrosini, 2014). Although consumption of sugar-sweetened beverages is often cited as a factor in child and adult obesity, a recent systematic review concluded that evidence supporting this relationship, after adjustment for energy intake and physical activity, was inconsistent for children as well as for adolescents and adults (Trumbo and Rivers, 2014). In contrast, another recent systematic review, which did not adjust for energy balance, reported that intake of sugar-sweetened beverages for individuals less than 6 years of age was associated with increased BMI and waist circumference later in childhood (Pérez-Morales et al., 2013).

The prevalence of obesity and overweight among children is high and differs with ethnicity and poverty. In the nationally representative NHANES 2011–2012, 22.8 percent of U.S. children aged 2 to 5 years were overweight and obese (combined) (see Table 6-4; Ogden et al, 2014). The prevalence of obesity and overweight combined was higher among Hispanic children (29 percent) and lower among Asian children (9 percent) compared to non-Hispanic white or African American children (21–22 percent) (Ogden et al, 2014). The prevalence of obesity and overweight combined in the 2011 PedNSS was 30 percent for children ages 2 to less than 5 years and higher than that reported from NHANES 2011–2012 (CDC, 2011b). The prevalence of obesity was 14 percent among children whose families had a poverty-to-income ratio (PIR) lower than or equal to 50 percent. This prevalence dropped to 12 percent among those whose families had a PIR of 151 to 185 percent (CDC, 2014b).

Nutrient-Related Health Risks in Children

The committee considered two nutrient-related health risks in children: iron deficiency and development of dental caries.

Iron

Iron remains important for growth and cognitive development and function in children 1–5 years of age, with the recommended iron intake decreasing from 11 mg per day in older infants to 7 mg per day in 1–3-year-old children and then increasing again to 10 mg per day in 4–5-year-old children (IOM, 2001). These changes in recommended iron intake reflect changes in growth and the steadily larger mass of the older child. Despite the importance of iron, Thompson et al.'s (2014) systematic review reported a lack of data on the effects of iron supplementation on anemia and cognitive development in children 2–5 years old.

Anemia Low hematocrit or hemoglobin concentration is indicative of all causes of anemia, and varies with age and ethnicity among U.S. children. The 2011 PedNSS reported a nationwide prevalence of anemia of 14.4 percent (ages less than 5 years) (see Table 6-4). Prevalence was higher in younger children ages 1 to less than 3 years (18.1 to 15.6 percent) than older children ages 3 to less than 5 years (10.5 percent). Prevalence was also higher among African American (22.5 percent) compared to white, Hispanic, Asian, Native American, and mixed-race children (CDC, 2011b).

Iron deficiency The committee was interested in iron deficiency specifically even though this is not a nutrition-related health risk reported by WIC because of the importance of iron to growth and development in children. Therefore, the committee examined national and regional evidence on iron deficiency in WIC and U.S. children aged 1 to 3 years available from two studies, which assessed iron deficiency using multiple biomarkers, as required. Some caution is needed in interpreting the results of both studies because of possible selection bias (see Chapter 3 for a discussion of selection bias). The first study analyzed nationally representative data for 960 children from NHANES 1999–2002 (see Table 6-4; Brotanek et al., 2007). Overall, iron deficiency[5] was 8 percent and declined with age from 11 percent at 1 year to 5.6 percent at 3 years (Brotanek et al., 2007). The second study examined iron deficiency in 350 children aged 1 to 3 years from two California counties (Schneider, 2005) and reported an overall prevalence of iron deficiency of 16 percent.

A number of factors influenced iron deficiency in the two studies. Discordant results were reported for ethnicity. Brotanek et al. (2007) report a higher prevalence of iron deficiency in Hispanic children (12 percent) than in white and African American children (6 percent), but Schneider (2005) did not find an association of Hispanic ethnicity with iron deficiency.[6] The two studies differ slightly in the biomarkers used to assess iron deficiency and the proportion of Hispanic children (40 percent in Brotanek's study and 25 percent Hispanic and Latino in Schneider's study). Other factors also influenced iron deficiency in Brotanek's study, including language, obesity, and food insecurity status of the household. However, poverty did not affect

[5] Iron deficiency was based on any two of three age-defined cutpoints for transferrin saturation, free erythrocyte protoporphyrin, and serum ferritin from Looker (1997).

[6] Iron deficiency was based on any two of the following three criteira: ferritin < 8.7 μg/L, transferrin receptors > 8.4 μg/mL, and transferrin saturation < 13.2 percent.

the prevalence of iron deficiency in 1–3-year-old children (Brotanek et al., 2007).

The relationship of WIC participation to iron deficiency also differed in the two studies, one of which examined participation of the mother during pregnancy (Schneider, 2005) and the other examined participation of the child (Brotanek et al., 2007). Schneider (2005) reported an increased risk (2.6 times) of iron deficiency in children 1–3 years old in California whose mothers did not participate in WIC compared to those whose mothers did participate in WIC while pregnant. In the NHANES analysis, no association of receipt of WIC in the past 12 months was found with iron deficiency in children aged 1–3 years (Brotanek et al., 2007).

Dental Caries

An important health concern with dietary carbohydrates in general, including sugars, is the development of dental caries, particularly early childhood caries (ECCs). The American Academy of Pediatric Dentistry (AAPD) has associated an increased risk of ECC with inappropriate feeding practices (e.g., bottle feeding with milk, ad libitum breastfeeding following introduction of carbohydrate-containing foods, night time bottle-feeding with juice, repeated use of a no-spill cup), inadequate oral hygiene, and frequent in-between meal consumption of sugar-containing snacks or drinks (AAPD, 2012). Relevant to the WIC food packages, a recent evaluation of NHANES 1999–2004 data found no association between ECC and consumption of 100% fruit juice in children 2 to 5 years of age (Vargas et al., 2014). Strategies to mitigate caries development include fluoridation of water and proper hygiene in conjunction with reduced frequency of carbohydrate consumption (WHO, 2003; ADA, 2015).

Cognitive Outcomes Related to WIC Participation During Childhood

Cognitive development, like child development overall, is a highly complex, dynamic, interactive, continuous, coordinated, and plastic process (IOM, 2000). Nutrition is one of many developmental, genetic, neurobiological, environmental, social, cultural, and toxicological factors driving cognitive outcomes. The roles of iron and omega-3 fatty acids in infant and child cognitive development were mentioned earlier in this chapter. Emerging evidence suggests a more global effect of WIC participation on cognitive development. Based on a combined analysis of data from more than 11,000 children in the Early Childhood Longitudinal Study and the Child Development Supplement of the Panel Study of Income Dynamics, children who received prenatal/early childhood WIC exposure scored about 0.062 standard deviations higher (a meaningful effect size for longer-run outcomes) on the Bayley Mental Development Index than their peers who were not exposed to WIC (Jackson, 2015). Additionally, children who received prenatal/early childhood WIC exposure performed significantly better (0.3 standard deviations higher) on reading assessments than those who did not receive such exposure. Caution is needed in evaluating this emerging evidence, given the temporal plasticity of cognitive development, its many potential confounding and mediating factors, and difficulties in assessing global cognitive development versus specific cognitive functions.

FOOD SAFETY CONSIDERATIONS

The committee considered potential nutrition-related health risks arising from foods themselves that may be of concern to the WIC population, with an understanding that the safety of the U.S. food supply is ensured by the U.S. Food and Drug Administration (FDA). Specifically, the committee considered food-borne illness, pharmaceutical residues in food, environmental contaminants in food, and arsenic in rice.

Food-Borne Illness

The FDA's food safety guidelines to reduce risk of food-borne illness for all consumers, as well as for particular subpopulations and life stages, including pregnancy, breastfeeding, and infancy, have been endorsed by the 2010 DGA and in the *Scientific Report of the 2015 Dietary Guidelines Advisory Committee* (2015 DGAC report) (USDA/HHS, 2010, 2015). Several of these guidelines are currently or potentially applicable to the WIC food package. For pregnant women, the two primary food-borne illness concerns are listeriosis (caused by exposure to *Listeria monocytogenes*) and toxoplasmosis (caused by exposure to *Toxoplasma gondii*) (FSIS, 2013). These pathogens can also be transmitted to a developing fetus. Listeriosis, for example, can increase the risk of spontaneous abortion, preterm birth, and fetal death, and may have consequences after birth.

Raw and unwashed fruits and vegetables carry some risk of transmission of both pathogens, but washing or cooking vegetables greatly reduces these risks (USDA/FNS, 2015). Although unpasteurized soft cheeses also carry some risk of *L. monocytogenes* and should be avoided, pasteurized, harder, and processed cheeses are appropriate for consumption in pregnancy and during breastfeeding. Other foods that carry a higher risk of *Listeria* contamination include luncheon meats and hot dogs. In pregnancy, raw meat, seafood, and eggs should be avoided. Infants should not consume raw foods, unpasteurized dairy foods, or juice, and honey should not be consumed before 12 months of age (FDA, 2014). Although liquids (e.g., ready-to-feed formulas) are generally sterilizable, powder formulas are typically not sterile and have a higher probability of containing pathogens, so care must be taken with home preparation to avoid inadvertent contamination (AAP, 2014).

Expressed human milk must be handled properly to maintain its quality and ensure that it is safe for infant consumption. The Academy of Breastfeeding Medicine has published guidelines for proper handling of human milk, including preparation, storage, and thawing (ABM, 2004).

Pharmaceutical Residues in Food

Consumers have become increasingly concerned with the presence of drug residues in food. The Center for Veterinary Medicine's (CVM's) Division of Compliance of the FDA evaluates drug residue levels in the food supply. In 2012, a CVM nationwide survey of 31 drug residues in cow's milk, including from farms previously violating tissue residue limits, found that levels were not of concern, although monitoring and development of testing methodology is ongoing to ensure the continuing safety of the nation's milk supply (FDA, 2015a). The FDA has not identified drug residues in other non-dairy foods included in the WIC food packages as contaminants of concern.

Endocrine Disruptors

Bisphenol A (BPA) is an endocrine disruptor previously used as a coating in baby bottles, no-spill infant cups, and infant formula packaging. A 2010 FDA report identified BPA as being of potential concern to the development of the brain and prostate glands in fetuses, infants, and young children (FDA, 2010). Following the release of the report, strong consumer and scientific interest led the FDA to investigate further. In 2012 and 2013, the FDA amended its regulations such that the use of BPA-based coatings was no longer permitted in baby bottles, sippy cups, and infant formula packaging. These amendments were based only on petitions filed by the American Chemistry Council and a congressperson that asserted that the use of BPA in these products had been abandoned in industry practice (FDA, 2015b). Based on the most recent safety assessment, the FDA changed its position to state that BPA is "safe at the current levels occurring in foods" (FDA, 2015b). However, the amendments that restricted the use of BPA in baby bottles, sippy cups, and infant formula packaging were still in effect at the time this report was prepared (FDA, 2015b).

Environmental Contaminants in Food

Food-borne environmental contaminants are classified by source as intentional or unintentional. Intentional contaminants are products manufactured for industrial or other applications that are found in food and pose a risk to human health. For example, polychlorinated biphenyls (PCBs) were manufactured for their electrical insulating properties, and then entered the food supply through soil and river silt and water and air transport (Brzuzy and Hites, 1995; Bushart et al., 1998). Unintentional contaminants are compounds present in the environment that were not intentionally manufactured, but originated from human activities (e.g., burning organic material, chemical manufacturing processes) (Czuczwa and Hites, 1984; Clement et al., 1989). Examples of unintentional contaminants include dioxins and dioxin-like compounds (DLCs).

Food-borne environmental contaminants are further classified by their biochemical profile. Lipophilic contaminants, which include PCBs, dioxins, and DLCs, accumulate in the fatty tissues of animal foods. Heavy metals, like methyl mercury, accumulate in lean tissues, such as muscle, rather than in fatty tissue.

Lipophilic Contaminants

High-fat meats, full-fat dairy foods, and fatty fish are common sources of lipophilic contaminants (e.g., PCBs, dioxins, and DLCs) (Fries, 1995). Concerns about exposure to these compounds relates to their long half-life (5–11 years) and very low rate of compound turnover (Geyer et al., 2002). Meats and full-fat dairy foods contribute a majority of the total dietary intake of dioxins and DLCs, whereas fish and shellfish are the greatest contributors of PCBs (Travis and Hattemer-Frey, 1991; Roeder et al., 1998). Fetuses are exposed to lipophilic contaminants through placental transfer of these substances; their body burden can be equivalent to about one-fifth of what it is for the mother (Koopman-Esseboom, 1994; Abraham et al., 1996). Additional exposure occurs through human milk. However, the concentration of PCBs, dioxins, and DLCs in human milk decreases throughout the period of lactation (Lorber and Phillips, 2002). Further, because of the rapid turnover of fatty tissue throughout infancy, children who were breastfed did not differ from those who were formula fed in total body burden of polychlorinated lipophilic contaminants (Patandin et al., 1997; Lorber and Phillips, 2002).

Levels of lipophilic contaminants in the environment, and thus in the food supply, have declined in recent years, likely as an outcome of stricter environmental regulation of emissions. Further, there is a high level of uncertainty in determining health risks from exposure because of the variable toxicity of different congeners. Nevertheless, a recommendation to federal nutrition assistance programs to include low-fat and skim milk for children more than 2 years of age was made to reduce potential exposure and body burden of these contaminants, particularly among young girls before entering their child-bearing years (IOM, 2003). This recommendation was incorporated into the 2014 WIC food package final rule in which only 1% or skim milk was permitted for individuals 2 years and older as a means of limiting fat intake (USDA/FNS, 2014).

Heavy-Metal Contaminants

Mercury, specifically methylated (organic) mercury, is the heavy-metal contaminant of greatest concern to human health, with pregnant women at the greatest risk. The FDA and the U.S. Environmental Protection Agency (EPA) joint guidance for pregnant women, women who may become pregnant, nursing mothers, and young children is to avoid consumption of shark, swordfish, tilefish, and King mackerel and to limit consumption of Albacore tuna to less than 6 ounces per week (FDA/EPA, 2014). Although the 2015 DGAC report encouraged fish consumption as a source of protein and omega-3 fatty acids (USDA/HHS, 2015), the 2015 DGAC report also agreed with the FDA/EPA joint federal fish advisory (USDA/HHS, 2015). At the same time, the 2015 DGAC report noted that methyl mercury levels are not static and should be periodically re-evaluated. Additionally, the 2015 DGAC report reviewed and concurred with the Food and Agricultural Organization of the United States/WHO Expert Consultation on the Risks and Benefits of Fish Consumption (FAO/WHO, 2011), which stated that the health benefits of fish consumption (whether farm raised or wild) outweigh risks with respect to both offspring development and mortality from cancers and cardiovascular diseases. Current WIC food packages provide less than the maximum recommended number of fish servings per week to fully breastfeeding women. The fish species for which the FDA advises limiting consumption are not included in the food packages. Fish is not provided to other WIC participants.

Arsenic in Rice

Inorganic arsenic is classified as a human carcinogen by the International Agency for Research on Cancer (IARC, 1987) and the EPA (1994). Long-term oral exposure to arsenic can result in darkened skin patches, skin cancer, and cancer of the liver, bladder, or lungs (ATSDR, 2007). In response to increasing concerns about arsenic exposure, in 2013 the FDA released a report on arsenic levels in rice and rice products and concluded that short-term adverse effects of arsenic toxicity from rice consumption are unlikely. The report also indicated no significant change in rice arsenic levels over the past 20 years. However, lifetime exposure to low levels of arsenic is still being evaluated by the FDA (2013) because rice is a dietary staple for many subpopulations in the United States.

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7

Promotion, Motivation, and Support of Breastfeeding with the WIC Food Packages

Promotion of breastfeeding is a primary goal of the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), in alignment with the *Healthy People 2020* target of 82 percent of infants being ever-breastfed by the year 2020 (HHS, 2015). The WIC food packages are designed to accommodate both full and partial breastfeeding (varying widely in proportions of human milk and formula consumption), with the full breastfeeding package containing proportionately more food for the mother and less for the infant. This chapter examines the health benefits of breastfeeding for mothers and infants, breastfeeding trends in the United States and in WIC populations, barriers and incentives to breastfeeding in the WIC population, and factors associated with breastfeeding initiation, duration, and exclusivity. The information presented here was collected from the committee's literature review, which was described in Chapter 3.

BREASTFEEDING AND THE WIC PROGRAM

Breastfeeding is a complex behavior determined by multiple layers of socioecological factors, ranging from federal and state policies to lactation management support (see Figure 7-1). Given that WIC provides support for over half of all U.S. births, the WIC program plays a key role in influencing infant feeding decisions, particularly among low-income women. In fact, more than any other entity, WIC comes closest to having a nationwide coordinated breastfeeding program in place. At the same time, paradoxically, the WIC program engages heavily in the distribution of infant formula. WIC infant formula accounted for between 57 and 68 percent of all

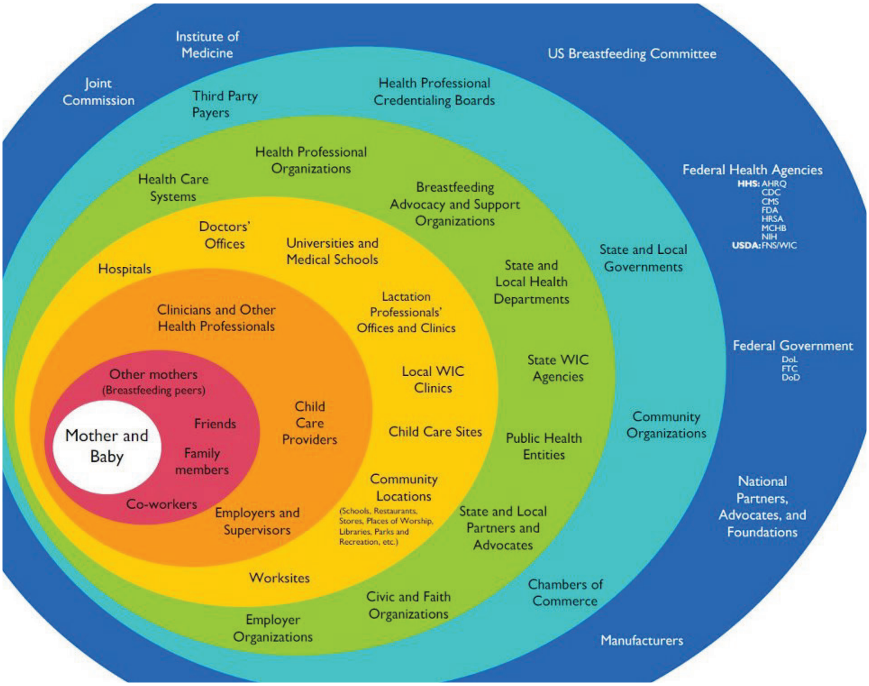

FIGURE 7-1 Socioecological model of breastfeeding.
SOURCE: Grummer-Strawn, 2011.

formula sold in the United States in 2004–2006 (the most recent years for which a published estimate was available) (USDA/ERS, 2010).

WIC program activities intended to increase breastfeeding prevalence parallel the three categories of global strategies known to improve breastfeeding outcomes (protection, promotion, and support)[1]:

1. WIC breastfeeding *protection* activities include not providing infant formula during the first month after birth to mothers who have expressed their desire to breastfeed.
2. WIC breastfeeding *promotion* activities include enhanced WIC food packages; counseling on maternal–child health benefits offered by

[1] Effective global strategies to improve breastfeeding outcomes include protection (e.g., enforcement of the World Health Organization Code for the Marketing of Breastmilk Substitutes, labor legislation to support the needs of employed women), promotion (e.g., mass media campaigns, World Breastfeeding Week), and support activities (e.g., the Baby-Friendly Hospital Initiative, breastfeeding peer-counseling programs) (Pérez-Escamilla and Chapman, 2012; Pérez-Escamilla et al., 2012).

WIC; and posters, brochures, and other materials posted at WIC clinics or offered to mothers to take home with them.

3. WIC breastfeeding *support* activities include the WIC breastfeeding peer-counseling program, lactation management support offered by certified lactation consultants hired by the program (i.e., certified by the International Lactation Consultant Association), and the provision of breast pumps to women.[2]

WIC has been actively protecting, promoting, and supporting breastfeeding since 1989, when Congress enacted the first of a series of laws affecting WIC breastfeeding activities. In 1989, WIC was required to develop standards to ensure adequate breastfeeding promotion and support at both state and local levels (USDA/FNS, 2013). In 1992, Congress required that the U.S. Department of Agriculture (USDA) establish a national breastfeeding-promotion program and provided various means by which this could be funded. Two years later, Congress passed the Healthy Meals for Healthy Americans Act, not only requiring that state WIC agencies spend $21 for each pregnant and breastfeeding woman in support of breastfeeding promotion, but also that state agencies collect (and report every 2 years) data on the incidence and duration of breastfeeding among WIC participants.[3] In 1998, the 105th Congress authorized WIC agencies to use food funds for the purchase or rental of breast pumps.[4]

BENEFITS OF BREASTFEEDING

It is widely accepted that breastfeeding is beneficial for both mother and infant (AAP, 2014). An abundant literature documents short-term benefits of human milk for infants in particular. In infants, beyond the essential nutritional value, human milk contains numerous protective factors that help prevent infectious disease (Gertosio et al., 2015). But the long-term effects for both infants and mothers are less well studied. This section summarizes available data on the long-term health benefits of breastfeeding in infants and mothers, with a focus on data specifically relevant to the WIC population.

Given that it is unethical to assign infants at random to be breastfed or not, the committee recognized that most of the studies in which the effects of breastfeeding on health outcomes of the mother and her child have been

[2] While these are common support activities, they are not available universally among WIC state agencies.

[3] 103rd Congress. 1994. Public Law 103-448: Healthy Meals for Healthy Americans Act.

[4] 105th Congress. 1998. Public Law 105-336: The William F. Goodling Child Nutrition Reauthorization Act.

evaluated are observational. They therefore have the well-known weaknesses characteristic of these types of studies. In particular, these studies are not suitable for causal inference. In addition, interpretation of the findings summarized here is limited by the variability across studies and among subjects in duration and intensity of breastfeeding. However, there is strong biological plausibility for an association between breastfeeding and several, but not all, infant health outcomes studied as well as some maternal health outcomes.

Although several recent studies suggest that association of breastfeeding with health outcomes including weight or obesity (Cope and Allison, 2008; Smithers et al., 2015) or cognition (Colen and Ramey, 2014; Jenkins and Foster, 2015) are not significant, a large body of evidence supports these associations (Horta et al., 2015a,b).

Infant Benefits of Breastfeeding

The World Health Organization (WHO) (2013) systematic review of the literature reported several long-term health benefits associated with breastfeeding, including decreased risk of obesity, particularly in high-income countries. Additionally, infants who are primarily breastfed have been shown to be at lower risk for type 2 diabetes, although the association is not necessarily causal and may be related to the lower incidence of childhood obesity among breastfed infants (Ip et al., 2007; WHO, 2013; Horta et al., 2015a). Additional evidence suggests that breastfeeding is associated with lower systolic blood pressure, but not with cholesterol concentrations or the incidence of cardiovascular disease (WHO, 2013; Aguilar Cordero et al., 2015). Breastfeeding is associated with a lower risk for many other health complications as well, including childhood leukemia, non-specific gastroenteritis, severe lower respiratory tract infections, sudden infant death syndrome, and atopic dermatitis (Ip et al., 2007; Amitay and Keinan-Boker, 2015). Additionally, breastfed infants may have increased protection from asthma later in childhood (Lodge et al., 2015). Finally, Tham et al. (2015) reported that breastfeeding for up to 12 months may be protective against the development of early childhood dental caries, but data were inconclusive for such an association after 12 months of age.

Available data regarding cognitive outcomes for breastfed infants are mixed (Ip et al., 2007; WHO, 2013). In a recent systematic review, Horta et al. (2015b) reported that breastfeeding was positively associated with intelligence test outcomes as late as 19 years of age, after adjusting for maternal intelligence. Meta-regression performed as part of this meta-analysis confirmed that the association between breastfeeding and intelligence remained when only the studies with the strongest research designs were included. The strength of the evidence varies for each of the associations described above, and is strongest for reduced obesity, type 2 diabetes, and childhood leukemia. (Chapter 6 summarizes additional evidence on cognitive outcomes associated with infant nutrition, although not breastfeeding specifically.) The mechanisms underlying these associations remain to be elucidated.

Maternal Benefits of Breastfeeding

Although not as frequently studied as infant outcomes, breastfeeding is also associated with positive maternal health outcomes. In their systematic review, Ip et al. (2007) reported that breastfeeding was associated with decreased risks for type 2 diabetes and ovarian and breast cancer; this association was recently confirmed by Chowdhury et al. (2015). Additionally, Chowdhury et al. (2015) reported finding some evidence to suggest that shorter duration of breastfeeding is associated with higher risk of postpartum depression, although the direction of causation was unclear. Lastly, they found no evidence to suggest an association of breastfeeding with osteoporosis (Ip et al., 2007). In their recent review, Chowdhury et al. (2015) also found that breastfeeding was associated with a reduced risk of maternal type 2 diabetes but did not detect a relationship between breastfeeding and maternal depression, bone mineral density, or postpartum weight change. Recently, Gunderson et al. (2015) published findings from a large prospective cohort study in which longer breastfeeding duration was associated with lower carotid intima-media thickness (a marker for cardiovascular disease risk) (Gunderson et al., 2015).

The association between breastfeeding and postpartum weight retention is more complex than for these other outcomes, because both breastfeeding duration and postpartum weight are affected by pre-pregnancy body mass index (BMI) and gestational weight gain; the role of these factors has not been considered in many published studies. As a result, except for the two WIC-specific studies mentioned below (Krause et al., 2010; Østbye et al., 2010), the committee found variable evidence supporting a relationship between breastfeeding and postpartum weight loss.

Breastfeeding and Health Outcomes in the WIC Population

The committee identified only 10 studies in which the associations between breastfeeding and health outcomes had been examined in the WIC population (Dennison et al., 2006; Reifsnider and Ritsema, 2008; Maalouf-Manasseh et al., 2011; Barroso et al., 2012; Davis et al., 2012, 2014; Lindberg et al., 2012; Anderson et al., 2014; Edmunds et al., 2014; Shearrer et al., 2015). All of these studies used an observational design. The most prominent trend among these studies was a lower risk for childhood obesity among infants who were breastfed for at least 4 months (see Appendix S, Figure S-1). However, there was no statistically significant difference in child weight comparing those who were exclusively or partially breastfed. A single study showed that children who were breastfed for more than 6 months had lower odds of rapid infant weight gain (Edmunds et al., 2014).

In addition to weight status, another primary focus of many of these WIC-focused studies was iron status. However, small sample sizes and heterogeneity in iron status measures, analytical approaches, and age ranges of the children studied make it difficult to draw conclusions about the relationship between breastfeeding and iron status among WIC children.

For maternal health outcomes, the committee identified two studies that reported less maternal weight retention in mothers who breastfed their infants for more than 20 weeks (Krause et al., 2010; Østbye et al., 2010). These results suggest that longer breastfeeding duration is associated with lower postpartum weight retention.

BREASTFEEDING TRENDS IN THE UNITED STATES AND THE WIC POPULATION

Breastfeeding Trends in the U.S. Population

Healthy People 2020's goals for breastfeeding are presented in Table 7-1 (HHS, 2015). In 2011, the U.S. Surgeon General called for action to support these goals, recommending that families, communities, health care centers, and employment sites provide the support necessary to initiate and continue breastfeeding (HHS, 2011). To assess progress toward reaching these goals, in 2014 the Centers for Disease Control and Prevention (CDC)

TABLE 7-1 Healthy People 2020 Breastfeeding Objectives Compared to 2014 Proportion (%) of Children Who Were Breastfed at Various Ages

Breastfeeding Behavior and Infant Age	*Healthy People 2020*: Objectives	2014 U.S. Breastfeeding Prevalence
Proportion who ever breastfed	81.9	79
Proportion breastfeeding at 6 months	60.6	49
Proportion breastfeeding at 1 year	34.1	27
Proportion exclusively breastfeeding at 3 months	46.2	NA
Proportion exclusively breastfeeding at 6 months	25.5	NA

NOTE: NA = Not available.
SOURCES: CDC, 2014a; HHS, 2015.

estimated breastfeeding prevalence across the United States using data from the 2012 and 2013 U.S. National Immunization Surveys (on children born in 2011). These estimates are also presented in Table 7-1.

Although the national goal for initiation of breastfeeding has nearly been achieved, goals for duration of breastfeeding have been more challenging to meet (CDC, 2014a). This may result, in part, from differences in breastfeeding behavior related to racial and ethnic groups, maternal education and age, and WIC participation (CDC, 2010). Trends in breastfeeding prevalence for 6-month-olds for all U.S. infants (1971–2013) and for WIC infants (1978–2011) are illustrated in Figure 7-2 (Ryan et al., 2002; CDC, 2015).

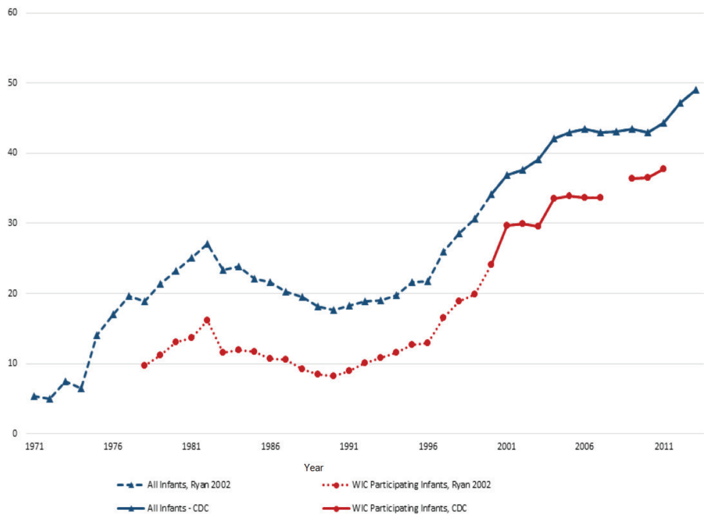

FIGURE 7-2 6-month breastfeeding prevalence: 1971–2013.
NOTES: Data exclusively for non-WIC participants was not available. Therefore, the comparison of all infants to WIC infants is an underestimate of the difference of interest, namely non-WIC versus WIC infants.
Two data sources were used to construct this time series: the Ross Laboratories Mothers Survey (Ryan et al., 2002) and the Centers for Disease Control and Prevention (CDC, 2015). The Ross Laboratories Mothers Survey is a large national survey conducted by Ross Laboratories, a manufacturer of infant formula. Ross sent questionnaires each month to a sample of mothers. Nearly 1 million surveys were sent annually in the 1990s (Ryan, 2005). For example, in 1996, 744,000 questionnaires were mailed (Ryan et al., 2002). Data for 1971 to 1999 are from Ross Mothers Survey.
SOURCES: Ryan et al., 2002; CDC, 2015.

Breastfeeding Trends in the WIC Population

Since the food package revision in 2009, there has been a concerted effort within WIC to increase the proportion of women who breastfeed. Although other measures of breastfeeding prevalence were available to the committee, the longest time-series for which all-infant and WIC-infant prevalence of breastfeeding at 6 months of age could be compared is presented in Figure 7-2. In 2013, the all-infant 6-month breastfeeding prevalence was 49 percent, while the WIC-infant estimate was 38 percent. Although a lower proportion of WIC infants were breastfed than those in the general population, the prevalence of breastfeeding in both groups has been increasing since the late 1970s.

From 2008 to 2011, 6-month breastfeeding prevalence in the United States has consistently tracked with income, being as low as 33 to 38 percent for women under 100 percent of the poverty level to as high as 60 to 68 percent in women at 600 percent or more of the poverty level (see Table 7-2). Although breastfeeding increased between 2008 and 2011 for women in all income levels by about 13 percent, increases were highest among women with the highest incomes. The most recent WIC Participant and Program Characteristics (PC2012) report, indicated that 67 percent of infants (being served by agencies that provided data) were ever breastfed in 2012 (USDA/FNS, 2013). Other available data indicate that between 2004 and 2008, breastfeeding prevalence was lower for WIC women compared to non-WIC, low-income women (CDC, 2010).

A number of breastfeeding promotion and support strategies have been in place as part of *Healthy People 2020* that may have helped to increase the prevalence of breastfeeding in both WIC and non-WIC populations. Goals related to promotion include increasing the proportion of employers that have worksite lactation support programs, reducing the proportion

TABLE 7-2 6-Month Breastfeeding Prevalence (%), by Income from 2008–2011

Income Relative to Poverty Level	2008	2009	2010	2011
Less than 100%	33.5	35.7	38.1	37.8
100–199%	41.3	44.7	42.5	45.5
200–399%	50.0	53.4	55.1	57.7
400–599%	55.1	61.1	59.3	61.9
600% or greater	60.2	61.7	65.4	67.9

SOURCE: National Immunization Survey Data, as analyzed by the Office of Disease Prevention and Health Promotion, *Healthy People 2020* (HHS/CDC, 2015).

of breastfed newborns who receive formula supplementation within the first 2 days of life, and increasing the proportion of live births that occur in facilities that provide recommended care for lactating mothers and their babies (HHS, 2015). The Baby-Friendly Hospital Initiative has been assisting hospitals with meeting these goals (IOM, 2011; WHO, 2012).

BARRIERS, MOTIVATORS, AND INCENTIVES TO BREASTFEEDING IN THE WIC POPULATION

As part of its literature search, the committee looked for evidence on barriers, motivators, and incentives to breastfeeding in the WIC population. Key findings from this search are summarized in Table 7-3 and described below. Some additional searches were conducted in low-income populations in general, or to identify barriers among specific cultural groups. Breastfeeding is influenced by a complex web of interrelated systems operating at different levels of the socioecological model (Pérez-Escamilla and Chapman, 2012). During its evaluation, the committee recognized these many different layers of influence surrounding WIC mothers that affect their ability to breastfeed successfully (see Figure 7-1), including the role of the health care system.

Social and Cultural Factors Associated with Breastfeeding in WIC Women

Studies show that low-income women are less likely to initiate and sustain breastfeeding compared to their higher-income counterparts. Moreover, even in studies that specifically target low-income women, women who participate in WIC have lower breastfeeding initiation rates and shorter breastfeeding duration than those who are not enrolled in the program (Jensen, 2012; also see Table 7-4). A number of social, cultural, and structural barriers to breastfeeding in the WIC population have been reported, including the lack of prenatal, perinatal, and postpartum breastfeeding support (e.g., support from health care providers, family members, and partners); the need to return to work and lack of access to breast pumps, time, and inadequate pumping facilities at worksites; lack of child care; social norms regarding breastfeeding in public; and promotion of a sexualized body image in western society (Hurst, 2007; Heinig et al., 2009; Mickens et al., 2009; Stolzer, 2010; Wojcicki et al., 2010; Shim et al., 2012; Hedberg, 2013; Spencer et al., 2015).

Additionally, one topic that has been widely discussed among researchers, advocates, and other WIC stakeholders has been the provision of formula in WIC. Research suggests that the availability of formula may contribute to lower breastfeeding adoption and duration in women enrolled

TABLE 7-3 Barriers and Incentives to Breastfeeding in WIC Populations

	Barrier	Reference
Support	Lack of prenatal support	Hedberg, 2013[a] Tenfelde et al., 2011[b]
	Lack of support in hospital	Varela et al., 2011
	Lack of social support (partner, family, social network)	Hurst, 2007[b] Varela et al., 2011 Wojcicki et al., 2010[b] Heinig et al., 2009 Spencer et al., 2015
	Lack of professional support	Hurst, 2007[b] Varela et al., 2011
	Lack of knowledge	Varela et al., 2011
	Lack of access to breast pumps	Holmes et al., 2009
Time	Return to work or school, unsupportive workplace, time away from baby	Hedberg, 2013[a] Holmes et al., 2009 Hurst, 2007[b] Stolzer, 2010 USDA/FNS, 2012[b] Tenfelde et al., 2013[b]
Provision of formula	Formula from WIC valued over expanded food package	Hedberg, 2013[a]
	Formula supplementation in hospital	Holmes et al., 2009 Tender et al., 2009[b]
Psychosocial	Belief that formula and solids are unavoidable in certain situations	Heinig et al., 2006
	Belief that providers would not understand family's circumstances	Heinig et al., 2006
	Impact of BF on body and sexuality	Johnston-Robledo and Fred, 2008[b] Varela et al., 2011
	Culturally constructed belief systems, e.g., African American	Ma and Magnus, 2012[b] Stolzer, 2010 Hedberg, 2013[a] Varela et al., 2011
	Embarrassment/discomfort nursing in public	Holmes et al., 2009 Hurst, 2007[b] Johnston-Robledo and Fred, 2008[b] Wojcicki et al., 2010[b]

TABLE 7-3 Continued

	Barrier	Reference
	Perception of insufficient milk (PIM)	USDA/FNS, 2012[b] Tenfelde et al., 2013[b]
	Fear	Hedberg, 2013[a]
	Dislike BF	USDA/FNS, 2012[b]
	Relatives, not parents, caring for child	Shim et al., 2012[b] Wojcicki et al., 2010[b]
Physical	Mother became sick	USDA/FNS, 2012[b]
	Physical discomfort and difficulty	Hedberg, 2013[a] USDA/FNS, 2012[b] Wojcicki et al., 2010[b] Varela et al., 2011 Tenfelde et al., 2013[b]
	Incentive	**Reference**
Support	Professional advice delivered with empathy, confidence, respect, and calm	Heinig et al., 2009
	Support groups, group classes	Mickens et al., 2009[b] Varela et al., 2011 Tender et al., 2009[b]
	Clear and effective BF education from WIC	Murimi et al., 2010[b]
	Individual consultation, peer counseling	Varela et al., 2011
	BF initiation and BF education in hospital	Ma and Magnus, 2012[b]
Psychosocial	Belief that BF is beneficial	Vaaler et al., 2010[b] Heinig et al., 2006
	Culturally constructed belief systems, e.g., Hispanic	Wojcicki et al., 2010[b]
	BF costs less than formula	Wojcicki et al., 2010[b]

NOTES: BF = breastfeeding. References lacking a symbol are qualitative in nature.
[a] Systematic review.
[b] Observational study.

in the program (Varela et al., 2011; Hedberg, 2013). However, as noted by Jiang et al. (2010), a major challenge to measuring the causal effect of WIC on breastfeeding (and the causal effects of WIC on many outcomes, as described in Chapter 3) is the issue of selective enrollment. WIC participants tend to be more socioeconomically disadvantaged than eligible nonparticipants, which may partially explain their lower tendency to breastfeed

TABLE 7-4 Association Between WIC Participation and Breastfeeding Outcomes: Summary of Evidence

Author, Year Location	Study Design (N)	BF Initiation	Any BF Duration	Exclusive BF Duration
Flower et al., 2008 North Carolina and Pennsylvania	Longitudinal cohort (788 WIC; 504 non-WIC)	↓↓	↓↓	
Jiang et al., 2010 U.S. nationwide	Secondary analysis of longitudinal data (1,373 WIC; 1,812 non-WIC)		↓↓ (adjusted mean BF duration) ↔ (propensity matching)	
Bunik et al., 2009 U.S. nationwide	Cross-sectional (2,492 WIC; 865 non-WIC)	↔	↔	
Hendricks et al., 2006 U.S. nationwide	Cross-sectional (626 WIC; 1,889 non-WIC)	↔	↓↓	
Jacknowitz et al., 2007 U.S. nationwide	Cross-sectional (4,221 WIC; 1,055 non-WIC)			↓↓
Jensen, 2012 U.S. nationwide	Cross-sectional (6,997 WIC; 1,188 non-WIC)	↓↓	↓↓	
Li et al., 2005 U.S. nationwide	Cross-sectional (1,705 WIC; 165 non-WIC)		↓	↓
Ma et al., 2014 South Carolina	Cross-sectional (1,024 WIC; 214 non-WIC)	↓↓		
Mao et al., 2012 Washington, DC	Cross-sectional (62 WIC; 189 non-WIC)	↓		
Marshall et al., 2013 Mississippi	Cross-sectional (2,317 WIC; 1,177 non-WIC)	↓↓		

TABLE 7-4 Continued

Author, Year Location	Study Design (N)	BF Initiation	Any BF Duration	Exclusive BF Duration
Ryan and Zhou, 2006 U.S. nationwide	Cross-sectional (213,613 WIC; 261,613 non-WIC)	↓↓	↓↓	
Shim et al., 2012 U.S. nationwide	Cross-sectional (3,830 WIC; 3,685 non-WIC)		↓↓	
Sparks, 2011 U.S. nationwide	Cross-sectional (NR)		↓↓	
Ziol-Guest and Hernandez, 2010 U.S. nationwide	Cross-sectional (3,100 WIC; 1,350 non-WIC)	↓↓	↓↓	↔

NOTES: BF = breastfeeding; NR = not reported; ↓ = WIC was significantly associated with lower BF initiation, shorter duration (continuous or categorical outcomes), or less exclusivity in unadjusted/crude analysis; ↓↓ = WIC was significantly associated with lower BF initiation, shorter duration (continuous or categorical outcomes), or less exclusivity in adjusted analysis; ↔ = no significant association; data excluded in summary if no significance tests were performed.

(Gundersen, 2005; Jiang et al., 2010). Chapter 3 includes a detailed discussion of the challenge posed by selective enrollment ("selection bias") when analyzing WIC-specific data.

As mentioned in Chapter 2, studies of breastfeeding in the WIC population have shown that the prevalence varies among cultural groups, with the greatest differences appearing at the point of initiation. Although African Americans face similar barriers to breastfeeding that other women in the United States face, evidence suggests that they face these barriers to a greater extent (Spencer and Grassley, 2013). Sparks (2011) found that African American women were significantly less likely to initiate breastfeeding compared with women from other racial/ethnic groups, but this was no longer true when the model was adjusted for covariates. Several studies have indicated that African American women receive less encouragement to breastfeed from physicians and WIC counselors (Beal et al., 2003; Johnson et al., 2015; Spencer et al., 2015). Evidence suggests that African American women experience unique historical, cultural, and structural barriers to initiating and sustaining breastfeeding. Several studies have noted that as compared to white women, African American women are less likely to receive breastfeeding information and support from their health care providers (Spencer and Grassley, 2013) and WIC providers specifically (Beal et al., 2003). Additionally, historical images of African American women serving as wet nurses for white children during slavery (Gross et al., 2015; Johnson et al., 2015) as well as existing perceptions of African American women as "strong" or "hypersexual" may also impede the support they received for breastfeeding both within and outside their African American community (Gross et al., 2015; Johnson et al., 2015; Spencer et al., 2015). These and other barriers suggest a need for implementing multilevel approaches to promote and alleviate breastfeeding disparities among WIC and WIC-eligible women.

In addition to barriers to breastfeeding, researchers have identified multiple factors that facilitate breastfeeding initiation among both WIC participants and low-income women more generally. These include support from health care providers, breastfeeding promotion and assistance at the hospital, use of breastfeeding peer counselors, inclusion of lactation services in existing community-based programs, and supportive breastfeeding policies at the state and local levels (Ma and Magnus, 2012; CDC, 2014a; Lilleston et. al., 2015). However, the effectiveness of these approaches may vary among different racial and ethnic groups (Smith-Gagen et al., 2014).

Barriers to Breastfeeding

In its literature search, the committee identified many barriers to breastfeeding among WIC women (see Table 7-4) and in low-income populations generally. This section highlights barriers that the committee considers to be relevant to WIC and WIC-eligible populations.

Employment and Breastfeeding

Many women who choose to breastfeed do not continue into late infancy, which may result in part from the need to return to work. Several factors related to returning to work have been identified as barriers to breastfeeding, including anticipated lack of acceptance by coworkers (Rojjanasrirat and Sousa, 2010; Hedberg, 2013). Onsite lactation is another challenge. A goal of *Healthy People 2020* is to ensure that 38 percent of employers provide an onsite lactation room (HHS, 2015), starting from a 2009 baseline of 25 percent. To help reach this goal, the 2010 Patient Protection and Affordable Care Act amendment to the Fair Labor Standards Act (FLSA) required employers to provide a time and location to express human milk for 1 year after the child's birth (DOL, 2011). However, while this amendment may have reduced barriers to breastfeeding for some working mothers, its effect on the promotion of breastfeeding among WIC mothers is unclear.

Biomedical Barriers: Perceived Insufficient Milk (PIM) and Maternal Obesity

Perceived insufficient milk (PIM) is one of the most common reasons WIC mothers give for initiating formula supplementation and for discontinuing breastfeeding prematurely (USDA/FNS, 2012). PIM is likely to be the result of a combination of metabolic, physiological, and psychosocial factors and has been associated with both delayed onset of lactation and maternal obesity (Segura-Millán et al., 1994; Chapman and Pérez-Escamilla, 2000; Bever Babendure et al., 2015). As discussed in Chapter 6, maternal obesity has consistently been identified as a risk factor for poor breastfeeding outcomes among WIC women (Hauff et al., 2014; Turcksin et al., 2014), with breastfeeding interventions among obese mothers showing limited success (Chapman et al., 2013).

Lack of Access to Breast Pumps

Lack of access to breast pumps has been identified as a barrier to breastfeeding success among WIC mothers (Haughton et al., 2010; Hedberg, 2013). The Affordable Care Act's requirement that most insurance companies cover the cost of breast pumps may be helping to remove this barrier (HHS, 2014).

Incentives to Breastfeeding

Important incentives identified in the literature included appropriately delivered professional advice (Heinig et al., 2009); support groups and group classes (Mickens et al., 2009; Tender et al., 2009; Varela et al., 2011); and clear and effective education from WIC (Murimi et al., 2010) including individual and peer counseling (Varela et al., 2011). Education in the hospital was also reported as an incentive to breastfeed (Ma and Magnus, 2012). On an individual level, existing perceptions (cultural or otherwise) of breastfeeding as beneficial was associated with an increased likelihood of breastfeeding (Heining et al., 2006; Vaaler et al., 2010; Wojcicki et al., 2010).

The provision of formula through WIC appears to be a major incentive for women to enroll in the program, but it competes as an incentive with the enhanced food package offered to breastfeeding mothers (see Chapter 2 for a review of relevant behavioral economics principles). Unfortunately, women enrolled in WIC or who are considering enrollment in the program perceive the formula feeding package to be of higher economic value than the enhanced breastfeeding package (Haughton, 2010; Jensen and Labbok, 2011). For many women, the program delivers conflicting messages by supporting breastfeeding while at the same time distributing infant formula at no cost to participants (Holmes, 2009).

Association of the 2009 Food Package Revisions with Breastfeeding in the WIC Population

A key goal of the 2009 changes to the WIC food packages was to help improve breastfeeding behaviors. In its literature search, the committee identified six observational studies that have examined whether this goal was achieved. Collectively, the studies suggest that the enhanced food packages, together with improved support for breastfeeding in anticipation of the new packages, may have had a small effect on improving breastfeeding outcomes, although evidence is not conclusive. The six studies, all of which used a repeated cross-sectional design, are summarized here.

Based on a time-series analysis using data from three sources (2004–2010 Pregnancy Risk Assessment Monitoring System [PRAMS] data covering 19 states, 2004–2010 National Immunization Survey [NIS] data from 50 states plus Washington, DC, and 2007–2010 Pediatric Nutrition Surveillance System [PedNSS] data), Joyce and Reeder (2015) found that, between 2004 and 2010, breastfeeding outcomes improved among both WIC and low-income non-WIC participants. The trends in improvements in "any breastfeeding" and "breastfeeding for at least 4 weeks" were similar in both groups, and the increased prevalence of exclusive breastfeeding for at least 3 months was more pronounced among low-income non-WIC participants. The 2007–2010 PedNSS data showed a steady increase in ever-breastfeeding prevalence, but no acceleration in improvement around the time of the implementation of the food packages was detected.

In an analysis of WIC administrative records in a large 10-state sample, Abt Associates found that participants' choice of the partially breastfeeding package decreased from 24.7 percent before implementation of the revised packages to 13.8 percent afterward (see Figure 7-3) (USDA/FNS, 2011). While this decrease corresponded to an increase in the selection of the full breastfeeding package, an increase in the formula package and total amount of formula was also seen. Breastfeeding initiation did not appear to be affected by the revised food packages. An important limitation of this study is the short periods for the pre- and for post-implementation observations.

The committee also considered four regional studies. In a study conducted in New York State, Chiasson et al. (2013) reported an increase in the prevalence of breastfeeding initiation from 72.2 percent in 2008 to 77.5 percent in 2011. Similarly, two studies reported improved breastfeeding

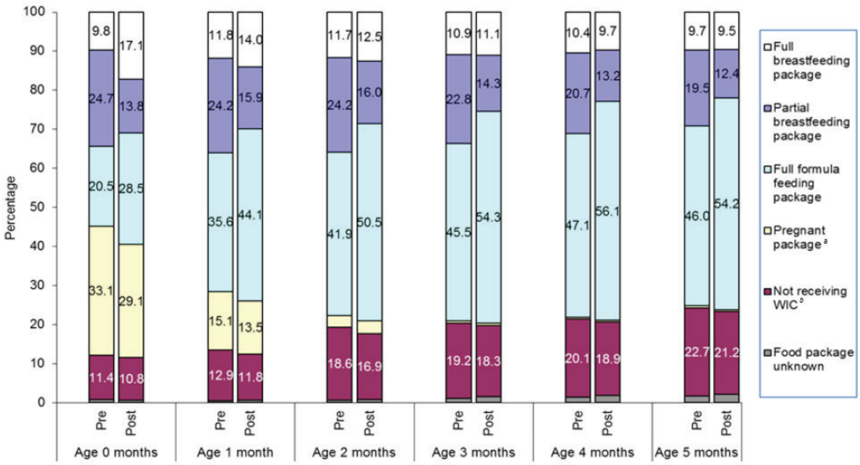

FIGURE 7-3 WIC food packages issued to new mothers, by age of infant, 2009.
NOTES: Data were sourced from the administrative records from 17 local state agencies. Data represent all dyads with infants aged 0 to 5 months, n = 129,606 (pre) and n = 528,597 (post) in analysis months 1–2 (pre) and analysis months 5–12 (post). Interpretation Guide: Among dyads whose infants were in their birth month, 9.8 percent (pre) and 17.1 percent (post) received the full breastfeeding package as the mother's WIC food package.

[a] Mothers with infants certified for WIC.

[b] Mothers who have not recertified postpartum, but who have infants who have been certified.

SOURCE: USDA/FNS, 2011.

outcomes among WIC participants living in Los Angeles (Whaley et al., 2012; Langellier et al., 2014), with both ever-breastfeeding and exclusive breastfeeding at 3 and 6 months increasing between 2005 to 2008 and 2011 (Langellier et al., 2014). Finally, in a small pre-post cross-sectional study conducted in central Texas, Thornton et al. (2014) found small increases in both the prevalence of breastfeeding initiation and duration among WIC infants. Schultz et al. (2015) included the work of several of these research groups (Whaley et al., 2012; Wilde et al., 2012; Langellier et al., 2014) in their recent systematic review and also concluded the results of these studies were mixed.

Importantly, five of the aforementioned studies were based on pre/post or time-series designs without low-income, non-WIC participants as a comparison group. The only study that included such a comparison group, Joyce and Reeder (2015), concluded that, because improvements in breastfeeding outcomes among WIC participants were similar to those of non-participants, the changes they observed in the WIC population were unlikely to be explained by the 2009 food package changes.

BREASTFEEDING INITIATION, DURATION, AND EXCLUSIVITY: INFLUENCE OF WIC PARTICIPATION

The committee's literature search led to the identification of many studies with data describing the associations between WIC participation on breastfeeding initiation, duration, and exclusivity (see Table 7-4). Overall, the findings suggest WIC participation may be associated with a lower prevalence of breastfeeding. A summary of the literature follows.

Initiation

The committee identified nine studies on the association between WIC participation and breastfeeding initiation (Hendricks et al., 2006; Ryan and Zhou, 2006; Flower et al., 2008; Bunik et al., 2009; Ziol-Guest and Hernandez, 2010; Jensen, 2012; Mao et al., 2012; Marshall et al., 2013; Ma et al., 2014). All but two (Hendricks et al., 2006; Bunik et al., 2009) reported that WIC participation was associated with significantly lower odds of breastfeeding initiation.

Duration

Several studies have reported associations between WIC participation and either lower odds of breastfeeding or higher risk for discontinuation of breastfeeding at 4, 6, or 12 months (Li et al., 2005; Hendricks et al., 2006; Ryan and Zhou, 2006; Flower et al., 2008; Bunik et al., 2009; Ziol-Guest and Hernandez, 2010; Sparks, 2011; Shim et al., 2012). Additionally, in a cross-sectional study using data from the NIS, Jensen (2012) found that mean breastfeeding duration was 1.91 (95% confidence interval [CI] 1.43, 2.40) months shorter in WIC participants than in WIC-eligible nonparticipants. In another study in which the mean duration of breastfeeding among WIC participants and nonparticipants was compared, Jiang et al. (2010) reported different results between two statistical analyses. Their multiple regression analysis showed that the adjusted mean breastfeeding duration was significantly longer in non-WIC participants than in WIC participants (3.88 versus 3.35 months). In their propensity matching analysis, they did not find a significant difference in the mean breastfeeding duration between WIC participants and nonparticipants. Inasmuch as propensity matching methods can balance baseline characteristics of the two-matched groups to reduce the self-selection bias, the difference between results obtained by using these two approaches indicates that baseline demographic differences, rather than WIC participation, are more likely to explain the differences in the breastfeeding duration.

Exclusivity

Based on an analysis of data from the Early Childhood Longitudinal Study-Birth Cohort (ECLS-B), Ziol-Guest and Hernandez (2010) found no significant association between entry into WIC (at any trimester of pregnancy) and exclusive breastfeeding. In contrast, also based on an analysis of ECLS-B data, Jacknowitz et al. (2007) reported that WIC participants had 5.9 percent (95% CI –9.82%, –1.98%) and 1.9 percent (95% CI –3.82%, 0.06%) lower prevalences of exclusive breastfeeding for more than 4 and 6 months, respectively, compared with WIC-eligible nonparticipants. Li et al. (2005) also reported that exclusive breastfeeding was significantly less likely for individuals participating in WIC at 7 days and at 1, 3, and 6 months postpartum.

Associations Between the Timing of WIC Exposure and the Initiation, Duration, and Exclusivity of Breastfeeding

In its examination of the literature to determine whether the timing of a woman's participation in WIC was associated with breastfeeding behavior, the committee identified seven analyses of either national longitudinal data (PRAMS and the ECLS-B) or regional survey data (Chicago, Kansas, Los Angeles, Louisiana, Massachusetts) (Joyce et al., 2008; Ziol-Guest and Hernandez, 2010; Tenfelde et al., 2011; Langellier et al., 2012; Ma and Magnus, 2012; Jacobson et al., 2014; Metallinos-Katsaras et al., 2015). Details of most of these studies are provided in Appendix S, Table S-1. Some studies reported significant associations were found between earlier entry to WIC and breastfeeding initiation, any breastfeeding, exclusive breastfeeding, or breastfeeding duration, with some evidence of geographical variation (urban versus rural) (Joyce et al., 2008; Tenfelde et al., 2011; Jacobson et al., 2014; Metallinos-Katsaras et al., 2015). In contrast, other studies have shown negative or no associations between early WIC participation and breastfeeding initiation, breastfeeding at 4 months, exclusive breastfeeding, and breastfeeding duration (Ziol-Guest and Hernandez, 2010; Langellier et al., 2012; Ma and Magnus, 2012). Findings from Ma and Magnus (2012) should be interpreted with caution as the analyses were not adjusted for confounders. Overall, these findings suggest that earlier entry into the WIC program is associated with an increased probability of any breastfeeding. The evidence is inconclusive regarding an association between timing of WIC entry and exclusivity or duration of breastfeeding.

Factors Other Than WIC Participation That Are Associated with Initiation, Duration, and Exclusivity of Breastfeeding

Aside from WIC participation and time of entry into the WIC program, the committee's literature search identified a wide array of additional interrelated factors that may affect breastfeeding initiation, duration, and exclusivity among WIC women. Again, see Appendix S, Table S-1 for details. Highlights are summarized here. Many of the studies are qualitative, and few focus on the same factor.

Initiation

Initiation of breastfeeding among WIC-participating mothers has been positively associated with the following:

- Breastfeeding in the hospital after delivery (Ma and Magnus, 2012)
- Contact with a peer counselor (Gross et al., 2009)
- Foreign-born mothers (Ziol-Guest and Hernandez, 2010)
- The mother being married (Ziol-Guest and Hernandez, 2010; Darfour-Oduro and Kim, 2014)
- The mother being non-Hispanic white (Ziol-Guest and Hernandez, 2010; Ma and Magnus, 2012) or Hispanic (Jacobson et al., 2014)
- Living in the Western United States (Ziol-Guest and Hernandez, 2010)
- Mother's income being above the poverty level (Ziol-Guest and Hernandez, 2010)
- Participation in WIC for 3 months or longer (Yun et al., 2010)
- Older maternal age (age 45 or more) (Gross et al., 2009)
- Maternal overweight (Gross et al., 2009)

Breastfeeding initiation has been negatively associated with the receipt of food stamps, younger maternal age, and mothers being at or below the poverty level (Gross et al., 2009).

Duration

The duration of breastfeeding appears to be greater when mothers begin to breastfeed in the hospital (Langellier et al., 2012), when the mother is foreign-born (Ziol-Guest and Hernandez, 2010; Langellier et al., 2012), and when child care is provided by a relative (Shim et al., 2012).

Exclusivity

Exclusive breastfeeding in WIC women has been positively associated with breastfeeding in the hospital after delivery (Langellier et al., 2012), higher income (Wojicki et al., 2010), prenatal intention to breastfeed (Tenfelde et al., 2011), higher maternal age and income (Ziol-Guest and Hernandez, 2010), being non-Hispanic white (Langellier et al., 2012), and living in the Western United States (Ziol-Guest and Hernandez, 2010). Exclusivity breastfeeding in WIC women has been negatively associated with the need to return to work (Langellier et al., 2012), receiving formula at the hospital (Langellier et al., 2012), pre-pregnancy overweight or obesity (Tenfelde et al., 2011), and being African American (Ziol-Guest and Hernandez, 2010).

Associations Between Breastfeeding Promotion Strategies and Initiation, Duration, and Exclusivity of Breastfeeding Among WIC Participants, and Among WIC-Eligible or Low-Income Populations

The committee identified 17 intervention studies evaluating associations between breastfeeding promotion and support strategies on the initiation, duration, and exclusivity of breastfeeding among WIC participants, and among WIC-eligible or low-income populations (Anderson et al., 2005, 2007; Bonuck et al., 2005; Hayes et al., 2008; Meehan et al., 2008; Hopkinson and Gallagher, 2009; Petrova et al., 2009; Sandy et al., 2009; Bunik et al., 2010; Olson et al., 2010; Pugh et al., 2010; Kandiah, 2011; Chapman et al., 2013; Haider et al., 2014; Hildebrand et al., 2014; Howell et al., 2014; Reeder et al., 2014). Interventions included professional support, lay support, breast pumps, telephone breastfeeding support, and education. Multimodal intervention deliveries were employed including individual face-to-face, group, and telephone support. Comparison groups and characteristics of study participants were heterogeneous across studies. The findings from this body of literature are presented in Appendix S.

Initiation

Overall, multimodal professional and lay breastfeeding support increased the proportions of women who initiated breastfeeding by 19 to 50 percent compared to standard of care without breastfeeding support (Olson et al., 2010; Haider et al., 2014; Hildebrand et al., 2014). However, in one study the same proportion of women (84 percent) initiated breastfeeding in low-income mothers who received behavioral educational intervention and those who received an enhanced usual care (Howell et al., 2014).

Duration

In six intervention studies, professional and/or lay breastfeeding support was associated with the increased occurrence of any breastfeeding up to 6 months (Bonuck et al., 2005; Olson et al., 2010; Pugh et al., 2010; Chapman et al., 2013; Haider et al., 2014; Reeder et al., 2014), but the effects were not maintained at 9 and 12 months postpartum (Olson et al., 2010; Haider et al., 2014). However, one study did not find significant effects of breastfeeding promotion or support on prevalence of any breastfeeding compared with standard care (Bunik et al., 2010). One other study that compared electric breast pumps with manual breast pumps also did not find significant difference in the prevalence of breastfeeding at 6 months (Hayes et al., 2008; see Appendix S, Figure S-2).

Furthermore, results from four studies showed that breastfeeding support (breast pump, education and infant hunger cue, and lay support) can increase the duration of any breastfeeding by an average of 2 to 17 weeks compared with control interventions (Meehan et al., 2008; Olson et al., 2010; Kandiah, 2011; Haider et al., 2014) (see Appendix S, Figure S-3).

Exclusivity

Of the seven studies that reported breastfeeding exclusivity outcomes, four showed that breastfeeding promotion or support significantly increased the prevalence of exclusive breastfeeding at 1 week to 3 months (Anderson et al., 2005, 2007; Hopkinson and Gallagher, 2009; Sandy et al., 2009). However, the other three studies found no significant difference in the prevalence of exclusive breastfeeding (ranging from 1 week to at least 6 months) between breastfeeding support (telephone peer counseling or education) and controls (Petrova et al., 2009; Howell et al., 2014; Reeder et al., 2014).

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8

Meeting Diverse Dietary Needs and Preferences: Considerations for the WIC Food Packages

The 2009 revised Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) food packages were designed to accommodate a broader array of dietary needs and preferences than in the past. This chapter considers the issuance of food package III for certain medical conditions, the extent to which WIC food packages accommodate the dietary needs of individuals with food allergies and other food-triggered sensitivities, and the availability of WIC package food items to accommodate varying food preferences (i.e., vegetarian and vegan diets) and food-related religious practices (i.e., Kosher and Halal dietary practices). Details of the literature search used to gather this information are provided in Chapter 3.

FOODS TO ADDRESS MEDICAL CONDITIONS

The revised WIC food packages can accommodate a wide range of medical conditions. This section summarizes the circumstances under which food package III can be issued and the extent to which the WIC food packages (all of the packages, including food package III) accommodate the dietary needs of individuals with food allergies and other food-triggered sensitivities.

The Special Case of Food Package III

At the discretion of a health care provider, individuals may be considered, "medically fragile" and can receive food package III for either themselves or their children. There exists no generally accepted definition

BOX 8-1

Definition of WIC-Eligible Medical Foods

(7 C.F.R. § 246.3)

WIC-eligible medical foods means certain enteral products that are specifically formulated to provide nutritional support for individuals with a qualifying condition, when the use of conventional foods is precluded, restricted, or inadequate. Such WIC-eligible medical foods must serve the purpose of a food, meal, or diet (may be nutritionally complete or incomplete) and provide a source of calories and one or more nutrients; be designed for enteral digestion via an oral or tube feeding; and may not be a conventional food, drug, flavoring, or enzyme. WIC-eligible medical foods include many, but not all, products that meet the definition of medical food in Section 5(b)(3) of the Orphan Drug Act (21 U.S.C. 360ee(b)(3)).

of medical fragility. Examples include an infant with failure to thrive and an adult with a wired jaw. Individual states have policies regarding who may qualify under WIC.

Nutrition plays a pivotal role in the health of medically fragile individuals, especially children, with appropriate nutrition preventing or mitigating significant neurodevelopmental deficiencies and being potentially life-saving. Depending on an individual's specific medical needs, food package III can be tailored by including non-contract[1] infant formulas with unique nutritional composition or WIC-eligible medical foods (see Box 8-1). As detailed in the interim rule and verified in the final rule, individuals receiving food package III may be issued 455 ounces of WIC formula[2] per month, but only in addition to (not instead of) the maximum allowance of all other foods in the package appropriate for their life-stage (USDA/FNS, 2014). Exceptions to these food package regulations may be made as necessary and as dictated by the final rule (USDA/FNS, 2014).[3]

[1] Any formula that is non-contract is not subject to rebates. Exempt infant formula is always non-contract. By federal regulation, for WIC participants who are also on Medicaid, the Medicaid program is the primary payer for exempt infant formulas, as well as for WIC-eligible medical foods. WIC is the payer of last resort for the Medicaid beneficiaries and the payer for those not on Medicaid. Some private insurance may also cover exempt formula.

[2] WIC formula refers to infant formula, exempt infant formula, or a WIC-eligible medical food.

[3] As specified in the final rule, exceptions for food package III include (1) whole milk may be provided to children more than 2 years of age and to women with a qualifying condition; (2) state agencies have the flexibility to provide children and women the option of receiving commercial jarred infant food fruits and vegetables in lieu of the cash value voucher; and (3) infant formula may be provided in lieu of foods at 6 months of age.

There are no publicly available data for estimating how many WIC participants nationwide receive food package III. A report detailing electronic benefit transfer (EBT) redemption patterns in Kentucky, Michigan, and Nevada indicated that, on average, 1.5 percent of WIC families in these states were issued a medical food of some kind, although not necessarily through food package III (Phillips et al., 2014). Only 54 percent of these families redeemed the entire package and 14 percent redeemed none of the package. Non-Hispanic Asian and non-Hispanic white families were more likely to redeem the entire package than non-Hispanic black families, and 72 percent of families in urban areas redeemed the full benefit compared to 53 percent in large rural areas (Phillips et al., 2014). Missouri state data from September 2015 indicate that 2 percent of Missouri WIC participants are receiving food package III (personal communication, R. Arni, Missouri WIC, October 9, 2015). In a recent study of National Health and Nutrition Examination Survey (NHANES) 2003–2010 data, Rossen et al. (2015) found that 6.5 percent of infants living at or below 185 percent of the federal poverty-to-income ratio (PIR) (the qualifying PIR for WIC) consumed "specialty" formulas (those having clear clinical indications for use). Similarly, data from 2004 indicated that 6 percent of infant formulas issued through WIC nationally were exempt (non-contract formula for special medical needs), ranging from 1 to 23 percent by state (USGAO, 2006). This is higher than the proportions of WIC families in the Phillips et al. (2014) study who were reportedly issued medical foods, which is likely to include specialty (exempt) formulas.

Food-Triggered Immune-Mediated Sensitivities

All of the food packages, including food package III, can support the nutritional needs of several different types of food-triggered immune-mediated sensitivities, including food allergies, celiac disease, non-celiac gluten sensitivity (NCGS), and lactose intolerance. This section summarizes evidence from the literature on the nutritional needs of individuals with these medical conditions, and ways that the 2009 revised food packages accommodate individuals with these conditions.

Food Allergies

Allergy has been defined as a hypersensitivity disorder of the immune system where the immune system reacts to substances in the environment normally considered harmless (CDC, 2013). When allergy manifests as disease, those diseases, such as dermatitis, asthma, and rhinitis, are commonly referred to as "atopic" diseases. Researchers still do not understand the underlying factors that cause atopic disease, although several theories have been put forth. Prominent among these is dysbiosis of the microbiome (Brown et al., 2013), which at one time was known as the "hygiene hypothesis" (Strachan, 1989). It has also been suggested that how and when foods are introduced into the diet of infants influences the risk of food allergy in particular (NIAID, 2010).

Food allergy has been defined as an adverse health effect arising from a specific immune response that occurs reproducibly on exposure to a given food; the specific food component eliciting the immune response and causing symptoms is the allergen (NIAID, 2010). Proper diagnosis of allergy is important because, in 50 to 90 percent of cases, symptoms presumed to be associated with food allergy are not related (NIAID, 2010).

Food allergies can be either IgE-mediated or non-IgE-mediated. The symptoms of IgE-mediated food allergy include cutaneous, ocular, respiratory, gastrointestinal, cardiovascular, and other miscellaneous effects. Diagnoses of IgE-mediated allergies are made using food elimination diets and oral food challenges (i.e., symptoms resolve when the causative food is removed from the diet and recur following an oral challenge). Non-IgE-mediated immunologic reactions to food include food protein-induced enteropathy, eosinophilic gastrointestinal diseases, allergic contact dermatitis, and systemic contact dermatitis. Some, but not all, non-IgE-mediated allergies can be diagnosed using food elimination diet and oral food challenges.

Several expert groups have made still-evolving recommendations for prevention of food allergy. In 2000, the American Academy of Pediatrics (AAP) recommended delaying the introduction of allergenic foods in infants at higher risk of allergy development (AAP, 2000). However, subsequently, the AAP reported insufficient data to document a protective effect of any dietary intervention beyond 4 to 6 months of age (Greer et al., 2008). Likewise, a committee convened by the National Institute of Health's (NIH's) National Institute of Allergy and Infectious Diseases recommended that infants be breastfed for 4 to 6 months to prevent food allergy but that the introduction of solid foods not be delayed beyond 4 to 6 months, regardless of whether they are potentially allergenic (NIAID, 2010). Based on accumulating evidence (Osborn and Sinn, 2006; see also Alexander et al., 2010), the NIH committee further recommended hydrolyzed[4] (and not soy) formula for the prevention of allergy in non-breastfed or supplemented breastfed at-risk infants (NIAID, 2010). In accordance with these earlier recommendations, in 2013 the American Academy of Allergy recommended breastfeeding for 4 to 6 months, use of a hydrolyzed protein infant formula

[4] Hydrolyzed refers to formulas containing cow's milk proteins that have been extensively broken down so they are unlikely to cause an allergic reaction.

for at-risk infants who are not breastfed, and the introduction of solid foods at 4 to 6 months of age (Fleischer et al., 2013).[5]

In addition to recommending the delayed introduction of allergenic foods, AAP (2000) recommended avoidance of some foods by breastfeeding mothers. However, authors of a recent systematic review of maternal intake during pregnancy or lactation did not find any conclusive evidence of an effect of maternal diet on atopy in infants (Netting et al., 2014). Similarly, the NIH committee referenced above recommended against maternal restriction of allergenic foods during pregnancy and lactation as a means of reducing the likelihood of allergy development in infants (NIAID, 2010).

Despite these ever-evolving recommendations, the prevalence of reported food allergy has continued to rise. Centers for Disease Control and Prevention (CDC) data indicate that, among children ages 0 to 17 years, reports of food allergies increased approximately 50 percent between 1997 and 2011 (CDC, 2013). The prevalence of food allergies appears to be higher in non-Hispanics and in families with higher household incomes (CDC, 2013). The most common food allergies are allergies to peanuts, tree nuts, seafood, milk, and hen's egg (NIAID, 2010), although wheat, fish, and soy allergies are also relevant to the WIC food packages. There is some evidence that early introduction of peanut protein reduces the likelihood of peanut allergy (Du Toit et al., 2008, 2015; Gruchalla and Sampson, 2015). Based on this evidence, in September 2015 AAP issued interim guidance for the early (between 4 and 11 months of age) introduction of peanut protein to high-risk infants under care of a health care provider (Fleischer et al., 2015).

WIC food package options for individuals with food allergies In sum, with respect to food allergy, the committee's review of the literature indicated that most experts recommend breastfeeding for approximately 6 months and the provision of hydrolyzed protein formula for non-breastfed infants who are at risk of developing allergy. In accordance with these recommendations, hydrolyzed protein infant formulas for allergy at-risk infants are available to formula-fed WIC infants with a physician's prescription. Because it is not fully understood how introduction of solid foods in the first year of life might influence the development of allergy, there is no currently defined role for WIC-provided infant foods in allergy prevention.

For children and adults, the current WIC packages include substitutions for allergenic foods so individuals with most major food allergies can be accommodated (see Table 8-1). However, as noted in the table, there is no current substitution in the case of an egg or a fish allergy. Importantly, WIC

[5] Additional indications for the use of hydrolyzed formulas are summarized in Chapter 9.

TABLE 8-1 Options in WIC Food Package Categories Potentially Unsuitable for Special Diets and Major Allergies

	Special Diet			
WIC Food Category	Vegetarian	Vegan	Gluten-free	Lactose-free
Ready-to-eat cereal			✓	
Whole wheat bread			✓	
Milk[b]		✓		✓
Cheese		✓		✓
Eggs		✓		
Peanut butter				
Canned fish	✓	✓		

NOTES: ✓ Indicates that the primary food in the category is not likely to be suitable for the particular diet or allergy unless a suitable substitution is made available. The major allergens shellfish and tree nuts were excluded from the table because no WIC foods are provided in these categories. Soy is excluded because the baseline food packages do not contain soy products. The WIC food categories "mature legumes" and "juice" were excluded from the table because they are suitable for all cases covered in this table.

offers participants with food allergies a number of educational resources to support adherence to dietary restrictions (USDA/FNS, 2015a).

Celiac Disease

Approximately 1 in 200 individuals living in the United States have celiac disease, an immune-mediated inflammation of the small bowel caused by sensitivity to dietary gluten (a protein found in wheat and other grains) and related proteins (Guandalini and Assiri, 2014; Mooney et al., 2014). The disorder is neither IgE- nor IgG-mediated. A diagnosis is based on histology of a small bowel biopsy. A recent meta-analysis that included data from more than 4 million women indicated that women with celiac disease have an increased risk of obstetrical complications (Saccone et al., 2015). These included preeclampsia and preterm birth, intrauterine growth

Major Allergen					Substitutions Allowed (% of State Agencies Allowing Substitution)
Milk	Eggs	Fish	Peanuts	Wheat	
				✓	Corn, rice, or oat certified gluten-free cereal[a]: 78%
				✓	Brown rice: 90%; Tortillas: 82%; Oats: 34%
✓					Soy beverage: 71%; Tofu: 40%; Lactose-free milk: 73%
✓					No substitution
	✓				No substitution
			✓		Canned beans: 72%; Dry beans: 70%
		✓			No substitution

[a] States may offer several gluten-free options. Seventy-eight percent of states allow the most commonly offered gluten-free rice cereal.
[b] Lactose-free milk is also permitted for individuals with lactose intolerance. Milk substitutions such as soy beverage and tofu are unsuitable for people with soybean allergies.
SOURCES: USDA/FNS, 2011, 2014.

restriction, stillbirth, low birthweight, or a small for gestational age infant (Saccone et al., 2015). An Academy of Nutrition and Dietetics (AND) systematic review indicated that women with undiagnosed celiac disease who follow a gluten-free diet have an increased risk of adverse pregnancy outcomes (evidence graded as fair) (AND, 2006).

Delayed introduction of wheat proteins to the diet was once thought to prevent or delay the onset of the disease (Norris et al., 2005). However, results from a recent study and meta-analysis suggest that the time to first introduction of gluten into the diets of infants is not an independent risk factor for developing celiac disease by 5 years of age (Aronsson et al., 2015; Szajewska et al., 2015). Additional research may be needed on the optimal timing and amount of introduced foods containing gluten (Lebwohl et al., 2015).

Treatment for celiac disease includes lifelong avoidance of wheat, barley, and rye. Individuals with symptoms for celiac disease should be tested and, if positive, receive detailed nutritional counseling on gluten avoidance, because even milligram levels in the diet can have severe long-term health consequences (Rubio-Tapia et al., 2013). Because gluten-free grains (e.g., rice, potato flour, tapioca flour, corn) are not typically fortified, gluten-free diets may be low in iron and folate, as well as dietary fiber (Thompson, 2000). Nutrients of particular concern for pregnant women who follow a gluten-free diet include carbohydrates, iron, folic acid, niacin, calcium, phosphorus, zinc, and fiber (AND, 2014).

WIC food package options for individuals with celiac disease As of 2009, the majority of states (96 percent) offered a non-wheat option for the "whole wheat bread" food category that is suitable for gluten-free diets (USDA/FNS, 2011). The final rule for the WIC food packages does not require that states provide a gluten-free option for cereals, although the provision allows state agencies to offer corn or rice-based cereals which may be appropriate for participants who must avoid gluten (USDA/FNS, 2014). Such cereals are not necessarily certified as gluten-free, however, and gluten content may not fall under the U.S. Food and Drug Administration (FDA) limit of 20 parts per million of gluten that is tolerated by most individuals with celiac disease (21 C.F.R. § 101). Individuals with non-celiac gluten sensitivity (NCGS) may also benefit from these non-wheat options (see section on NCGS that follows). Table 8-1 indicates the currently available WIC foods and substitutions that meet the dietary needs of individuals who must or choose to avoid gluten.

Non-Celiac Gluten Sensitivity

NCGS is defined as the occurrence of gastrointestinal symptoms after the ingestion of wheat-containing foods in the absence of celiac disease or wheat allergy. Because there is no biomarker for gluten sensitivity, NCGS is not clinically diagnosable and is generally self-diagnosed (Branchi et al., 2015; Elli et al., 2015; Lebwohl et al., 2015). DiGiacomo et al. (2013) reported a 0.55 percent prevalence of NCGS in NHANES 2009–2010, although gluten-free diets may have become more prevalent since then. Additional studies are needed to understand the etiology and underlying physiology of NCGS (Husby and Murray, 2015).

The AND has not issued guidance for dietary practices related to the mitigation of NCGS. WIC nutritionists may counsel individuals self-diagnosing with NCGS to clinically test for possible celiac disease and to ensure dietary adequacy of micronutrients (also see Rubio-Tapia et al., 2013).

WIC food package options for individuals with NCGS As mentioned above, Table 8-1 indicates the currently available WIC foods and substitutions that meet the dietary needs of individuals who choose to avoid gluten.

Lactose Intolerance

Lactose intolerance is a set of symptoms caused by lactase deficiency. Its prevalence varies greatly by racial and ethnic background, with primary lactase deficiency being nearly 100 percent in Asian and American Indian, 60 to 80 percent in black and Ashkenazi Jewish, and 50 to 80 percent in Hispanic subgroups. Lactose intolerance is rare in individuals of generally northern European descent. In Hispanic, Asian, and black children, evidence of lactase deficiency can appear before the age of 5; in white children, symptoms often appear after age 5 (Heyman et al., 2006). The condition can be diagnosed by a lactose challenge and breath test.

Individuals with lactose intolerance may be able to consume small amounts of dairy products (up to 8 ounces of milk or yogurt at one time) (Suarez et al., 1995, 1997; Lomer et al., 2007) or specific forms of dairy products (e.g., natural cheddar cheese contains 0.18 percent lactose, whereas skim milk contains 5.09 percent lactose [USDA/ARS, 2014]), although nutrition education might be necessary to ensure adequate calcium intake.

Food package options for individuals with lactose intolerance Table 8-1 also indicates the currently available WIC foods and substitutions that meet the dietary needs of individuals who choose to avoid lactose. Of note, there is no substitution for cheese for participants unable to tolerate that quantity of lactose.

VARYING FOOD PREFERENCES AND PRACTICES

The committee considered how WIC food packages accommodate preferences for vegetarian and vegan diets and food-related religious practices (e.g., Kosher and Halal diets). This section summarizes the committee's evaluation of evidence supporting inclusion of foods in the packages that adhere to these practices.

Vegetarian or Vegan Diets

Several authoritative bodies hold the position that, when carefully planned, plant-based diets can be nutritionally adequate for infants, children, and adults. A vegetarian diet does not include animal flesh foods (i.e., meat, fish, seafood), but does include other animal products (e.g., eggs, milk, cheese, yogurt), whereas a vegan diet excludes all animal foods and products. In 2015, the Dietary Guidelines Advisory Committee developed and evaluated a healthy vegetarian food pattern and found that it can meet nutrient intake needs for individuals ages 2 years and older (USDA/HHS, 2014). Individuals who consume a vegan diet should pay particular attention to their intakes of vitamins B12 and calcium, but their requirement for these nutrients can be met by consuming fortified foods (AND, 2014). If no eggs are consumed (as in a vegan diet), intake of eicosapentaneoic (EPA) and docosahexaenoic acids (DHAs) may be low (AND, 2015). The position of AND is that both vegetarian and vegan diets are not only adequate, but may promote the prevention or aid in the treatment of certain health conditions (AND, 2009).

The WIC food package includes several foods that by nature are compliant with vegetarian and vegan diets, including fruits, vegetables, legumes, peanut butter, and grains. However, there are currently no vegetarian/vegan substitutions for fish and no vegan substitutions for eggs or cheese (see Table 8-1). The proportion of the WIC population that prefers these types of diets is unknown, but 2012 estimates indicated that approximately 5 percent of Americans considered themselves vegetarian and 2 percent vegan (Newport, 2012).

With respect to infant feeding practices, AAP supports the provision of soy protein-based formulas in cases where an infant's caretaker prefers to provide a vegetarian diet (as well as in cases where an infant does not tolerate cow's milk formula) (Bhatia et al., 2008; AAP, 2014). A potential nutrition-related health challenge for these infants is ensuring adequate iron intake. As described in Chapter 6, the introduction of complementary foods to infants at approximately 6 months of age is recommended, in part, to ensure adequate iron intake, with AAP (2014) encouraging early introduction of red meats and other foods rich in iron. A vegetarian or vegan substitution for infant meat is not currently permitted in the WIC food packages. AAP (2014) further recommends that oral iron supplementation is appropriate for infants 6 to 12 months of age who are not consuming the recommended amount of iron from formula and complementary foods.

Kosher or Halal Diets

Regarding the extent to which the 2009 revised food packages accommodate food-related religious practices, some states offer options for Kosher or Halal foods prepared in accordance with Jewish and Islamic dietary laws, respectively. Eliasi and Dwyer (2002) provide a detailed description of Kosher and Halal diets. Very generally, for Kosher diets, meats must be prepared a certain way, animal products must come from Kosher-prepared animals, and packaged foods must be Kosher-certified. Fruits and vegetables are considered inherently Kosher. To be considered Halal, meats must be prepared in a particular way and milk and foods prepared from milk must come from Halal animals. With respect to the WIC food packages, although federal regulations do not specify any requirement for availability of food that meet the needs of individuals who follow either of these diets, states have the option to accommodate these individuals. In 2009, 34 percent of WIC participants nationwide had the option to purchase Kosher items, 19 percent had the option to purchase Kosher or Halal foods, and 27 percent were allowed no substitution (see Table 8-2) (USDA/FNS, 2011; personal communication, N. Cole, Mathematica, March 17, 2015). A 2015 update of state options indicated that 7 percent of state agencies allowed Kosher milk, 100 percent of state agencies did not specify whether they allowed Kosher eggs, 92 percent did not specify whether Kosher juice was allowed, and 8 percent did not allow Kosher juice. No additional data were available for other Kosher options, and an update of the national availability of Halal options was not presented (USDA/FNS, 2015b). There were no available data on requests for Kosher or Halal foods either among WIC participants in general or in states in which these foods are available.

TABLE 8-2 Authorization of Kosher and Halal Substitutions

Substitutions Offered for WIC Foods	WIC State Agencies Authorizing Substitutions (%)	Nationwide WIC Participants Covered by the Option (%)*
Kosher	17	34
Kosher and Halal	6	19
No Substitutions	42	27
Not Specified	36	19

NOTES: Results were obtained from a database of WIC food lists for all 90 state agencies as of October 2009, as well as foods that were approved in the period immediately preceding implementation of the interim rule. WIC state plans, vendor manuals, and grocery shopping guides were also reviewed. The most recent WIC Food Packages Policy Options Study (USDA/FNS, 2015b) did not quantify the number of state agencies allowing Kosher and Halal options nationally. The report indicated that 7 percent of state agencies covering 21.3 percent of WIC participants allowed Kosher milk.

* Percentages represent the number of WIC participants linked to the state agencies offering the option.

SOURCE: USDA/FNS, 2011. WIC Food Packages Policy Options Study, with update from personal communication with N. Cole, Mathematica, March 17, 2015.

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9

Background and Approach to Considering Food Package Options

Chapters 4, 5, and 6 of this report summarized the committee's evaluation of nutrient intake, food intake, and health status of Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) participants. This information helped the committee to identify dietary gaps and food priorities for consideration during its phase II deliberations. Additionally, the committee was tasked with considering six other factors to support recommendations in phase II:

1. The role of the WIC food packages as intended by the U.S. Department of Agriculture's Food and Nutrition Service (USDA-FNS),
2. The 2015 *Dietary Guidelines for Americans* (DGA) (here, the *Scientific Report of the 2015 Dietary Guidelines Advisory Committee* [2015 DGAC report] recommendations),
3. Science supporting the health benefits of functional ingredients in infant formulas and also foods,
4. The infant formula regulatory and market landscape,
5. Choice and flexibility within food packages, and
6. Cost.

This chapter summarizes the committee's approach to considering each of these factors.

THE ROLE OF THE WIC FOOD PACKAGES

First, the committee reviewed the intended role of the WIC food packages as a supplemental program that promotes optimal health and development, supports breastfeeding, prevents food insecurity, and reinforces nutrition education messages. This section describes each component of this role in detail and its relevance to the committee's charge, using information collected through a literature and report review. A description of the committee's literature search methodology was provided in Chapter 3.

The Role of the WIC Food Packages as a Supplemental Program to Promote Optimal Health and Development

WIC was designed to be a supplemental food program. The definition of supplemental in this context has evolved since the program's inception (see Appendix T). Most recently, as mentioned in Chapter 1, the 2007 interim rule defined supplemental foods as:

> those foods containing nutrients determined by nutritional research to be lacking in the diets of pregnant, breastfeeding, and postpartum women, infants, and children, and foods that promote the health of the population served by the WIC program as indicated by relevant nutrition science, public health concerns, and cultural eating patterns, as prescribed by the Secretary in § 246.10.[1]

USDA-FNS's task to the committee, as stated in Box 1-1 of Chapter 1, covers all components of this definition (i.e., nutrition, health, breastfeeding practices, and cultural norms of the WIC population), and all committee activities were (and will be, in phase II) conducted with an awareness of the intended supplemental nature of the food packages.

The Role of the WIC Food Packages in Supporting Breastfeeding

The primary way that the WIC program has endorsed and supported breastfeeding is through its "Loving Support" initiative (USDA/FNS, 2015a). Drawing on less than 5 percent of the WIC program's overall budget (NWA, 2014), Loving Support is a social marketing effort that promotes breastfeeding to mothers, builds family and community support for breastfeeding women, and serves as the home for WIC's breastfeeding peer counseling program that operates across the vast majority of local WIC agencies (USDA/FNS, 2015a,b). In addition to Loving Support, WIC supports breastfeeding by providing women who choose to breastfeed fully with substantially

[1] 95th Congress. 1978. Public Law 95-627, § 17: Child care food program.

enhanced food packages, compared to packages received by women who breastfeed only partially or feed infant formula exclusively. As an additional incentive, breastfeeding women in WIC may participate for up to 1 year, whereas mothers who formula feed may participate only for up to 6 months postpartum. Additional details about breastfeeding trends, barriers, and promotion in the WIC population were provided in Chapter 7.

The Role of the WIC Food Packages in Preventing Food Insecurity

The 2015 DGAC report identified food insecurity as one of three significant nutrition-related health issues facing the U.S. population (USDA/HHS, 2015). Food insecurity occurs when individuals or families lack consistent access to enough food of adequate nutritional value for an active and healthy life.

National Prevalence of Food Insecurity

USDA assesses the prevalence of food security on an annual basis using an 18-item food security module that is administered as a supplement to the nationally representative Current Population Survey (CPS) (USDA/ERS, 2015b). The food security survey sampled 43,253 households in 2014 representative of the U.S. population and comprised a series of questions about behaviors and experiences that could indicate food insecurity, including inability to afford balanced meals and hunger due to inability to afford food. Household food security status was assigned based on the number of food insecurity indicators reported. Rates of food insecurity have been relatively stable since 2008. As detailed in the most recent assessment, 14.0 percent of all U.S. households experienced food insecurity at some point in 2014. Households with children were at higher risk. About one in five (19.9 percent) households with children less than age 6 experienced food insecurity. Food insecurity was higher among African American (26.1 percent) and Hispanic (22.4 percent) households, compared to white, non-Hispanic households (10.5 percent). Among low-income households (incomes below 185 percent of the federal poverty level), the prevalence of food insecurity was 33.7 percent.

Health and Social Effects of Food Insecurity

Research has shown that food insecurity is associated with the risk of a broad range of social and health consequences. These consequences include decreased food and nutrient intakes (Tarasuk, 2001), obesity (Larson and Story, 2011), increased rates of iron deficiency and anemia (Skalicky et al., 2006), maternal depression (Siefert et al., 2001), poorer health (Siefert et al., 2001; Cook et al., 2004), and increased hospitalizations (Cook et al., 2004). Food insecurity may delay infant and toddler development (Rose-Jacobs et al., 2008) and have adverse effects on children's academic performance and social skills (Jyoti et al., 2005). Specific to pregnancy outcomes, food insecurity has been associated with pregravid obesity, higher gestational weight gain, higher adequacy of weight gain ratio, low birth weight, and gestational diabetes (Ivers and Cullen, 2011). Recent studies conducted among the WIC population have found that those who live in food-insecure households score lower on mental health scales (Matthews et al., 2010), have lower diet quality (Kropf et al., 2007; Mathews et al., 2010), and are more likely to exhibit child feeding styles that are associated with development of childhood obesity (Gross et al., 2012). WIC children who live in food-insecure households may be at higher risk of being overweight or obese (Metallinos-Katsaras et al., 2011, 2012).

Relationship Between WIC Participation and Food Insecurity

Inasmuch as the WIC program is only one policy instrument used in the national effort to reduce or prevent food insecurity in the United States, it is challenging to evaluate its independent contribution to this effort. This is because much of the literature that assesses the possible role of WIC in preventing food insecurity suffers from critiques about confounding (other factors that are associated with both WIC use and food insecurity), selection bias, reverse causality, or other concerns. The committee reviewed the literature to identify studies that examined the link between WIC participation and food insecurity while accounting for selection or other possible sources of bias to the estimated effects of WIC. Only one such study was identified (Kreider et al., 2016). The committee acknowledges the body of literature that examines the effects of other food assistance programs and demonstration projects on household food insecurity and related outcomes, such as food distribution among household members. However, it was beyond the committee's charge to conduct a comprehensive review of this literature.

Kreider et al. (2016) examined the effect of WIC on food insecurity among infants and children using data from the 1999–2008 National Health and Nutrition Examination Survey (NHANES) and applied methods that control for selection bias (see Chapter 3 for a discussion of selection bias), as well as the under-reporting of WIC in household surveys. Specifically, they examined data from 4,614 infants and children less than the age of 5 who lived in households with incomes below 185 percent of the federal poverty threshold and measured food security status using the 18-item module. Under nonparametric assumptions about the nature of the selection and misreporting, they found that WIC participation reduced the prevalence of food insecurity by 20 percent, while other assumptions led to smaller effects.

The Potential of the WIC Food Packages to Affect Food Insecurity

WIC may improve food security by increasing access to healthy foods. However, the relationship between food security and participation in nutrition assistance programs such as WIC is complex, and is difficult to capture in the cross-sectional survey that is used to monitor food security in the United States. Inasmuch as WIC provides food and nutrition education, one might expect that households that participate in WIC would have lower rates of food insecurity than comparable households that do not participate in the program. On the other hand, if food insecurity leads households to enroll in WIC, the proportion of households that are food insecure may be higher among participants than nonparticipants. (Again, see the discussion in Chapter 3 on selection bias and how it limits interpretation of results from WIC-only studies or comparisons of WIC and non-WIC participants.) Indeed, among WIC-eligible households in 2014,[2] 41.1 percent of households that received WIC benefits were food insecure and 32.1 percent of households that did not receive WIC benefits were food insecure (USDA/ERS, 2015b). Similar patterns were observed among households eligible for the Supplemental Nutrition Assistance Program (SNAP) and the National School Lunch Program (NSLP), and comparable patterns have been observed among WIC participants and nonparticipants in smaller, local studies (Burkhardt et al., 2012; Odoms-Young et al., 2014).

The Role of the WIC Food Packages in Nutrition Education

Nutrition education is key in supporting WIC participants' choices to purchase healthy foods, prepare those foods in a healthful manner, and consume them as part of a diet in alignment with the DGA. Indeed, WIC is the only federal supplemental nutrition assistance program to have a nutrition education component required by law (as specified in sections 17(b)(7), 17(f)(1)(C)(x), and 17(j) of the Child Nutrition Act of 1966, as amended, and the federal WIC regulations in sections 246.2 and 246.11 [NARA, 2007]). Under these regulations, WIC nutrition education must "be available at no cost to participants, be easily understood by participants, bear a practical relationship to the participant's nutritional needs, household situation, and cultural preferences, and be designed to achieve the regulatory nutrition education goals" (USDA/FNS/NAL, 2006).

[2] Household income below 185 percent of poverty and WIC recipients meeting other eligibility requirements.

WIC state agencies have the responsibility to develop educational materials aligned with these federal requirements (USDA/NAL, 2006). In addition, the food packages themselves provide foods that serve as a tool to meet the dietary goals of the DGA and around which education can be designed.

Results from multiple studies document the effect of WIC nutrition education on participant knowledge, attitudes, and behavior change (USDA/ERS, 2007; Kavanagh et al., 2008; Ritchie et al., 2010; USDA/FNS, 2010; Sullivan et al., 2011; Whaley et al., 2012a,b; Hildebrand et al., 2014; Isbell et al., 2014). In California, Ritchie et al. (2010) demonstrated that nutrition education alone led to increased consumption of low-fat milk and whole grains even before the 2009 changes to the WIC food packages took place. Following the policy change, consumption of these foods increased further (Whaley et al., 2012a). A study of the effect of the 2009 breastfeeding food package change on rates of breastfeeding (Whaley et al., 2012b) demonstrated significant increases in exclusive breastfeeding in the 6 months prior to the policy change, when staff training and participant education focused on exclusive breastfeeding and the upcoming policy changes. Similar changes were not evident in other states where staff training and participant education specific to the breastfeeding food package changes were not a focus prior to the food package change. These studies suggest that the maximum intended health impact of the WIC food package and 2009 revisions is linked to staff training and participant education.

DIETARY GUIDANCE AND FOOD PACKAGE OPTIONS

Although recommended revisions in the WIC food packages for individuals ages 2 years and older will align with the 2015 DGA, those guidelines were not released during the committee's phase I deliberations. For this report, the committee relied on recommendations in the 2015 DGAC report, on which the 2015 DGA will be based (USDA/HHS, 2015). For infants and children less than 2 years old, the committee relied on guidance issued by the American Academy of Pediatrics (AAP) and other authoritative bodies. The bulk of this section (1) summarizes findings from the 2015 DGAC report on nutrient and food intake inadequacies and excesses in the U.S. population at large, (2) compares these findings to findings from the committee's analyses of nutrient and food intake in WIC and low-income subgroups (as detailed in Chapters 4 and 5), and (3) considers the role of the WIC food packages in providing these foods and nutrients. The section ends with a summary of dietary guidance for individuals less than 2 years old.

Findings from the 2015 DGAC Report: Inadequacies to Excesses

As mentioned in Chapter 1, the 2015 DGAC report stated that several nutrients are under-consumed (relative to their Dietary Reference Intakes [DRIs]) by the U.S. population ages 2 years and older (USDA/HHS, 2015). These "shortfall" nutrients include vitamins A, D, E, and C; folate; calcium; magnesium; potassium; and fiber (see Table 1-6). For adolescent and premenopausal females, iron is also a shortfall nutrient. Of the shortfall nutrients, calcium, vitamin D, fiber, and potassium are also classified as nutrients of "public health concern" because under-consumption of these nutrients is linked with adverse health outcomes. Iron is included as a nutrient of public health concern for adolescent and premenopausal adult females because of increased risk of iron deficiency for these groups. The 2015 DGAC report also identified two nutrients—sodium and saturated fat—that pose health risks because of overconsumption (USDA/HHS, 2015). Added sugars were also identified as a nutrient that is overconsumed and should be limited (USDA/HHS, 2015).

With respect to food intakes, the 2015 DGAC report found that the majority of the U.S. population is consuming less than the recommended intakes of vegetables, fruits, whole grains, and dairy, all of which are important food sources of the shortfall nutrients (USDA/HHS, 2015). Intakes of refined grains exceed recommendations. Children between the ages of 2 to 5 years, however, do consume the recommended amounts of fruit and dairy. Given that WIC served approximately 28 percent of U.S. children ages 2 to less than 5 years in 2012 (U.S. Census Bureau, 2013; USDA/FNS, 2013), it is likely that the WIC food packages contribute to these population estimates of both nutrient and food group intakes. The committee's NHANES analysis of nutrient intakes comparing children participating in WIC with children eligible for WIC but not participating provides further insight (see Chapters 4 and 5).

Dietary Guidance for Specific Food Groups Applicable to the WIC Food Packages

Here, food groups that are under-consumed based on the 2015 DGAC report are considered first (vegetables and whole grains for women and children and fruit and dairy for women), followed by foods for which consumption is important but are not considered to be of concern in the 2015 DGAC report (protein foods). For ease of reference, Table 9-1 provides a summary of the 2015 DGAC report's major food group categories and examples of one serving equivalents in each category (similar information for food subgroups can be found in Appendix T, Table T-1).

TABLE 9-1 2015 DGAC Major Food Groups, Definitions, and Serving Examples

Food Group	Definition and Unit	Examples of 1 Serving Equivalent
Fruits	Total intact fruits (whole or cut) and fruit juices (c-eq)	1 c raw or cooked fruit; 1 c fruit juice
Vegetables	Total dark green, red and orange, beans and peas, starchy, and other vegetables (c-eq)	1 c raw or cooked vegetables
Grains	Total whole and refined grains (oz-eq)	1/2 c cooked rice, pasta; 1 slice bread
Whole grains	Grains defined as whole grains and contain the entire grain kernel—the bran, germ, and endosperm (oz-eq)	1/2 c cooked whole grain rice, pasta; 1 slice whole grain bread
Protein foods	Total meat, poultry, organ meat, cured meat, seafood, eggs, soy, and nuts and seeds, tofu, peanut butter, beans (oz-eq)	1 oz meat, poultry, fish; 1 egg; 1/2 oz nuts or seeds
Dairy	Total milk, yogurt, cheese, and fortified soy milk (c-eq)	1 c milk; 1–2 oz cheese
Oils	Fats naturally present in nuts, seeds, and seafood; unhydrogenated vegetable oils, except palm oil, palm kernel oil, and coconut oil; fat present in avocado and olives above the allowable amount; 50 percent of fat present in stick and tub margarines and margarine spreads (grams)	1.5 g per 100 g in olives and avocados; 100 g per 100 g in vegetable oil; 60 g per 100 g in tub margarine
Solid fats	Fats naturally present in meat, poultry, eggs, and dairy (lard, tallow, and butter); fully or partially hydrogenated oils; shortening; palm, palm kernel, and coconut oils; fats naturally present in coconut meat and cocoa butter; and 50 percent of fat present in stick and tub margarines and margarine spreads (grams)	100 g per 100 g in coconut or palm oil; 81.1 g of 100 g in butter
Added sugars	Foods defined as added sugars: honey, corn syrup, white sugar, brown sugar, fructose (tsp-eq)	1 tsp-eq of added sugars = 4 g of added sugars such as honey or corn syrup

NOTES: c-eq = cup equivalents; oz-eq = ounce equivalents; tsp-eq = teaspoon equivalents.
SOURCES: USDA/HHS, 2015; serving sizes from USDA/ARS, 2014b.

Vegetables

Vegetables are the source of many of the shortfall nutrients including nutrients of public health concern, including fiber, potassium, iron, folate, and vitamin A (USDA/HHS, 2015). According to the 2015 DGAC report, the U.S. population consumes few servings of vegetables. Specifically, at ages 1 to 3 years, only 10 and 15 percent of boys and girls, respectively, consumed the recommended amounts of vegetables (1 cup of vegetables per day) (USDA/HHS, 2015). According to the committee's analyses (see Chapter 5), even fewer (at most, 6 percent) of children participating in WIC or from low-income households ages 1 to less than 5 years consumed the recommended amounts of vegetables. These trends were similar among young adult females in the United States. Less than 10 percent of women ages 19 to 30 years met the recommendation for 2 to 3.5 cups per day, and at most, 4 percent of pregnant, breastfeeding, or postpartum women participating in WIC or from low-income households consumed this amount.

With respect to vegetable subgroups, again based on the 2015 DGAC report findings, more than 90 percent of individuals in the United States do not meet the recommended intakes for red and orange vegetables and more than 80 percent do not meet intake recommendations for dark greens, starchy vegetables, and dry beans and peas. Based on the committee's analyses, at least 74 percent of WIC participants and individuals from low-income households failed to meet recommended intakes of dark green vegetables. Intake of dry beans and peas was similarly poor for women in the committee's analysis, but higher for younger WIC participants and low-income populations than the general U.S. populations. The computation of intake of dry beans and peas was slightly different in the committee's analysis compared to that of the 2015 DGAC report.[3]

Vegetables in the WIC food packages WIC participants can acquire vegetables from the WIC food package either by choosing 100% vegetable juice with the juice allowance or by purchasing vegetables with the cash value voucher (CVV). Vegetable juice can be purchased within the same quantity limits allowed for fruit juice. The quantity of vegetables that can be purchased with the CVV varies greatly depending on the vegetables selected and local price. Using national price data, the committee estimated that an $11 CVV would permit women to purchase 0.4 cup-equivalents of vegetables and 0.5 cup-equivalents of fruit per day in total, assuming that 50 percent of the voucher would be spent on fruits and 50 percent on

[3] In the 2015 DGAC report analysis, dry beans and peas are first applied to the total protein group until requirements for that group are satisfied, and the remainder is allocated as a vegetable. In the analysis for this report, dry beans and peas are allocated to the vegetable group only.

vegetables (see Table 1-7). This equates to approximately 16 percent of vegetable intake recommendations.

Whole Grains

Whole grains are good sources of several key shortfall nutrients, including fiber, iron, folate, magnesium, and vitamin A. The U.S. Food and Drug Administration (FDA) defines whole grains as "cereal grains that consist of the intact, ground, cracked, or flaked kernel, which includes the bran, the germ, and the inner most part of the kernel (the endosperm)" (FDA, 2009). If the kernel is no longer intact, the grain mixture must have the same relative proportions of bran, germ, and endosperm as the original grain, with the rationale that the balance of nutrients is maintained. The Whole Grains Council issues two related stamps (symbols placed on food packaging). Products eligible for the "100% Whole Grain" stamp must contain at least 16 g of whole grains per serving. Products eligible for the "Whole Grain" stamp must contain at least 8 g of whole grains per serving (Oldways Whole Grains Council, 2013). Examples of whole grains include brown rice, popcorn, bulgur, whole wheat, oats, and barley. Whole grain product availability in the marketplace has grown substantially, from approximately 360 new product introductions in 2005 to more than 900 new product introductions in 2012. Whole grain product innovations in the marketplace include whole grain ready-to-eat cereals, pancakes, French toast, breads, pasta, crackers, snacks, wraps, entrees, and pizza crusts (Mintel International, 2012).

The 2015 DGAC report included the recommendation that half of all grain intake come from whole grains and reported that, overall, whole grain intake of the U.S. population is too low (nearly 100 percent of women 19 to 50 years of age had intakes below recommendations). Intake of refined grains, in contrast, is too high. The same was the case for all subgroups analyzed in this report (see Chapter 5).

Whole grains in the WIC food packages Whole grains in the WIC food packages may come from either the whole wheat bread or breakfast cereal food categories. Whole grains must be the primary ingredient by weight in all whole grain bread products, and all whole grain bread products must conform to the FDA standard of identity specifying that "whole wheat flour" and/or "bromated whole wheat flour" are the only flours that can be listed in the ingredient list (USDA/FNS, 2015c). WIC food package substitutions permitted for whole grain bread include brown rice, bulgur, oats, and whole grain barley, pasta/macaroni, and tortillas (USDA/FNS, 2014). For the WIC cereals food package category, at least 50 percent of breakfast cereals on state agency food lists are required to contain a whole grain as the primary ingredient. This parallels the National School Lunch and Breakfast programs requirements that half of the grains offered during the school week must meet the whole grain rich criteria[4] (USDA/FNS, 2012a). All foods in both the whole wheat bread and breakfast cereal categories must meet FDA labeling requirements for making a health claim as a whole grain food of moderate fat content (FDA, 2003; USDA/FNS, 2011). In terms of what participants may ultimately redeem, options in the whole wheat bread category must be whole grain, but options selected for breakfast cereals from the state-authorized food lists may or may not be whole grain.

As noted in Chapter 6, the FDA does not require fortification of whole grain products with folic acid. For example, "bread, whole wheat, commercially prepared" (from the USDA Standard Reference Database, Release 27 [USDA/ARS, 2014a]) provides 12 μg of dietary folate equivalents (DFE) per ounce, whereas "bread, white, commercially prepared" provides 48 μg DFE per ounce. Assuming that grain intake of women in the NHANES analysis conducted for this study was 100 percent bread (realizing that in reality it is a combination of different grain-based foods), current daily intake of folate from whole grains would be 7.2 μg DFE and, from refined grain sources, 313 μg DFE. If all grain intakes were changed to whole grain sources, total daily intake (from grains) would drop from 321 to 86 μg DFE. Thus, there is a trade-off between increasing consumption of whole grains versus increasing consumption of folic acid from enriched, but not whole grain, products.

Fruits (Including Fruit Juice)

According to the 2015 DGAC report, fruit contributes substantial amounts of fiber and potassium, two nutrients of public health concern. The majority of children 1 to 8 years of age in the general U.S. population meet recommended intakes for total fruit (1 cup and 1.5 cups per day, respectively). However, few adult women consume the recommended daily amount (2.5 cups per day). More than half the fruit intake for Americans 1 year of age and older comes from whole fruit. Fruit intake is composed of slightly less whole fruit for children ages 1 to 3 years of age. In the analyses conducted for this report, children ages 2 to less than 5 years in both the WIC and low-income subgroups consumed approximately half the recommended fruit intakes (including 100% juice), and women (pregnant, lactating, or postpartum) consumed even less.

[4] "Foods that qualify as whole grain-rich for the school meal programs are foods that contain 100 percent whole grain or contain a blend of whole-grain meal and/or flour and enriched meal and/or flour of which at least 50 percent is whole grain" (USDA/FNS, 2012a).

Recommendations specific to fruit juice The fruit category in the 2015 DGAC report includes both whole fruit and 100% fruit juice (see Box 9-1 for the regulatory definition of 100% fruit juice), with 1 cup (8 ounces) of 100% fruit juice being equivalent to 1 cup of whole fruit (USDA/HHS, 2015). Although whole fruit is not distinguished from 100% fruit juice in either the 2010 DGA or the 2015 DGAC report, the 2010 DGA recommended limiting the amount of 100% juice consumed in place of whole fruit given the lack of fiber and potential to contribute excess calories to the diet (USDA/HHS, 2010). Likewise, the AAP recommends that 100% fruit juice be limited to 4 to 6 ounces per day for children ages 1 to 6 years (AAP, 2014). The AAP rationale was that 100% fruit juice is easily overconsumed because it tastes good, but it lacks the fiber contained in whole fruit and offers no nutritional advantages over whole fruit. For infants younger than 6 months, the AAP recommends no juice be provided (AAP, 2014). Its rationale was to avoid displacement of other key nutrients from human milk, formula, or complementary foods.

In the analyses presented in Chapter 5, children ages 2 to less than 5 years had a mean usual intake of fruit of 1.43 c-eq per day (compared to a recommended intake of 1.19 c-eq per day). Applying the 2015 DGAC report estimate that approximately 42 percent of fruit intake is from juice (USDA/HHS, 2015), this equates to approximately 0.6 cup-equivalents of juice per day, which falls within the AAP recommended limit of 4 to 6 ounces per day.

Fruit juice and health Although the 2015 DGAC report did not review the effect of fruit juice on health, several groups have conducted evidence-based reviews to examine the impact of 100% juice consumption on health. They

BOX 9-1

Regulatory Definition of 100% Juice

1. Juices expressed from a fruit or vegetable (i.e., not concentrated and reconstituted) shall be considered to be 100% juice.
2. Single-strength juice should contain at least the minimum Brix level specified by the U.S. Food and Drug Administration. (A Brix level indicates the sugar content of an aqueous solution. One degree Brix equates to 1 g of sucrose in 100 g of solution and represents the strength of the solution as a percentage by mass.)

SOURCE: NARA, 2014f.

failed to find a link with the risks of developing either type 2 diabetes (Xi et al., 2014) or childhood obesity unless the portion sizes were large (AND, 2014). The results of other reviews suggest potential positive effects of consumption of 100% juice on a number of health outcomes, including cancer, cardiovascular disease, cognition, hypertension, urinary tract infections, and disease-related processes (i.e., inflammation, oxidation, platelet function, vascular reactivity) (Coelho et al., 2013; Lamport et al., 2014; Hyson et al., 2015). Authors of the Academy of Nutrition and Dietetics review (AND, 2014) reported that children who consume 100% fruit juice tend to consume more calcium and potassium and are therefore at lower risk of inadequacy for these nutrients.

Fruit juice in the WIC food packages Fruit juice (100% only) is provided in the WIC food packages as a separate food category. The juice provided must adhere to the FDA standards of identity for fruit (NARA, 2014a) or vegetable juice (NARA, 2014b), be pasteurized and unsweetened, and contain at least 30 mg of vitamin C per 100 mL of juice. Vegetable juice may be reduced in sodium. The 2009 food package revisions eliminated juice for infants and reduced juice for children from 288 to 128 fluid ounces, which is the equivalent to 4 ounces per day, the lower end of the AAP recommendation (AAP, 2001) (see Table 9-2) . Currently, both children 1 to 4 years of age and women (depending on the food package) may receive up to 128 fluid ounces of juice, or the equivalent of 4.27 ounces per day, for a 30-day period. Andreyeva et al. (2013) evaluated the effect of the reduction in the juice allotment in the 2009 food packages on juice consumption in Connecticut and Massachusetts. They found that purchases of 100% juice declined by 25 percent in WIC households and were not offset by non-WIC funds used for additional juice or other beverages.

TABLE 9-2 American Academy of Pediatrics Recommendations for Fruit Juice Consumption

Age	Recommendation
Birth to 6 months	No fruit juice, unless used to relieve constipation
6 to 12 months	If juice is given, limit to 4 to 6 ounces (118 to 177 milliliters) per day and serve in a cup to avoid tooth decay
1 to 6 years	Up to 6 ounces (177 milliliters) per day
All children	Encourage to eat whole fruits to meet fruit intake recommendations

SOURCE: AAP, 2001.

Dairy

Dairy foods provide vitamin D, calcium, and potassium, all nutrients of public health concern. Consumption of dairy foods is associated with lower risk of diabetes, metabolic syndrome, cardiovascular disease, and obesity (USDA/HHS, 2015). Dairy foods in the USDA food patterns include fluid milk, cheese, yogurt, ice cream, milk-based replacement meals, and some nondairy milk products, including fortified soy milk, but not almond or other plant-based milk-type products. The 2015 DGAC report identified low- or nonfat dairy as part of a healthy dietary pattern. (A summary of evidence on the health effects of dairy fat is provided later in this chapter.) Among the U.S. population at large, dairy intake begins to decline in adolescence and persists at very low levels among adult females, with fewer than 5 percent of women consuming the recommended 3 cup-equivalents of dairy per day (USDA/HHS, 2015). In contrast, in the analyses for this report, dairy intakes were met by approximately 50 to 70 percent of WIC participant children and low-income children ages 1 to less than 5 years and an even greater proportion of women (86 to 92 percent).

Dairy in the WIC food packages In the WIC food packages, dairy foods include milk, cheese, and yogurt. The milk category includes several possible dairy substitutions (e.g., cheese, yogurt), depending on the state, and non-dairy substitutions (e.g., soy beverage, calcium-set tofu). The substitutions are intended to provide calcium when milk is not selected for the participant's food package. Currently, the U.S. population consumes similar amounts of milk and cheese (53 percent of dairy intake comes from milk and 45 percent comes from cheese) (USDA/HHS, 2015).

Protein Foods

Protein foods provide essential amino acids, and some protein foods are important sources of iron. As previously mentioned, iron is a nutrient of public health concern for adolescent and adult females. Meat foods in the protein group provide heme iron, which is more bioavailable than non-heme plant-derived iron. Heme iron is especially important for young children and pregnant women (USDA/HHS, 2015). Protein foods include meat, poultry, fish, seafood, eggs, soy, nuts, and seeds. Dairy foods also provide protein, but are part of a separate food group in the food patterns.

The 2015 DGAC report stated that nearly 80 percent of boys and 75 percent of girls ages 1 to 3 years meet or exceed the recommended intake of protein foods, approximately 60 percent of boys and girls ages 4 to 8 years also meet or exceed these recommendations, and approximately 40 percent of females ages 19 to 30 years meet the recommendation for intake of protein foods. (USDA/HHS, 2015). Most of the protein foods consumed across all age groups are from the meat, poultry, and eggs group. In the analyses presented in this report for WIC participants and low-income individuals, fewer than 20 percent of children ages 1 to less than 2 years and slightly less than 50 percent of children ages 2 to 5 years met recommended intakes for total protein foods. For women, approximately 30 to 40 percent met recommended intake amounts. Intakes of seafood and nuts, seeds, and soy were very poor across all age groups.

Protein foods in the WIC food packages Protein foods are included in several WIC food categories, including peanut butter (which can be substituted with legumes), eggs, fish, and infant (baby food) meats. Protein is also provided by milk and some milk food package substitutions and cheese.

Nutrients to Limit: Saturated Fat, Sodium, and Added Sugars

In addition to identifying many shortfall nutrients, the 2015 DGAC report identified several "nutrients to limit," namely saturated fat, added sugars, and sodium. This section summarizes the 2015 DGAC report's findings related to these three nutrients, the committee's findings for WIC and low-income populations (detailed in Chapter 4), and the role of the WIC food packages in providing these nutrients (see Table 9-3). The 2015 DGAC report's changes to recommended cholesterol intakes are also covered in this section.

Saturated Fat

Although the 2015 DGAC report did not include an upper limit for total fat intake, recommendations included replacing saturated fats with polyunsaturated alternatives and replacing solid animal fats with non-tropical vegetable oils and nuts (USDA/HHS, 2015). Additionally, the 2015 DGAC report noted, "a potential approach to increasing intake of shortfall nutrients and nutrients of public health concern while simultaneously decreasing intake of overconsumed nutrients of public health concern would be to increase intake of fat-free or low-fat fluid milk in lieu of cheese" (USDA/HHS, 2015, p. 108). Major sources of saturated fat in the American diet include mixed dishes (burgers, pizza, sandwiches, and tacos), snacks and sweets, protein foods (meats, deli and cured meats, and poultry), and dairy (higher-fat milk, yogurt, and cheese) (USDA/HHS, 2015).

Since 2012 the National School Lunch Program (a federal nutrition assistance program that is also required to align with dietary guidance) has required that all milk served in schools be low fat or fat free and, if flavored, fat free (USDA/FNS, 2012b). Similarly, the current WIC food package

TABLE 9-3 Sodium, Saturated Fat, and Added Sugars Content of Representative Currently Allowable WIC Foods

Food Option	Sodium (mg)[a]	Percentage of the 2015 DGAC Report Daily Recommendation[b]	Solid Fat[c] (g)	Percentage of the 2015 DGAC Report Daily Recommendation	Added Sugars (g)[d]	Percentage of the 2015 DGAC Report Daily Recommendation
Milk, skim, 1 c-eq	103	4.5	0.1	0.8	0.0[e]	0.0
Milk, 1%, 1 c-eq	108	4.7	1.6	8.9	0.0	0.0
Cheese, 1 ounce[f]	183	8.0	5.5	30.6	0.0	0.0
Yogurt, plain, low fat, 1 c-eq	172	7.5	2.5	13.9	0.0	0.0
Yogurt, vanilla, low fat, 1 c-eq	162	7.0	2.0	11.0	16.6*	51.6*
Tofu, 1 oz-eq	9	0.4	0.9	4.8	0.0	0.0
Soy milk, 1 c-eq	115	5.0	0.5	2.8	0.0	0.0
Egg, 1 oz-eq (1 egg)	71	3.1	1.6	8.9	0.0	0.0
Cereal, oat flakes with almonds, 1 oz-eq[g]	118	5.1	0.2	1.3	5.4	16.8
Instant oats, 1 oz-eq	62	2.7	0.4	2.1	0.0	0.0
Whole wheat bread, 1 oz-eq (1 slice)	73	3.2	0.1	0.7	0.0	0.0
Canned light tuna, packed in water, 1 oz-eq	70*	3.0*	0.1*	0.2*	0.0	0.0
Canned light tuna, packed in oil, 1 oz-eq	118*	5.1*	0.4*	1.6*	0.0	0.0
Canned pinto beans, 1 c-eq	41	18.2	0.3	1.6	0.0	0.0
Peanut butter, salted, 1 oz-eq (1 T)	68	3.0	1.6	8.9	1.0*	2.9*

NOTES: c-eq = cup-equivalents; DGAC = *Report of the Dietary Guidelines Advisory Committee*; NA = not applicable; oz-eq = ounce-equivalents; T = tablespoon. Cup-equivalents and ounce-equivalents generally equate to consumer serving sizes. However, serving sizes may vary for processed consumer foods.

[a] The 2015 DGAC report recommendation for sodium is 2,300 mg/day for adults.

[b] The 2015 DGAC report recommendation is for total daily intake; therefore, the values should be interpreted in this context. "DGAC report daily recommendations" are based on a 2,200 kcal food pattern, which was the mean Estimated Energy Expenditure of WIC women in the NHANES analysis conducted for this report.

[c] The limit for solid fats for a 2,200 kcal food pattern is 18 g/day. Saturated fat was compared to the recommended limit for solid fats. The limit for solid fat for the 1,000–1,300 kcal weighted diet applied to children ages 1 to less than 5 years in this report was 7.8 g/day.

[d] Added sugars were calculated by subtracting naturally occurring sugar from total sugars. The limit for added sugars for a 2,200 kcal food pattern is 32 g/day. The USDA final rule permits ≤ 40 g total sugar per cup of yogurt and ≤ 6 g per ounce of breakfast cereal. The limit for added sugars for the 1,000–1,300 kcal weighted diet applied to children ages 1 to less than 5 years in this report was 13.6 g/day.

[e] Not applicable because the nutrient to limit is not present in the food, as allowed under the WIC program.

[f] Dairy equivalents of cheese range from 1 to 2 ounces. One ounce was selected as a conservative example.

[g] Serving sizes vary for processed consumer cereals. For example, an ounce-equivalent of cereal is 28.35 g according to the Food Patterns Equivalents Database 2011–2012, whereas the product label for the brand name cereal specifies a serving size of 32 g. Naturally occurring sugars accounted for 0.28 g in cereal.

* These values were corrected from the prepublication version of this report. Naturally occurring sugars in yogurt was corrected from 10.3 g to 17.3 g and for peanut butter was corrected from 0.76 to 0.67 g. Corresponding corrections were made to the amount of added sugars in "yogurt, vanilla, low fat," and in "peanut butter, salted." The contributions to the daily recommendation for added sugars were correspondingly lowered. Values for tuna were corrected from the prepublication version of this report, which were expressed per 100 grams of tuna instead of oz-equivalents.

SOURCES: Recommended intakes from the *Scientific Report of the 2015 Dietary Guidelines Advisory Committee* (USDA/HHS, 2015). Sodium, saturated fat, and added sugars amounts from the USDA National Nutrient Database for Standard Reference Release 27 (USDA/ARS, 2014a). Cup- and ounce-equivalents are per the Food Patterns Equivalents Database 2011–2012: Methodology and User Guide (USDA/ARS, 2014b).

allows only 1% or fat-free milk for individuals ages 2 years and older, and quantities of cheese were reduced in 2009 to a maximum of 1 or 2 pounds per month, depending on the food package. Rehm et al. (2015) modeled replacement of whole, reduced-fat, or flavored milk with plain low-fat or skim milk and found that replacement reduced intakes of energy and saturated fat and did not compromise calcium or potassium intakes. Table 9-3 illustrates that consumption of 1 ounce of cheese plus 1 cup of 1% milk per day provides approximately 40 percent of the recommended daily limit for saturated fat (18 g) for a 2,200 kcal food pattern.

Considerations for dairy fat Some emerging data suggest that dairy fat consumption may have different implications for health than other types of saturated fats (Holmberg and Thelin, 2013; Kratz et al., 2013, 2014; Scharf et al., 2013; Da Silva et al., 2014; Yakoob et al., 2014; DeBoer et al., 2015; Keast et al., 2015). This topic was not covered by the 2015 DGAC report because these data were just appearing in the published literature at the close of DGAC deliberations (Personal communication, A. Lichtenstein, Tufts University, as commented to the committee in their workshop held on March 12, 2015). The committee reviewed studies published since the DGAC 2015 completed their deliberations. Highlights are summarized here.

Kratz and colleagues (2013) reviewed 16 studies on the relationship between consumption of dairy fat or high-fat dairy foods and obesity or cardiometabolic disease. They found no positive associations between intake of dairy fat or high-fat dairy foods and either adiposity at baseline or adiposity over time. Most of the studies that they reviewed (11 of the 16) showed an inverse association between high-fat dairy consumption and indices of adiposity. Studies in which the relationship between high-fat dairy consumption and metabolic health was examined reported either an inverse or no association. The authors concluded that observational evidence does not support the hypothesis that either dairy fat or high-fat dairy foods contribute to either obesity of cardiometabolic risk. Keast and colleagues (2015) analyzed data from the 2005–2008 NHANES and found that despite greater energy and saturated fat intakes, dairy consumption was not associated with greater body weight or measures of adiposity. Scharf et al. (2013) examined 10,700 children at age 2 and 4 years participating in the Early Childhood Longitudinal Study-Birth Cohort (ECLS-B), a representative sample of U.S. children. Across racial, ethnic, and socioeconomic status subgroups, 1%/skim milk drinkers had higher body mass index (BMI) z-scores than 2%/whole milk drinkers. As the ECLS-B was an observational study, it is possible that reverse causality was an issue and the results may be a reflection of parents of children with higher BMIs being more likely to be counseled by their health care provider and more likely to adhere to recommendations to select low-fat milk. Scharf and colleagues (2013) speculated that one explanation for the inverse association with dairy fat and childhood adiposity may be that the presence of fat in milk may induce satiety and reduce the appetite for other energy-dense foods.

Added Sugars

Added sugars are sweeteners of various types added to foods (i.e., corn syrup, fruit juice concentrate, fructose, maltose, among many others), and do not include naturally occurring sugars such as those in 100% fruit juice or lactose in dairy products (USDA, 2015). The 2015 DGAC report recommended that added sugars not exceed 10 percent of total energy intake (USDA/HHS, 2015). Specifically, the 2015 DGAC report recommended replacing soft drinks and other sugar-sweetened beverages (including sports drinks) with nonfat milk to reduce the intake of added sugars and increase the intake of calcium, vitamin D, and magnesium (USDA/HHS, 2015). As discussed in Chapter 6, one concern with added sugars (and dietary carbohydrates in general) is the development of dental caries, particularly early childhood caries (ECCs).

Major sources of added sugars in the American diet include beverages (not including unflavored milk and 100% fruit juice), snacks and sweets, breakfast cereals and bars, and some dairy foods (such as flavored milks and sweetened yogurt). With few exceptions, foods with added sugars are generally not permitted in the WIC food package. However, although the FDA has issued a proposed rule, at present manufacturers are not required to label added sugars. Therefore, total sugars are limited in the WIC food specifications (USDA/FNS, 2014). Specifically, cereals may contain no more than 6 grams of sucrose and other sugars per dry ounce (a typical serving size), and yogurt must contain no more than 40 grams of total sugars per 1 cup (USDA/FNS, 2014). Fruited yogurts generally exceed the 40 g regulatory limit and are therefore not permitted for purchase. One serving of yogurt that meets WIC specifications (i.e., based on the USDA Standard Reference Database, Release 27 [USDA/ARS, 2014a]), for example low-fat vanilla yogurt, provides 52 percent of the recommended added sugars limit (32 g per day) for women consuming a 2,200 kcal diet. One serving of a breakfast cereal containing the limit of 6 grams of added sugars would contribute 19 percent of the recommended added sugars limit per day for an individual adhering to a 2,200 kcal diet.

Sodium

The 2015 DGAC report recommended lowering sodium intakes to less than 2,300 mg per day (USDA/HHS, 2015). Sodium is ubiquitous in the

U.S. food supply and is contained in many food categories, with the exception of fruits and fruit juices, which contain little sodium. The Centers for Disease Control and Prevention (CDC)-dubbed "salty six" food categories that contribute the most to sodium consumption among Americans include breads and rolls, cold cuts and cured meats, pizza, poultry, soup, and sandwiches (AHA/ASA, 2014). The 2015 DGAC report encouraged efforts to reduce sodium in prepared and processed foods, as well as in home cooking by using recipes with small amounts of sodium (USDA/HHS, 2015).

In the WIC food packages, sodium intake comes primarily from cheese, canned vegetables, and canned fish. It is otherwise limited in most other food categories, and lower-sodium options are generally encouraged (USDA/FNS, 2014). For some products, the low-sodium version costs more, which may affect inclusion of these products on state WIC food lists.[5] For example, the typical sodium content of a 1 ounce-equivalent serving of representative WIC cheese (cheddar) contributes 12 percent of the recommended sodium intake for women who consume a 2,200 kcal diet (see Table 9-3).

Cholesterol

Previously, the DGA recommended that cholesterol intake be limited to no more than 300 mg/day (USDA/HHS, 2010). The 2015 DGAC report did not make this recommendation; it stated that available evidence shows no appreciable relationship between consumption of dietary cholesterol and serum (blood) cholesterol. This position is consistent with recommendations made by the American College of Cardiology/American Heart Association (ACC/AHA, 2014). In addition, the 2015 DGAC report analysis of national survey data indicated that cholesterol was not overconsumed (USDA/HHS, 2015). Eggs, a primary source of cholesterol in the American diet, are currently included in the WIC food packages for children and women. Amounts were reduced in the 2009 revisions, primarily to allow room for additional foods and secondarily to reduce the total amount of cholesterol in the package (protein was not considered a priority nutrient) (IOM, 2006). Although cholesterol appears to be of less concern at this time, eggs also contain saturated fat (9 percent of the daily recommended limit per egg on a 2,200 kcal diet), which, as previously mentioned, is considered a nutrient to limit. The WIC food packages provide 0.4 eggs per day in all packages, with the exception of the package for fully breastfeeding women, which provides approximately 0.8 eggs per day.

[5] States may implement cost-containment practices in order to reduce the average food cost per WIC participant. This may include limiting food selection by branch, package size, form or price, or mandating the use of particular brands.

Dietary Guidance for Infants and Children 0 to 24 Months of Age

To establish a basis for intake evaluation for WIC participants from birth up to 2 years of age, the committee evaluated the most recent recommendations of the AAP, AND, the World Health Organization (WHO), and other published sources, as presented in Chapter 3, Table 3-1.

The AAP recommends human milk as the sole food for healthy, full-term infants for approximately the first 6 months of life and supports continued breastfeeding for at least 12 months (AAP, 2014). The AAP (2014) further recommends that, in the absence of human milk, iron-fortified formulas are the most appropriate substitutes for feeding healthy, full-term infants during the first year of life. WHO recommends exclusive breastfeeding for the first 6 months of life (WHO, 2013).

The introduction of complementary foods should begin at approximately 6 months of age, depending on an individual infant's development (e.g., whether the infant has attained the necessary oral motor skills, whether growth faltering has occurred) (AAP, 2014). Acknowledging that iron and zinc deficiencies may occur in older breastfed infants, the AAP further recommends the introduction of meats, vegetables with higher iron content, and iron-fortified cereals for infants and toddlers as the first foods (Baker and Greer, 2010). Cow's milk is not recommended before 1 year of age by the AAP because of the increased risk of iron-deficiency anemia (i.e., because of low bioavailability of iron from cow's milk, low concentration of iron in cow's milk, and potential for intestinal blood loss) (AAP, 2014). WHO recommends porridge and a wide variety of pureed foods, including meats, to initiate the transition from a fluid to a solid diet (WHO, 2013).

Some infants may be developmentally ready for finger foods or foods of different textures at an earlier age. In alignment with the AAP guidance, WIC educates participants that infants may be ready to take solids earlier than 6 months (USDA/FNS, 2014). Chapter 5 (Tables 5-2, 5-3, and 5-4) summarizes results from the committee's analyses of food intakes for infants and children under the age of 2 years, which indicated concerns around early introduction of complementary foods including cow's milk and foods of poor nutritional value, as well as iron supplementation. The committee recognizes that the WIC food packages provide complementary foods only as early as 6 months of age (USDA/FNS, 2014).

FOODS CONTAINING FUNCTIONAL INGREDIENTS

The committee was asked to consider the current science on functional ingredients (e.g., docosahexaenoic acid [DHA], arachidonic acid [ARA], probiotics, prebiotics, beta-carotene, lutein, and lycopene) added to foods for infants, children, and adults to determine how USDA-FNS might approach the inclusion of foods containing these ingredients in the WIC food packages.

Regulatory Framework for Functional Ingredients

At the time this report was written, the FDA had not established a definition for functional foods or ingredients. Functional ingredients are permitted in foods if evidence indicates the ingredients are safe at estimated national levels of consumption, but efficacy of these ingredients is not evaluated or regulated by the FDA. Broadly, functional foods and ingredients are thought to provide a "health benefit beyond basic nutrition," and may be beneficial to long-term health (Crowe and Francis, 2013). At present, no nationally agreed-upon framework exists for determining the levels of substances in foods that can be linked to health benefits, although development of such a framework is under discussion in the nutrition community. Global organizations use various criteria to evaluate benefits (e.g., level of evidence supporting the beneficial outcome, level of exposure to the component, forms and sources of the component) (Crowe and Francis, 2013).

A functional ingredient can be a nutrient or non-nutrient component, while functional foods are generally regarded as having properties—taste, aroma, and/or nutritive value—of conventional foods. These characteristics set functional nutrients and functional foods apart from supplements (GAO, 2000). The position of AND is that "functional foods" can be whole, fortified, enriched, or enhanced foods (Crowe and Francis, 2013).

Findings on Health Benefits

Functional ingredients that have been systematically evaluated for outcomes within WIC's target population are listed in Table 9-4 (see Chapter 3 for a summary of how the functional ingredients and studies listed in this table were selected). Two characteristics of the table should be noted. First, aside from statements related to formula-fed infants, the reviews and positions listed in the table are largely evaluations of the ingredient administered as a supplement and not in a food form. However, while these statements may not accurately represent the health effects that occur when the ingredient is consumed as part of a food matrix (Jeffery, 2005; Crowe and Francis, 2013), the relationships and strength of evidence provide insight into the current understanding of the biological role of the component. Second, diseases or conditions that are atypical in the WIC population (e.g., gout) or that may not be affected by the short-term, supplemental nature of the WIC program (e.g., cancer, heart disease) were not included in this evaluation.

Data that support a link between functional components and health

TABLE 9-4 Functional Ingredients and Health Benefits—Summary of the Evidence

Component	Evidence	Specific Population and Health Parameter	Reference
Infants			
DHA (LCPUFA, omega-3 fatty acids)	Inconclusive	Growth, visual acuity, cognition, and neurodevelopment for breastfed infants of supplemented mothers	Delgado-Noguera et al., 2010
	No benefit	Preterm infants receiving LCPUFA supplemented formula (visual acuity, neurodevelopment, growth)	Schulzke et al., 2011
		Growth, visual acuity, cognition, and neurodevelopment of formula-fed infants	Simmer et al., 2011
Probiotics	Insufficient evidence	Clinical efficacy for formula-fed infants	Thomas and Greer, 2010; AAP, 2014
		Prevention of allergic disease or food hypersensitivity in formula-fed infants	Osborn and Sinn, 2007
Prebiotics	Inconclusive/ possible benefit	Prevention of allergy in formula-fed infants	Osborn and Sinn, 2013
	No Benefit	Formula-fed infants (general)	AAP, 2014
Beta-carotene	No (or very limited) benefit	Morbidity of supplemented postpartum mothers and their infants	Oliveira-Menegozzo et al., 2010
	No benefit	Mortality of supplemented postpartum mothers and their infants	Oliveira-Menegozzo et al., 2010
Hydrolyzed protein	Inconclusive/ possible benefit	Reducing risk of atopic dermatitis in healthy infants who are not exclusively breastfed and who have a family history of allergy	FDA, 2011
	Inconclusive	Prevention of childhood allergy and infant cow milk allergy in high-risk infants not exclusively breastfed	Osborn and Sinn, 2006
	No benefit	Prevention of allergy in formula-fed infants (compared to exclusive breastfeeding)	Osborn and Sinn, 2006

continued

TABLE 9-4 Continued

Component	Evidence	Specific Population and Health Parameter	Reference
Soy protein	Inconclusive/no benefit	Prevention of allergy or food intolerance in infants at high risk or infants with a history of allergy in a first degree relative	Osborn and Sinn, 2006
Lactose-reduced or free	Inconclusive/ possible benefit	Earlier resolution of acute diarrhea in young children (< 5 years old) who are not predominantly breastfed	MacGillivray et al., 2013
	Insufficient evidence	Growth and feeding tolerance of preterm infants receiving feedings with lactase	Tan-Dy and Ohlsson, 2013
Children			
DHA (LCPUFA, omega-3 fatty acids)	Insufficient evidence	Improving autism spectrum disorder symptoms in children	James et al., 2011
PUFAS	Inconclusive/ no benefit	Symptoms of ADHD in supplemented children and adolescents	Gillies et al., 2012
	Insufficient evidence	Learning outcomes for children with specific learning disorders	Tan et al., 2012
Probiotics	Benefit	Prevention of antibiotic-associated diarrhea in children	Johnston, et al., 2011
	Inconclusive/ possible benefit	Treating persistent diarrhea in children	Bernaola Aponte et al., 2013
		Reduce incidence of acute upper respiratory tract infections and reductions in mean episodic duration, antibiotic use, and cold-related school absences	Hao et al., 2015
	No benefit/ potential harm	Treatment for children with eczema	Boyle et al., 2008
Lactose-reduced or free	Inconclusive/ possible benefit	Earlier resolution of acute diarrhea in young children (< 5 years old) who are not predominantly breastfed	MacGillivray et al., 2013

TABLE 9-4 Continued

Component	Evidence	Specific Population and Health Parameter	Reference
Women			
DHA (LCPUFA, omega-3 fatty acids)	Inconclusive	Treatment of antenatal depression	Dennis and Dowswell, 2013
	Insufficient evidence	Prevention of postnatal depression	Miller et al., 2013
Probiotics	Insufficient evidence	Gestational diabetes Preterm labor Bacterial vaginosis (women of any age)	Barrett et al., 2014 Othman et al., 2007 Senok et al., 2009
Lycopene	Insufficient evidence	Prevention of preeclampsia	Rumbold et al., 2008
Beta-carotene	No (or very limited) benefit	Morbidity of supplemented postpartum mothers and their infants	Oliveira-Menegozzo et al., 2010
	No benefit	Mortality of supplemented postpartum mothers and their infants	Oliveira-Menegozzo et al., 2010
Age Groups Mixed or General Evaluations			
DHA (LCPUFA, omega-3 fatty acids)	Mixed results	May lower triglycerides and VLDL cholesterol in type 2 diabetics, but may also raise their LDL cholesterol	Hartweg et al., 2008
	Inconclusive/ no benefit	Treatment for patients with established atomic eczema/ dermatitis	Bath-Hextall et al., 2012
Probiotics	Benefit	Shortening the duration and reducing the stool frequency in a cute infectious diarrhea	Allen et al., 2010
		Preventing *Clostridium difficile*-associated diarrhea	Goldenberg et al., 2013
	Inconclusive	General safety	AHRQ, 2011
Beta-carotene	No benefit/ potential harm	Mortality, adults with and without various diseases	Bjelakovic et al., 2012

NOTE: DHA = docosahexaenoic acid; LCPUFA = long-chain polyunsaturated fatty acids; PUFA = polyunsaturated fatty acids.

outcomes are generally insufficient or inconclusive. Probiotics appear to have the most consistent data indicating a beneficial effect (i.e., in relation to diarrheal conditions). However, with regard to the inclusion of probiotics in routine formulas, the German Federal Institute for Risk Assessment has recently released an opinion stating there is currently insufficient data to make a judgment on the safety and health benefits of probiotics for healthy infants (BfR, 2015). For other functional ingredients listed in Table 9-4, evidence for health effects may be apparent for specific subpopulations or health conditions of less relevance to the general WIC population. For example, the 2015 DGAC report noted that evidence for effects of EPA and DHA on neuropsychological health is substantial, and combined supplementation is now considered a complementary therapy for major depressive disorder (USDA/HHS, 2015). Note that the 2015 DGAC report did not review probiotics or prebiotics and that lutein, lycopene, and beta-carotene are all considered collectively as "carotenoids" (USDA/HHS, 2015).

In addition to health outcomes, cost is another important factor to consider when determining if foods with functional ingredients should be added to WIC food packages. Functional foods may have higher prices than their conventional counterparts, but may be cost-effective in the long run if a health impact were to offset medical costs (Schmier et al., 2014). Following their designation as being "generally recognized as safe" (GRAS) by the FDA, DHA and ARA were added to infant formulas sold in the United States starting in 2002. At present, as explained in detail in the next section in this chapter, nearly all nonexempt standard formulas distributed through the WIC program contain both DHA and ARA.

INFANT FORMULA: FUNCTIONAL INGREDIENTS AND THE MARKET LANDSCAPE

Infant formula is legally defined as a food that "purports to be or is represented for special dietary use solely as a food for infants by reason of its simulation of human milk or its suitability as a complete or partial substitute for human milk" (FDA, 2012 [section 201(z)]). USDA-FNS requested that the committee evaluate three specific aspects of infant formulas as a component of the food packages. Two of these aspects were addressed in Chapter 4, namely the maximum monthly allowances for infant formula and iron concentration. The third aspect was the nutritional and health effects of functional ingredients in infant formulas. A summary of the committee's review of the science related to the nutritional and health impact of functional ingredients in infant formulas is provided here. Since the 2009 food package changes, the variety of infant formula products available in the marketplace has expanded substantially. As a foundation for this task, the committee reviewed changes in the infant formula market landscape over the past decade, including but not limited to functional ingredients.

The Regulatory Process Governing Infant Formula

During the first several months of life, infants are unique in that all their nutrient requirements must be met by a single food source, namely either human milk or formulas. In recognition of the importance of a single food source for infant health, the U.S. Congress passed the Infant Formula Act of 1980, later amended in 1986, as section 412 of the Federal Food, Drug, and Cosmetic Act (NARA, 2014c). The associated regulations (NARA, 2014d) set standards for safety and nutrient sufficiency; establish premarket submission, registration, and records retention requirements; specify infant formula adulterant; grant the FDA mandatory recall authority; and mandate that formula meet "quality factors" (i.e., supporting normal growth, biological quality of protein). Formulas currently sold in the United States must contain minimum concentrations of 29 nutrients[6] (3 of which are specifically required for all non-milk-based formulas) and not exceed the maximum concentrations for 9 of these nutrients. At least 90 days before introducing a new or a reformulated product (see 21 C.F.R. § 106.3 for definition of a "major change"), a manufacturer must submit a notification to the FDA that includes the product composition, processing, and packaging information, and required assurances that it meets the quality factors. After first production of the formula and before it is introduced to the market, the manufacturer must submit to the FDA a summary of test results assessing the levels of each of the required nutrients in the formula and must certify good manufacturing practices were established, in accordance with 21 C.F.R. § 106 regulations. Additionally, because the infant formula market is continually evolving and to ensure suitability of new or reformulated infant formulas, manufacturers are required to test and document that products are safe, support healthy growth when provided as the sole source of nutrition, and contain protein of biological quality (NARA, 2014c).

Manufacturers may add ingredients that are not required but may have health benefits to formulas in ways that will set their products apart from their competitors (Aggett et al., 2001; AAP, 2014, p. 63). These additions and reformulations are permissible only when included in the premarket submission to the FDA. Each ingredient must be an approved food additive, be generally recognized as safe (GRAS) under the conditions of intended use, or be used in accordance with a prior sanction (21 C.F.R. § 140(a)).

[6] Selenium was recently added as the 30th nutrient to be regulated in infant formulas, with the mandate specifying both minimum and maximum levels. The effective date of this final rule is June 22, 2016.

To ensure the formula matrix meets the quality factor of supporting normal physical growth (21 C.F.R. § 106.96), manufacturers must demonstrate that the added ingredients do not interfere with the bioavailability of the required nutrients.

WIC Formulas

As discussed in Chapter 7, WIC encourages exclusive breastfeeding during an infant's first months of life and continued breastfeeding thereafter. In instances where an infant is partially breastfed or fully formula-fed, WIC aims to provide enough formula supplementation to meet, but not exceed, an infant's nutritional needs. As such, WIC does not function as a "supplemental nutrition program" in its provision of infant formula. The formulas provided by WIC must comply with the federal definition of and nutrient requirements for infant formulas. In particular, they must provide at least 1.5 mg iron per 100 kilocalories at standard dilution; provide approximately 20 kilocalories per 100 milliliters at standard dilution; be able to be delivered orally or via tube feeding; and require nothing but water to be added for them to be in a liquid, ready-to-drink state (USDA/FNS, 2014).

Partially or fully formula-fed infants can receive selected milk-based and soy-based formulas through the WIC program. Formulas intended for healthy full-term infants ("nonexempt" formulas) are generally provided in powdered or concentrate form, unless living conditions require use of a prepared formulation. In an effort to contain costs, manufacturers must bid to be the sole supplier of a state's standard formula. The manufacturer, in return for exclusivity, provides the agency with a significant rebate on each container of contract formula purchased with the WIC benefit ($1.7 billion in 2012 [USDA/ERS, 2013]).

As discussed in Chapter 8, in instances of medically documented qualifying conditions, infants may be eligible to receive nonstandard products. Given these infants' unique dietary needs, exempt formulas can deviate from the federal nutrient requirements if the FDA is provided with substantiated medical, nutritional, scientific, or technological justification (NARA, 2014e). Some exempt formulas are available at retail outlets, while others are only available with a physician's prescription (NARA, 2014e). At present, three infant formula manufacturers participate in the bidding process and each currently holds WIC contracts.

Infant Formula Developments

This section outlines advances and differences in the content of infant formulas available through the WIC program. The nutrition and ingredient lists, along with nutrient, health, and structure-function claims, were compiled from the websites of the manufacturers holding state WIC contracts. Components that differentiate the products or are not part of the FDA nutrient requirements are highlighted. Products included in this analysis were primarily nonexempt formulas. Extensively hydrolyzed formulas, which are exempt formulas, were also included for comparison to their partially hydrolyzed, nonexempt counterparts. Formulas intended for medical use were not included in this evaluation.

Docosahexaenoic Acid (DHA) and Arachidonic Acid (ARA)

DHA and ARA, long-chain polyunsaturated fatty acids found in breastmilk (Lauritzen and Carlson, 2011), have been linked to brain and eye development due to their concentrations in those tissues (Martinez, 1992; van Kuijk and Buck, 1992; Uauy et al., 2001). Manufacturers began adding DHA and ARA to infant formulas sold in the United States in 2002 after they were designated as GRAS (FDA, 2001a,b). The majority of nonexempt infant formulas currently contain DHA and ARA from *Crypthecodinium cohnii* oil (an algae source) and *Mortierella alpina* oil (a fungal source), respectively. The AAP does not have an official position on supplementing full-term infants with long-chain polyunsaturated fatty acids like DHA and ARA (AAP, 2014).

Prebiotics

Prebiotics are selectively fermented ingredients that increase the activity or growth of gut bacteria. Based on the committee's survey of the market (see Chapter 3 for details), all of the major infant formula manufacturers produce formulas with one or more of the following prebiotics: galacto-oligosaccharide, fructo-oligosaccharides, and polydextrose. However, these compounds are not in every formula product. The AAP does not believe the available evidence demonstrates health benefits of probiotics in infant formulas at this time (Thomas and Greer, 2010; AAP, 2014).

Probiotics

Probiotics are live microorganisms that can alter composition of bacteria in the gut. Although probiotics have been investigated for their effects on a range of conditions, the primary health benefit appears to be in preventing and potentially shortening the duration of diarrhea (see Table 9-4) (Allen et al., 2010; Johnston et al., 2011; Bernaola Aponte et al., 2013; Goldenberg et al., 2013). Based on the committee's survey of the market, three different types of probiotics are currently being added to infant formulas by two of the major manufacturers: *Lactobacillus reuteri*, *Bifidobacterium lactis*, and *Lactobacillus rhamnosus GG*. The AAP believes the evidence to support routinely adding probiotics to infant formulas is currently insufficient (Thomas and Greer, 2010; AAP, 2014).

Age-Specific Formulas

A conventional infant formula is typically indicated for use from birth through the first year of life. Although these 0–12 month formulas are standard for term infants, age-specific formulations are now available. Each of the major manufacturers has developed products for older infants, which are marketed for use beginning at 6 or 9 months through 12, 18, 24, or 36[7] months of age (Gerber, 2015a,b,c; Mead Johnson, 2015a,b,c,d; Ross Abbott, 2015). There is also a product marketed just for the newborn period (0–3 months; Mead Johnson, 2015c). These age-specific formulations must still comply with federal nutrient specification requirements for infant formulas (NARA, 2014c) and, as such, vary only slightly in terms of composition from the standard 0–12 month formulations. The AAP states that there are no obvious benefits to these "follow-on" or "follow-up" formulas compared to standard formulas during the first year of life, although they have the potential to be advantageous for toddlers with iron-deficient and imbalanced diets (AAP, 2014).

Hydrolyzed Protein

The protein in hydrolyzed formulas has been broken down into mixture of peptides and amino acids. When a formula has been partially hydrolyzed, intact proteins may still be present and could elicit an allergenic response (AAP, 2014). As such, these formulas are often marketed as a means of managing feeding-related issues of healthy full-term infants (e.g., discomfort, fussiness) and potentially reducing the risk of atopic dermatitis (FDA, 2011), rather than as a way to avoid cow milk protein allergy (AAP, 2014). Completely or extensively hydrolyzed formulas, in contrast, are indicated for infants who have an allergy to cow-milk protein or soy (AAP, 2014).

Carotenoids

The term *carotenoids* encompasses a broad group of natural pigments, including provitamin A molecules. Selected carotenoids have been investigated for their antioxidant properties and potential health benefits related

[7] The formula indicated for use up to 36 months is a hypoallergenic, lactose-free formulation used for children with cow's milk allergy and is suggested by the manufacturer to be a milk alternative.

to morbidity, mortality, and cancers (see Table 9-4). Although all infant formulas are required to contain vitamin A (NARA, 2014c), there are currently no standards for individual carotenoids. Only one manufacturer currently adds a blend of beta-carotene, lutein, and lycopene to all of its standard milk- and soy-based formulas, and promotes lutein through a structure-function claim ("Lutein: Found in areas of the brain related to learning and development" [Abbott Nutrition, 2015b]). The AAP nutrition handbook does not have specific recommendations on the inclusion of carotenoids in infant formulas (AAP, 2014).

Soy Formulas

Soy formulas have long been available on the market as an alternative to cow milk-based formulas. The AAP recommends the use of soy formulas when a term infant has galactosemia, hereditary lactase deficiency, transient lactase deficiency, or immunoglobulin E-associated allergy to cow milk, or if a vegetarian-based diet is sought (AAP, 2014). Soy formulas, however, cannot be recommended for the prevention of milk allergy or intolerance in high-risk infants with a history of allergy in a first-degree relative (Osborn and Sinn, 2006).

Nucleotides

Found in human milk, nucleotides (monomers for nucleic acids) are currently added to standard milk-based formulas by the major manufacturers. Nucleotides are believed to play a role in proper immune function and intestinal development. An international workgroup has recommended a maximum of 10.8 mg/100 kcal for follow-up formulas for children 6–36 months old (Koletzko et al., 2013). The AAP recognizes that nucleotides may have beneficial health effects, but recommends a better understanding of the mechanism, the clinical impact, and long-term outcomes (AAP, 2014).

Lactose-Reduced or Lactose-Free Formulas

Cow milk-based, lactose-reduced, or lactose-free formulas are available as formulations typically intended to manage an infant behavior such as fussiness (e.g., colic, gas, spit-up). Reduced-lactose or lactose-free formulas may transiently help with the management of acute diarrhea in young children (MacGillivray et al., 2013).

Formulas for Managing Feeding Issues

A range of formulas is available on the U.S. market for the management of feeding issues commonly experienced by infants. Partially hydrolyzed protein-containing formulas, for instance, are marketed as being soothing, providing comfort, and promoting regularity. Various formulas are advertised as managing colic, gas, fussiness, and spit-ups because some of the ingredients (e.g., lactose, protein source, or composition) have been modified. Partially hydrolyzed formulas may also be indicated in infants at risk of allergy (see Chapter 8 for additional detail). In accordance with the Federal Food, Drug, and Cosmetic Act (21 U.S.C. 343(a)), any statement or claim on the label must be truthful and not misleading. Most label claims fall under the structure/function claim category, referring to an effect "derived from nutritive value" (FDA, 2014a). As such, the relationship describes a nutrient or a compound in the food rather than the food as a whole. The only type of infant formulas with a qualified health claim are those that are 100 percent whey-protein partially hydrolyzed, but the claim includes a statement of the relative dearth of data supporting it (e.g., "Little scientific evidence suggests that . . . ") (FDA, 2011).

Organic and Non-GMO Formulas

Only one of the manufacturers holding WIC state contracts makes an organic infant formula (although other manufacturers make organic brands). In June 2015, this company launched a "non-genetically modified organism (GMO)" version of one of its infant formulas. The ingredients in this product are identical in nutritional composition to the original version, but come from sources that have not been genetically engineered (GE). In conjunction with the USDA and the Environmental Protection Agency, the FDA regulates foods from GE crops, which must meet the same safety standards as traditionally bred plants (FDA, 2015).

Lower-Energy Formulas

In 2014, a manufacturer introduced lower-energy infant formulas to the U.S. market. The new products were a modification of available products and provide one less kilocalorie per prepared fluid ounce (19 versus 20 kcal/fl oz). The rationale for transitioning to lower-energy formulas was that it better reflected the energy density of human milk (Abbott Nutrition, 2015a). Inasmuch as the standard WIC formulas must provide 20 kcal/fl oz (USDA/FNS, 2015c), states can choose to offer these lower-energy formulas in cases of medically documented qualifying conditions rather than as standard issue.[8] However, given the lower energy in these formulas, concern has been raised about effects on infant growth. Findings from a recent systematic review suggest that healthy full-term infants consuming formulas with lower protein and/or lower energy levels than standard formulas have adequate growth, comparable to breastfed infants, although the authors recommended additional long-term evaluations of these formulas (Abrams et al., 2015). One manufacturer that did not reformulate its products to be lower in energy, however, has challenged the need for lower-energy formulas and currently (at the time this report was being written) intends to maintain the caloric density of its formulas at 20 kcal/fl oz (Mead Johnson, 2014). A taskforce of the AAP submitted a letter to USDA-FNS requesting a reevaluation of the 20 kcal/fl oz criterion for WIC formulas (AAP, 2012).

CHOICE AND FLEXIBILITY

Public comments received by the committee indicated that both participants and WIC program staff are generally supportive of increasing options within the food packages. Each food category fulfills a need for specific nutrient or food group, and increasing options that support intake of key nutrients may promote redemption. See Chapter 2 for a detailed discussion of factors related to redemption. Low redemption implies that issued foods are not being consumed and that the goal of the WIC program to provide needed nutrients and foods is not being met.

Changes Made in the 2009 WIC Food Packages to Improve Flexibility

Given the racial and ethnic diversity of the WIC population described in Chapter 1, the 2006 Institute of Medicine (IOM) review of WIC food packages recommended that the WIC program provide more flexibility to state agencies and more variety and choice for WIC participants. Accordingly, in the 2009 revision of the WIC food packages, new food options were added. These included corn tortillas, brown rice, soy-based beverages as an alternative to milk, and a cash value voucher (CVV) for fruits and vegetables that allowed choice at the participant level (IOM, 2006).

Satisfaction with the 2009 WIC Food Package Changes

As discussed in Chapter 2, multiple studies have documented moderate to high satisfaction with the 2009 changes in the WIC food package, but

[8] More than one-third of states held contracts with this manufacturer when the formulation change occurred and had to modify their prescribing policies to accommodate the lower-energy formulas.

with some cultural variation in participants' satisfaction with food items in the packages (Gleason and Pooler, 2011; Ritchie et al., 2014). Additionally, since 2009, the Altarum Institute has been conducting interview, survey, and focus group studies with WIC participants across sites. A key theme emerging from these studies is that participants are especially satisfied with the flexibility allowed in the food packages (e.g., being able to choose canned beans instead of dried beans or corn tortillas instead of bread) and want as much food and brand variety as possible (Phillips et al., 2014; Personal communication, S. Whaley, Public Health Foundation WIC Enterprises, June 4, 2015). In a study by Altarum of women who had left the WIC program, responses to the question "What could WIC do to encourage you to participate in the program again?" included negative comments about food selection (e.g., being allowed to acquire only store brands, not being able to acquire the type of milk or formula needed) (Phillips et al., 2014).

Considerations for Future Modifications to Improve Choice and Flexibility

As noted in the interim rule, substitution for a food in the WIC food categories "must be nutritionally equivalent or superior to the food it is intended to replace" (USDA/FNS, 2007, p. 69004). The implication of this statement is that the nutrient content of substitutions for WIC foods should be similar, components (i.e., protein) should be of similar quality, and nutrients should be similarly bioavailable. As an example of a substitution comparison, the 2015 DGAC report evaluated a number of milk alternatives and found that, while most contain potassium, the amounts of it vary. Additionally, although most are fortified with calcium, calorie amounts are higher in some alternatives for a similar intake of calcium and calcium absorption is lower in plant-based milk alternatives (USDA/HHS, 2015). Both the interim and final rules require that soy beverages (a currently allowed milk alternative) provide a minimum 8 g of protein, 100 IU for vitamin D and 500 IU for vitamin A, and 276 mg calcium per 8 ounces (USDA/FNS, 2007, 2014). The representative almond milk in the USDA's standard reference database contains similar amounts of micronutrients, but only 1 g of protein per 8 ounces (USDA/ARS, 2014a). Therefore, almond milk would not be considered nutritionally equivalent to cow's milk because of the notably lower protein content.

COST CONSIDERATIONS

As part of the task, USDA-FNS requested that modifications to the recommended food package be cost neutral to allow the WIC program to maintain the current average food package cost, adjusting for inflation and allowing for no more than 10 percent variance in per-participant average monthly food costs. As was the case for the 2006 IOM review, the term *cost neutrality* means that the average cost per participant of the complete set of revised WIC food packages proposed by the committee (in phase II) does not exceed the cost of the current WIC food packages. Table 9-5 illustrates how costs were contained in the 2009 food package revisions. Creating the final recommendations in the IOM (2006) report involved determining the priority nutrients and food groups, then evaluating cost of addressing those gaps in an iterative process. Details of these considerations are presented in that report. The same approach will be taken in phase II of this review. The committee was tasked with determining whether any cost increases associated with the potential expansion of options or new substitutions for foods could be offset by other package modifications while maintaining the overall nutritional goals, other population needs, and administrative constraints of the food package.

WIC is not an entitlement program. As a result, it has a fixed budget, so funds may not be available to cover the cost of WIC foods for those who are eligible. Consequently, cost containment is an important concern. A primary cost-saving practice of the WIC program is the negotiation of rebate contracts with infant formula manufacturers, as described previously. These rebates have contributed to significant savings and permitted more participants to be served by WIC (USDA/ERS, 2015a). Additional cost-containment practices include limiting approved brands, package sizes, forms, or prices (e.g., least expensive brand requirements), and limiting authorized vendors to stores with lower food prices. Smaller vendors, often with higher operating and procurement costs, are more likely to charge (and be reimbursed for) higher prices for WIC products than larger vendors. A recent USDA-ERS report documented that policies intended to reduce maximum allowable WIC reimbursement rates would have little to no effect on most standard-size supermarkets, where the majority of WIC transactions take place (USDA/ERS, 2014).

On the one hand, containing costs is essential for maximizing program funds to serve as many WIC-eligible individuals as possible. Yet strategies that limit cost are often synonymous with strategies that limit choice. Cost-containment practices that restrict participant choice in such a way that some foods become undesirable for purchase undermine WIC's goal to provide healthy and nutritious foods to low-income individuals. As a result, states attempt to balance containing cost with promoting enough variety and choice among healthy WIC foods that families will want to purchase those foods.

TABLE 9-5 2009 Food Package Changes That Achieved Cost Neutrality by Balancing Increases and Decreases in Cost: Public Comment Summary

Changes That Increase Cost	Comments on Implementation
Include CVV for fruits and vegetables for individuals 1 year and older	Very well received by WIC community.[a,b] Redemption rates vary by state: Average of 72.7% (KY, MI, NV; Phillips et al., 2014); approximately 90% in CA[a]
Include jarred meat and fruit/vegetables for infants 6–11 months	Low redemption of jarred meats: Average of 42.8% (KY, MI, NV; Phillips et al., 2014); below 50% for older infants 9 to less than 12 months (CA).[a] Jarred fruits and vegetables also low redemption for older infants (Kim et al., 2013), an effect of recent change to allow substitution of CVV for half of jarred fruits and vegetables remains unstudied
Increase formula for non-breastfed infants 4–5 months	No apparent concerns with implementation.[a,b]
Allow yogurt and soy beverage as milk substitutes	Substitutions are generally positively received by participants.[a,b] Yogurt is not yet available in most states.
Increase value of packages for breastfeeding mothers	Positively received, but evidence suggests that breastfeeding incentives can be improved.
Changes That Decrease Cost	**Comments on Implementation**
No juice for infants less than 1 year of age	Very popular change among WIC nutritionists.[a,b]
Reduce quantity of eggs	Initial dissatisfaction, no longer evident.[a,b]
Reduce quantity of milk	Initial dissatisfaction, no longer evident.[a,b]
Reduce quantities of cheese	Initial dissatisfaction, no longer evident.[a,b]
Reduce infant formula for partially breastfed infants	Initial dissatisfaction, no longer evident.[a,b]
No cereal for infants 4–5 months	Controversial. When to start complementary foods remains highly debated.[a,b]

NOTE: CVV = cash value voucher.

[a] Personal communication, S. Whaley, Public Health Foundation WIC Enterprises, June 2, 2015.

[b] Public comments; All public comments are accessible through the National Academies Public Access File. Email: paro@nas.edu.

SOURCE: Phillips et al., 2014, is a 2012 study of KY, NV, and MI redemption rates sponsored by USDA-FNS.

PUBLIC COMMENTS

Public comments were solicited through the IOM study website and in-person at three public comment sessions over the course of the phase I data-gathering period, which extended from September 2014 through August 31, 2015. A summary of common themes is presented in Appendix T, Table T-2. All comments were made available to committee members for consideration over the course of the study. The committee acknowledged that many suggestions for food package modifications fell outside of the task and therefore could not be addressed.

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10

Food Expenditure Analysis

In phase I, the committee was tasked with planning and implementing an analysis of food expenditures for the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) population using national data. This analysis is designed to provide estimates of the total food expenditures and expenditures on food groups[1] for WIC households to assess the relative contribution of the WIC food packages to their food expenditures. Analysis reported in the phase I report focuses on the level and contributions of at-home and away-from-home food expenditures and the WIC food package to total food expenditures for three kinds of households: (1) households that receive WIC benefits, (2) households that are eligible for WIC but do not participate in the program, and (3) higher-income households that would meet the eligibility criteria (e.g., having a pregnant woman or child in the household under the age of 5 years old) except for income. The analysis relied on recently released data from a national survey of households that was conducted by the U.S. Department of Agriculture's (USDA's) Economic Research Service (ERS) (USDA/ERS, 2015a). The analysis also provided insights into household demographics (e.g., presence of pregnant women, infants, and young children), food insecurity, and share of food acquired with WIC benefits (i.e., for households receiving WIC benefits). This chapter summarizes the methods and results of the committee's phase I food expenditure analysis.

[1] Expenditures on food groups will be presented in phase II because the data were not available soon enough to complete these analyses. See Chapter 3 for additional detail.

DATA AND METHODS

Description of the Survey Dataset

The National Household Food Acquisition and Purchase Survey (FoodAPS) served as the primary dataset for this analysis, accessed under a third-party agreement with USDA-ERS and through a confidential Web system.[2] Data were collected from a nationally representative, stratified sample of 4,826 households between April 2012 and January 2013 (USDA/ERS, 2015a,b). The survey design had four target groups defined in terms of Supplemental Nutrition Assistance Program (SNAP) participation and total reported household income. The three target income groups were income less than 100 percent of the federal poverty-to-income ratio (PIR); income greater than or equal to 100 percent and less than 185 percent of the PIR; and income greater or equal to 185 percent of the PIR. Sampled households were selected through a multi-stage sample design. Prior to release, several quality controls were exercised, including verification of reported SNAP participation by linking responses on SNAP participation and purchases to SNAP administrative records. Information on SNAP participation status (as revised in the match to administrative data) was used in constructing the final sampling weights. Each household was given a final sampling weight to be used in making the sample nationally representative of all non-institutionalized households in the contiguous United States, and the analyses and standard errors account for the complex sampling design.

With respect to food purchases and acquisitions, the survey is a unique source of information on foods eaten both at home (FAH) and away from home (FAFH), as well as extensive information on the sample households. Purchase and acquisition data for each household were collected over a 7-day period. The data provide information on quantities; prices; expenditures for all foods eaten both at home and away from home and purchased or acquired from all sources (including large and small grocery stores, mass merchandisers, convenience stores, gas stations, and food marts); and source of payment for foods consumed at home (i.e., WIC voucher or other method of purchase). During a shopping event where more than one type of tender was used to purchase foods, although it is impossible to determine exactly which foods were obtained with the WIC voucher, it is possible to determine how much the WIC voucher contributed to the total purchase cost and what food items were purchased during the shopping event.

In addition to food purchase and acquisition data, the survey collected

[2] The data survey and access procedures are available through USDA-ERS at http://www.ers.usda.gov/data-products/foodaps-national-household-food-acquisition-and-purchase-survey.aspx (accessed August 15, 2015).

information on income, food security status (a scale based on responses to 10 questions used to assess household food security; USDA/ERS, 2015b), and reported WIC participation as well as some demographic information (e.g., presence of a pregnant woman, infant, or young child) that were used here to differentiate among the three types of households. Of note, households were not asked about breastfeeding or postpartum women. Forty-eight percent of the WIC households also participated in SNAP (USDA/ERS, 2015c).

Application of the FoodAPS Dataset for This Report

The household served as the unit of analysis for this study. For example, if a WIC-participating mother and her infant lived in a household with the mother's (non-WIC-participating) parents, the entire household (mother, infant, and mother's parents) was coded as "WIC," not just the mother and her infant. As mentioned previously, three types of households were analyzed for this report: (1) WIC-participating households (i.e., households reporting either having a member participate in the WIC program or a purchase event with use of WIC voucher), (2) eligible non-WIC households (i.e., households with a pregnant woman or a child less than 5 years old and with income ≤ 185 percent PIR), and (3) non-eligible non-WIC households (i.e., households having a pregnant woman or a child younger than 5 years old and with income greater than 185 percent PIR). Although the survey did not cover breastfeeding or postpartum women, it is likely that these women were captured as part of WIC-participating households with infants.

All household members were asked to track and report their food purchases or acquisitions during the survey week, including all foods eaten at home and away from home. Each purchase or acquisition was considered a separate "event." The sum of events across food purchased and acquired for at-home and away-from-home use constitutes the total food expenditures for that household (for the survey week). Some households (4 percent of WIC participating households, 2 percent of eligible, non-WIC-participating households, and 3 percent of higher-income households) reported no food purchases or acquisitions (FAH or FAFH) during the survey week. Nonetheless, they were included in the analysis to generate a representative "average" amount of food expenditures for all households, because, over the course of 1 month, households vary widely in the frequency and size of their food purchases and acquisitions. Among all households examined in the FoodAPS, 7 to 9 percent reported no FAH expenditures in the interview week (including 8.7 percent of WIC households).

With respect to the 10 FoodAPS questions related to food insecurity, the sum of affirmative responses ("yes," "often," "sometimes," and "occurring 3 or more days" were all coded as affirmative) on questions related to food insecure conditions were used to assign USDA 30-day Adult Food Security Scale values. A raw score of 0 (none of the 10 questions eliciting an affirmative response) was assigned a value of 1 (high food security), a raw score of 1–2 (1–2 affirmative responses) was assigned a value of 2 (marginal food security), a raw score of 3–5 was assigned a value of 3 (low food security), and a raw score of 6–10 was assigned a value of 4 (very low food security). For this analysis, households with assigned values of 3 and 4 were identified as food insecure.

Data were weighted in estimates of mean values and standard errors using the household weights; all standard errors account for oversampling and the complex survey design of FoodAPS.[3] Mean food expenditures and food insecurity scores were compared using t-tests, and distributions of demographic and food insecurity data were compared using the Pearson chi-square statistic between WIC households and both types of non-WIC households (Rao and Scott, 1984).

RESULTS

Demographic Characteristics of the Survey Households

Compared to both types of non-WIC households, WIC households were more likely to have infants and pregnant woman but less likely to have young children (children ages 1 to less than 5 years old) (see Table 10-1). The latter finding is consistent with program data that find a decline in participation of children after the child's first year (USDA/FNS, 2013). The WIC households did not differ from non-WIC but eligible households with respect to either participation in SNAP or household size (see Table 10-1).

Thirty-four percent of WIC households were identified as food insecure (see Table 10-1). Although WIC households were more likely to be food insecure than demographically similar but higher income households, WIC households and non-WIC but eligible households reported similar levels of food insecurity (see Table 10-1). These estimates of food insecurity are higher than estimates from other national surveys of food insecurity during the previous 30 days among U.S. households (e.g., estimates from the 2012 Current Population Survey [CPS] and the 2012 National Health Interview Survey [NHIS]) (see also USDA/ERS, 2015c). This may be caused by the food security questions being administered differently in the FoodAPS than

[3] Sampling weights were constructed based on the FoodAPS survey stratification of households with the survey target groups determined by SNAP receipt and poverty status, and used to produce estimates that are nationally representative of U.S. households. To apply sampling weights, the committee used the *svyset* command in STATA (a data analysis and statistical software package).

TABLE 10-1 Households Examined in the Food Expenditure Analysis: Household (HH) Composition and Food Security Scores for WIC and Other Households, FoodAPS

	Proportion (%) of HH in the Sample (SE)		
Household Characteristic	WIC-Participating HH[a] (N = 461)	Eligible Non-WIC HH[b] (Pregnant, or Child < 5 years) (N = 306)	Non-WIC, Higher-Income HH[c] (Pregnant, or Child < 5 years) (N = 241)
Household Composition			
Any infants < 1 in HH	29.0 (2.7)	12.3 (3.0) [d]	14.9 (1.3) [d]
Any children (age 1– < 5) in HH	60.6 (5.1)	81.7 (4.0) [d]	79.3 (2.7) [d]
Any pregnant women in HH	24.8 (4.5)	10.8 (3.3) [d]	16.6 (3.9) [d]
Participation in SNAP	47.8 (3.7)	46.2 (4.7)	6.5 (1.5) [d]
Household size (number)	4.7 (0.2)	4.5 (0.2)	3.8 (0.9) [d]
Food Insecurity			
Food security score (sum of raw scores)	1.9 (0.2)[e]	1.8 (0.2)[e]	0.6 (0.1)[d,e]
1 (High food security)	43.9 (3.8)	47.4 (3.5)	66.9 (2.1)[d]
2 (Marginal food security)	22.2 (3.5)	23.8 (2.9)	23.3 (2.8)
3 (Low food security)	24.2 (3.2)	17.1 (3.5)	8.4 (2.5)[d]
4 (Very low food security)	9.6 (2.2)	11.7 (2.2)	1.5 (0.1)[d]
3&4 (Low and very low food security)	33.9 (3.0)	28.8 (4.5)	9.8 (1.8)[d]

NOTES: FoodAPS = Food Acquisition and Purchase Survey; HH = household; SE = standard error; SNAP = Supplemental Nutrition Assistance Program.
Subgroup definitions are as follows:

[a] All HH reporting participation in WIC regardless of income level.

[b] Low-income HH (≤ 185 percent of the PIR) that did not report participation in WIC.

[c] Higher-income HH (> 185 percent of the PIR) that did not report participation in WIC.

[d] Significantly different from the WIC households ($p < 0.01$). Levels of significance (tested between WIC HH and eligible non-WIC HH or higher-income HH) by t-test (for mean raw food insecurity scores) or by Pearson chi-squared (for household characteristics and the food security categories), and the Type I error rate was adjusted to account for multiplicity.

[e] Numbers represent the sum of raw scores. Lower numbers represent higher food security.

SOURCE: USDA Economic Research Service, National Household Food Acquisition and Purchase Survey (FoodAPS), data collected April 2012–January 2013 (USDA/ERS, 2015a). Population weights were applied.

in other surveys, particularly the CPS and the NHIS. In the FoodAPS, the period of reference was the 30-day period directly preceding the interview day. In the CPS, in contrast, households were first asked whether they experienced food-insecure conditions in the prior 12 months and only afterward, based on an initial affirmation of any food-insecure condition, were they asked about the past 30 days. The NHIS used a 30-day reference period but the survey was administered throughout the year, unlike the FoodAPS, which was administered between April and January. Also unlike the CPS and the NHIS, the FoodAPS was administered in the context of each household providing a detailed record of information on food purchases and acquisitions that is not collected in the other surveys (USDA/ERS, 2015b). (See also the section on food insecurity in Chapter 9.)

Food Expenditures

WIC households spent, on average, $184.80 per week on total food expenditures, mostly for FAH (see Table 10-2). Although the total food expenditures for WIC households were higher than those of eligible households that did not receive WIC benefits (significant at $p < 0.1$), differences in FAH and FAFH expenditures were not statistically significant. The higher-income households with similar demographic compositions (i.e., having a pregnant woman or child younger than 5 years old) spent more on total food, FAH, and FAFH, compared with the WIC households.

Nearly one-third of WIC households redeemed their WIC benefits to acquire food during the reporting week.[4] At the time of the FoodAPS, most WIC households had benefits provided in the form of paper vouchers. Some WIC products are provided in relatively large sizes or in forms (gallons of milk, dozen eggs, or 36 oz of ready-to-eat cereals) that could last for more than 1 week. Therefore, it is not expected that all WIC households would redeem some vouchers every week. Across all WIC households, the value of WIC benefits used was $10.80 per week, on average, representing almost 9 percent of FAH expenditures. Among the nearly one-third (32.3 percent) of WIC households using WIC benefits for purchases during the interview week, the average value of acquisitions made using WIC vouchers was $33.30 and represented 24 percent of FAH expenditures.

[4] Data-collection weeks for FoodAPS were distributed across each month based on when the household was determined eligible for the survey and when the initial interview could be scheduled. For food assistance programs like WIC and SNAP, data collection may have occurred up to 3 weeks after benefits were distributed.

TABLE 10-2 Weekly Food Expenditures for WIC and Other Households (HH) in FoodAPS

	Mean Weekly Expenditures in Dollars (SE)		
Expenditure Variable	WIC-Participating HH[a] (N = 461)	Eligible Non-WIC HH[b] (Pregnant, or Child < 5 years) (N = 306)	Non-WIC, Higher-Income HH[c] (Pregnant, or Child < 5 years) (N = 241)
Food Expenditures (1 week)			
Total food expenditures	184.80 (10.3)	160.20 (10.7)	242.50 (15.4)[d]
Food at home	124.20 (7.6)	113.20 (8.1)	164.10 (13.1)[d]
Food away from home	60.60 (6.6)	47.10 (4.9)	78.3 (6.4)[e]
Average value of WIC expenditures in week (for all WIC HH)	10.80 (1.8)		
Average value of WIC expenditures in week (for HH with WIC event in the interview week)	33.30 (4.1)		
WIC Expenditure Patterns (1 week)	*Percentage*		
Households using WIC in week	32.3 (3.8)		
WIC expenditures as share of total food expenditures (all WIC households)	5.8 (0.9)		
WIC expenditures as share of total food at home (for all WIC households)	8.8 (1.3)		
WIC expenditures as share of total food at home (for households with WIC event in week)	24.3 (2.5)		

NOTES: FoodAPS = Food Acquisition and Purchase Survey; HH = households; PIR = poverty-to-income ratio; SE = standard error; SNAP = Supplemental Nutrition Assistance Program. Subgroup definitions are as follows:

[a] All HH reporting participation in WIC regardless of income level.
[b] Low-income HH (≤ 185 percent of the PIR) that did not report participation in WIC.
[c] Higher-income HH (> 185 percent of the PIR) that did not report participation in WIC.
[d] Significantly different from the WIC households ($p < 0.01$).
[e] Significantly different from the WIC households ($p < 0.1$)

Levels of significance (tested between WIC HH and eligible non-WIC HH or higher-income HH) by t-test, and the Type 1 error rate was adjusted to account for multiplicity.

SOURCE: USDA Economic Research Service, National Household Food Acquisition and Purchase Survey (FoodAPS), data collected April 2012–January 2013 (USDA/ERS, 2015a). Population weights were applied.

SUMMARY AND LIMITATIONS

FoodAPS data provide a unique source of information on food expenditure patterns of U.S. households, including households that participate in the WIC program. The strengths and unique features of the data include being a nationally representative survey, sampling to represent SNAP participants and other households in three income groups, and having a sample with SNAP participation and expenditures verified through administrative records. The results of the committee's analysis show that, in any week of the month, an important share of WIC households redeem their WIC vouchers and, for these households, the value of the WIC foods is relatively high—almost one-fourth of the value of the foods acquired for home use.

There are a couple of noteworthy limitations to the data. The number of households surveyed is relatively limited (4,826 households). Although nationally representative, the FoodAPS relies primarily on self-reported participation in the WIC program to establish program participation. There were some households that redeemed WIC vouchers but did not report that they were currently participating in WIC. This difference may be due in part to lags in enrollment and benefit issuance. Also, as would be expected and as previously mentioned, some households had no food expenditures or no food expenditures for food at home during the survey week. The committee assumed that these households were similar to other households and that their lack of expenditures for that week reflected weekly variation in food purchase and acquisition patterns. That is, households with no food purchases captured in the survey week have purchased food at a different time in the month that WIC foods were prescribed.

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11

Findings and Conclusions

In response to its charge, the committee used evidence gathered from a range of sources, including a comprehensive literature review as well as targeted searches, government reports, workshops, on-site observations of the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) activities, and data analyses to develop the findings that are summarized in this chapter. The committee's conclusions from these findings were then used to establish a set of evaluative criteria and a framework to underpin the activities to be carried out in phase II and to guide the development of the committee's recommendations.

FINDINGS

The committee's findings are organized by chapter, with the exception of Chapter 3, "Approach to the Task," which covers the methods applied in this report and does not have findings.

Chapter 1

In Chapter 1 the committee reviewed the background and goals of the WIC program, as well as changes in the WIC population, WIC program administration, and changes to dietary patterns of the U.S. population and federal dietary guidance that have occurred since the 2006 review of WIC food packages. The key findings from the committee's review of this evidence are as follows:

1. The committee found that enrollment in WIC was stable up to 1 year after initial implementation of the 2009 food package changes; however, full implementation took place over several years during which further alterations to the food packages were made.
2. The decline in WIC participation after 2010 may have resulted from several national economic and demographic changes, which include a short-term decline in U.S. birth rate, changes in the U.S. economy, the 2013 federal government shutdown, and changes in the maximum benefit levels for other food assistance programs.
3. The 2009 changes in the food packages were based on Institute of Medicine (IOM) recommendations and options allowed in the final rule. These changes resulted in variability across states when the new food packages were actually implemented.
4. WIC serves a population with a diverse racial and ethnic composition, and this composition has not changed appreciably since the 2006 IOM review of WIC food packages.
5. Transitioning WIC benefits to the electronic benefit transfer (EBT) system is expected to improve participant flexibility in redeeming WIC foods. EBT should also allow for improved data collection on redemption patterns of WIC foods.
6. The committee found that the nine shortfall nutrients (vitamin A, vitamin D, vitamin E, vitamin C, folate, calcium, magnesium, fiber, and potassium for the general U.S. population as well as iron as a shortfall nutrient for adolescent and premenopausal females) identified in the *Scientific Report of the 2015 Dietary Guidelines Advisory Committee* (2015 DGAC report) should be considered in phase II. Four of these shortfall nutrients, calcium, vitamin D, fiber, and potassium, were also identified as nutrients of public health concern.
7. In contrast to the 2010 *Dietary Guidelines for Americans* (DGA), the 2015 DGAC report provided separate limits for intake of energy from saturated fats and added sugars, implying that energy from these two dietary components are not interchangeable.
8. The WIC food packages supplement the diets of women and children with smaller proportions of some foods than others relative to the amounts recommended in the 2015 DGAC report for 2,200 and 1,300 kcal food patterns, respectively.

Chapter 2

In Chapter 2, the committee reviewed factors that affect the WIC participant experience, including barriers to participation and redemption, availability and access to foods, and administrative and vendor challenges associated with implementing the WIC food packages. The key findings from this evidence are as follows:

1. Few studies have examined the cultural food preferences, feeding practices, or feeding styles of WIC participants.
   a. Although multiple studies have documented moderate to high satisfaction with the 2009 changes in the WIC food packages, evidence also indicates cultural variation in participants' satisfaction with certain types or amounts of food items.
   b. There were cultural differences in how young children are fed, but it was not possible to ascertain whether the WIC food packages were aligned with these feeding behaviors.
2. There were racial and ethnic differences in breastfeeding initiation and duration.
3. Barriers and incentives to WIC participation and benefit redemption were identified in the literature reviewed. However, the quantitative evidence was insufficient to support a causal relationship between these barriers and participation in the program.
4. Strategies from the field of behavioral economics may be promising when considering incentives to promote WIC participation and benefit redemption.
5. More than 90 percent of WIC participants primarily redeem their WIC benefits at supercenter-type stores or supermarkets.
6. Although there are challenges in the implementation of EBT, where implementation is complete, EBT has been positively received by WIC participants, state and local agencies, and the vendor community.
7. EBT data suggest that redemption varies among the different WIC foods. Relatively high redemption rates of fruits and vegetables suggest that the cash value voucher (CVV) is well utilized.
8. The final rule specified the required foods in the package, but options allowed within many food categories have permitted states to authorize a wider variety of options on state food lists.
9. Available evidence suggests that a wider variety of foods were available from WIC vendors to meet the package requirements after the 2009 changes to the food packages.
10. Despite administrative challenges, WIC vendors and the food industry were generally able to adapt to the 2009 interim rule and the 2014 final rule that implemented changes to food packages.

Chapter 4

In Chapter 4, the committee reviewed and analyzed evidence on nutrient intake and adequacy of WIC and low-income populations based on comparison to the Dietary Reference Intakes (DRIs). Analyses included a comparison between WIC participants and low-income nonparticipants before the 2009 food package changes (National Health and Nutrition Examination Survey [NHANES] 2005–2008), and comparison to the most recent data on intakes of WIC-eligible low-income children and women, regardless of WIC status (from NHANES 2011–2012). Unless otherwise indicated, the committee's findings were similar across the subgroups analyzed. Data were not evaluated for breastfed infants because sample sizes were too small for this group. As described in Chapter 3, if 5 percent or more of the population had an inadequate or excessive intake[1] of a nutrient in comparison to the appropriate DRI value, the committee considered intake for that nutrient to be low (or high if above the Acceptable Macronutrient Distribution Range [AMDR] or Upper Tolerable Intake Level [UL]) in that population. If the mean intake of the population was below the Adequate Intake (AI) value for a nutrient with an AI, the committee considered intake of that nutrient to be low for that population. The key findings from these analyses are as follows:

1. Across population subgroups, low-income women 19 to 50 years of age had inadequate intakes of calcium; copper; iron; magnesium; zinc; vitamins A, E, and C; thiamin; riboflavin; niacin; vitamin B6; folate; and protein compared to Estimated Average Requirements (EARs). Mean potassium, choline, and fiber intakes were below the AI.
2. Across population subgroups, low-income women 19 to 50 years of age had a 21 percent prevalence of inadequate vitamin D status, as measured by serum 25(OH)D.
3. Women 19 to 50 years of age who were participating in WIC had a higher prevalence of inadequacy for copper, iron, magnesium, zinc, vitamin C, thiamin, vitamin B6, and folate compared to low-income women not participating in WIC, although these differences were not statistically significant.
4. Across population subgroups, low-income fully formula-fed infants 0 to less than 6 months of age consumed less than the AI for choline.
5. Fully formula-fed infants ages 0 to 6 months are provided with approximately 8 mg of iron per day from formula, an amount that

[1] Low intake of carbohydrate was not considered of concern. Excess intake of zinc was not considered of concern because the method used to set the UL resulted in a narrow margin between the Recommended Daily Allowance (RDA) and the UL.

falls well above the AI (0.27 mg per day) but below the UL (40 mg per day) for this nutrient and age group.

6. Across population subgroups, low-income formula-fed infants 6 to less than 12 months of age had low iron intakes in comparison to the EAR, although prevalence of inadequacy was less than 10 percent across subgroups. WIC-participating infants 6 to less than 12 months of age had a lower prevalence of dietary iron inadequacy compared to income-eligible infants who were not participating in WIC, although these differences were not statistically significant.
7. Across population subgroups, low-income children 1 to less than 2 years of age had a high prevalence of vitamin E intakes below the EAR, and mean intakes of potassium and fiber that were below the AI for these nutrients.
8. Across population subgroups, low-income children 2 to less than 5 years of age had a high prevalence of calcium and vitamin E intakes below the EAR and mean potassium and fiber intakes below the AI.
9. Children 2 to less than 5 years of age who participated in WIC had a lower prevalence of calcium inadequacy compared to income-eligible children who were not participating in WIC.
10. More than 5 percent of WIC participants in specific subgroups exceeded the UL for a number of micronutrients[2]:
    a. Women ages 19 to 50 years: sodium, iron (slightly more than 5 percent of the population).
    b. Formula-fed infants 6 to less than 12 months: selenium.
    c. Children 1 to less than 2 years of age: sodium and selenium.
    d. Children 2 to less than 5 years of age: sodium, copper, and selenium.
11. The WIC food packages aim to reduce added salt, saturated fat, and added sugars. Nonetheless, across subgroups of WIC-participating women and children, intakes of all of these nutrients were excessive.[3]

[2] Excess zinc intakes in more than 5 percent of the population were found for formula-fed infants, children 1 to less than 2 years of age, and children 2 to less than 5 years of age. However, for the younger age groups, excess zinc intake was not considered of concern because the method used to set the UL resulted in a narrow margin between the RDA and the UL. For older children, there exists no evidence for adverse effects from zinc naturally occurring in food. Excess retinol intakes in more than 5 percent of the population were also found for formula-fed infants and children, but were not considered of concern due to a similarly narrow margin between the UL and the RDA. Toxicity from excess retinol intake is also rare (IOM, 2001).

[3] Excessive energy intakes were not included as a finding because likely under- or over-reporting in dietary intake surveys (as described in Chapter 4) complicates direct comparison to the Estimated Energy Requirement (EER).

12. The Nutrient-Based Diet Quality index indicated that the mean adequacy across 9 nutrients was 75 percent or less across all population groups, and only 50 percent for WIC women.

Chapter 5

Intakes of food groups and their subgroups among low-income populations were analyzed in Chapter 5, using the same population comparisons as in Chapter 4. In addition, the committee reviewed the available scientific literature for intake of foods among children less than 2 years of age. The key findings from these analyses are as follows:

1. Infants are progressively exposed to a variety of food groups as they transition to complementary foods, but may not have a broad exposure on any given day.
2. Introducing complementary food before 4 months of age appears to be more common among WIC-participating mothers compared to non-WIC mothers and those who do not exclusively breastfeed.[4] This practice has implications for infant weight gain and for health outcomes associated with inappropriate infant weight gain.
3. Estimates from the Infant Feeding Practices Study (IFPS) II suggest that approximately one-quarter of infants are introduced to cow's milk before the time recommended (1 year of age). Cow's milk consumption on any given day occurred in 13.3 percent of WIC infants 6 to less than 12 months of age in the 2008 Feeding Infants and Toddlers Study (FITS).
4. Published national survey data suggest four areas of concern for food group intakes of infants ages 0 to 24 months: early introduction of complementary foods; low intakes of iron-rich foods, particularly meats; early introduction of cow's milk; and consumption of desserts, sweetened beverages, and salty snacks.
5. Analyses of NHANES data for low-income children ages 2 to less than 5 years and women participating in or eligible for WIC showed that:
   a. For most food groups and subgroups, more than half of children and women had mean intakes below amounts recommended in the 2015 DGAC report.
   b. Whole grains, vegetables (particularly dark green and red-orange), and seafood were the food groups with the highest

[4] These data were collected prior to the 2009 food package changes, which delayed provision of complementary foods until 6 months of age.

prevalence of mean intakes below amounts recommended in the 2015 DGAC report.

c. Mean intakes of solid fats and added sugars exceeded the recommended limits specified in the 2015 DGAC report for almost all children and women (87 to 100 percent).

6. The number of low-income women in the NHANES 2011–2012 subgroups is small and distribution estimates are imprecise. This limits the ability to make population-level comparisons to recommended intake amounts. However, mean intake estimates can be compared across survey years.
7. Mean total Healthy Eating Index-2010 (HEI-2010) scores for women and children were well below the maximum possible score of 100 (51.9 for WIC women and 59.8 for WIC children). For WIC participating women, scores were lowest relative to the maximum possible score for greens and beans, whole grains, fatty acids (healthy fats), seafood and plant proteins, and empty calories. Scores for WIC-participating children were low for these components as well as for total vegetables. These findings are consistent with the committee's analysis on food group intakes.

Chapter 6

Nutrition-related health risks that are relevant to the WIC-eligible population were reviewed in Chapter 6. The key findings from this review are as follows:

1. General nutrition-related concerns for women of childbearing age include the high prevalence of overweight and obesity, excessive gestational weight gain, and poor breastfeeding success related to their weight and weight gain. Moreover, excess postpartum weight retention contributes to the development and persistence of overweight and obesity.
2. Iron is particularly important for pregnant and postpartum women because of the high prevalence of anemia among them, and the high amount required for optimal maternal and fetal health.
3. Folate is particularly important before and early in pregnancy for prevention of neural tube defects. Published evidence indicates that folate status is low among WIC participants.
4. For children, the primary nutrition-related concerns are the high prevalence of obesity and overweight, low iron status especially in children ages 1 to 3 years, and excessive intakes of added sugars and increased risk of dental caries.

5. Health concerns for the WIC population have not changed substantially since the last review.
6. There is some evidence to suggest that WIC has a positive effect on cognition in children, although it comes from observational studies and may be biased by self-selection into the program.
7. No evidence was found to suggest concern about the safety of foods in the WIC packages.

Chapter 7

In Chapter 7, the committee reviewed the literature on the health benefits of breastfeeding; breastfeeding trends in the general U.S. and WIC populations; barriers, motivators, and incentives for breastfeeding; and the effect of the WIC breastfeeding food package on breastfeeding promotion, initiation, and duration among WIC and low-income populations. The key findings from this review are as follows:

1. Literature specific to the WIC population suggests that breastfeeding (full or partial) for at least 4 months is associated with lower rates of childhood obesity.
2. National data show that there has been an increase in breastfeeding among women in the general population and a parallel increase among WIC participants, although at a lower prevalence.
3. Several barriers to breastfeeding were identified, including social norms, cultural factors, social structures, employment, and biomedical factors. The influence of each specific barrier on breastfeeding in the WIC population could not be determined.
4. WIC participation was associated with a lower proportion of women who initiate breastfeeding and shorter durations of exclusive and any breastfeeding compared to women not participating in WIC. Evidence on the effect of timing of entry into WIC on these outcomes was not conclusive.
5. Evidence suggests that breastfeeding promotion and support provided through the WIC program improve breastfeeding initiation and duration. Data are less convincing for effects of this promotion and support on exclusivity of breastfeeding.
6. WIC participants may perceive that the program delivers conflicting messages by supporting breastfeeding and also distributing infant formula at no cost to participants.
7. Small improvements in breastfeeding initiation were detected in some studies following the 2009 food package changes. However, it is not possible to determine whether these improvements resulted from the food package changes themselves, the enhanced breast-

feeding promotion and support activities that began at about the same time, or both.

Chapter 8

In Chapter 8, the committee considered subsets of the WIC population with unique dietary needs or food preferences, including the medically fragile, individuals with food allergies or intolerances, and those with unique dietary practices. The key findings from this review are as follows:

1. Food package III is critical to WIC participants, but providing the full food package in addition to the special foods/formula may be inappropriate for participants' conditions or may exceed their needs for supplementary food.
2. Food allergies among children increased approximately 50 percent between 1997 and 2011. The American Academy of Pediatrics (AAP) and the American Academy of Allergy recommend that infants be breastfed for 4 to 6 months to prevent food allergies and that the introduction of solid foods, whether they are potentially allergenic or not, should not be delayed beyond 4 to 6 months.
3. The current food packages allow substitutions for most allergenic foods but not for eggs and fish. Nearly half of states do not offer substitutions for those who follow Kosher or Halal diets.
4. The current food packages allow appropriate substitutions for celiac disease, gluten intolerance, and lactose intolerance.

Chapter 9

In Chapter 9, the committee reviewed the role of the WIC food packages in reducing nutritional risk factors in WIC participants, the relationship of dietary guidance to program goals, marketplace innovations, and flexibility, choice, and cost within the WIC food packages. The key findings from this review are as follows:

1. WIC promotes breastfeeding through "Loving Support," its social marketing program, and supports it more directly through peer counseling to individual participants and provision of breast pumps.
2. Lower proportions of individuals who began participating in WIC earlier in their pregnancies are food insecure compared to those who entered the program later. There is some evidence that self-selection bias may contribute to this finding.

3. WIC nutrition education enhances the intended health effects of the food package on participants' food selection and food preparation.
4. Although evidence suggests that a reduction in the energy density of infant formula to 19 kcal per fluid ounce does not inhibit physical growth, the long-term effects of using lower-energy formulas are unknown.
5. The 2015 DGAC report did not include a limit for cholesterol intake, which is consistent with recent recommendations from the American Heart Association/American College of Cardiology.
6. The WIC food packages are currently aligned with the 2015 DGAC report recommendations in that they provide whole grains, low-fat dairy, fruits, vegetables, and protein foods (legumes, peanut butter, fish, and eggs as well as in dairy foods). The allowed foods (other than cheese) are generally low in saturated fat and sodium. The allowed foods (other than yogurt) are low in added sugars.
7. The committee's review of functional ingredients (specifically, docosahexaenoic acid [DHA], arachidonic acid [ARA], probiotics, prebiotics, beta-carotene, lutein, and lycopene) and health outcomes requested by the USDA indicated insufficient scientific evidence supporting health benefits of these ingredients.

Chapter 10

In Chapter 10, the committee analyzed data from FoodAPS on food expenditures by WIC households and calculated the contribution of WIC benefits to total household food expenditures. The WIC households were compared with other households with a pregnant woman and/or child less than 5 years old. The key findings from these analyses are as follows:

1. Food insecurity is relatively high among surveyed WIC and other low-income households.
2. WIC households spend nearly two-thirds of total food expenditures for food at home.
3. Among the nearly one-third (32.3 percent) of WIC households using WIC benefits for purchases during the interview week, the value of acquisitions made using WIC vouchers represented 24 percent of food-at-home expenditures.

PRELIMINARY NUTRIENT AND FOOD GROUP PRIORITIES

The committee's data gathering and analyses described in Chapters 4 and 5, as well its review of health risks in Chapter 6, led to the identification of potential target nutrients and food groups for WIC participants of specific ages. These findings are organized in the following tables by age group: (1) nutrients for which inadequacy is apparent in more than 5 percent of the indicated age subgroup, or is prioritized based on other information (see Table 11-1a), (2) nutrients for which mean usual intakes fall below the AI value (see Table 11-1b), (3) nutrients for which more than 5 percent of the population exceeds the UL (see Table 11-2), and (4) food groups for which at least 50 percent of the population falls below or above recommendations (see Table 11-3).

CRITERIA FOR REVIEW OF THE WIC FOOD PACKAGES

The criteria that the committee established to underpin the phase II analyses and evaluation and to guide development of its recommendations are described below and incorporated into Figure 11-1. The final criteria were only slightly modified from the criteria applied by the IOM (2006) Committee to Review WIC Food Packages because, after a thorough review of the evidence, the committee concluded that these criteria were comprehensive and remained relevant. These criteria reflect the committee's priorities to, first, meet the goals of the WIC program; second, respond to the requirement that the WIC food packages be aligned with the 2015 DGA; and, third, provide a package that is acceptable to participants and feasible to implement at every level. The chapters of the report that contain information relevant to criteria are shown in parentheses.

Criterion 1

The packages contribute to reduction of the prevalence of inadequate nutrient intakes and of excessive nutrient intakes. Rationale: WIC is a supplemental food program and is designed to provide specific nutrients determined by nutritional research to be lacking in the diets of the WIC population. As described in Chapter 4 and listed in Tables 11-1a and 11-1b, the committee's evaluation of nutrient intakes among WIC-eligible populations led to the identification not only of shortfall nutrients for most subpopulations, but also nutrients with excessive intake for most subpopulations (see Chapters 4 and 6).

Criterion 2

The packages contribute to an overall dietary pattern that is consistent with the DGA for individuals 2 years of age and older. Rationale: At the request of USDA's Food and Nutrition Service (FNS), a goal of the phase II recommendations is to ensure that WIC food packages are consistent with the 2015 DGA. As described in Chapter 5, analyses of available data sug-

TABLE 11-1a Nutrients with Evidence of Inadequate Intake[a] in the Diets of WIC Participant Subgroups

Nutrient	Pregnant, BF, or PP Women, 19 to 50 Years	FF Infants 6 to Less Than 12 Months	Breastfed Infants 6 to Less Than 12 Months	Children 1 to Less Than 2 Years	Children 2 to Less Than 5 Years
Calcium	✓				✓
Copper	✓				
Iron	✓	✓	✓[b]		
Magnesium	✓				
Zinc	✓				
Vitamin A	✓				
Vitamin D[c]	✓				
Vitamin E	✓			✓	✓
Vitamin C	✓				
Thiamin	✓				
Riboflavin	✓				
Niacin	✓				
Vitamin B6	✓				
Folate	✓				
Protein	✓[d]				

NOTES: BF = breastfeeding; FF = formula fed; PP = postpartum. Table is based on results for WIC-participating individuals in NHANES 2005–2008. The committee found no evidence of inadequate intake in the diets of formula-fed infants 0 to 6 months of age.

[a] Nutrients listed represent those for which 5 percent or more of each population subgroup had intakes below the Estimated Average Requirement (EAR), unless otherwise noted.

[b] Based on the committee's literature review findings of a high risk of low iron intakes in breastfeeding infants.

[c] Based on serum 25(OH)D below 40 nmol/L. Serum levels were not available for infants.

[d] More than 5 percent of this subgroup had intakes below the Acceptable Macronutrient Distribution Range (AMDR).

SOURCES: Intake data were obtained from NHANES 2005–2008 (USDA/ARS, 2005–2008). EARs from Dietary Reference Intake reports (IOM, 1997, 1998, 2000, 2001, 2002/2005, 2011a).

TABLE 11-1b Nutrients for Which Mean Usual Intake Falls Below the Adequate Intake (AI) in the Diets of WIC Participant Subgroups*

Nutrient	P, BF, or PP Women, 19 to 50 Years	FF Infants 0 to 6 Months	Children 1 to Less Than 2 Years	Children 2 to Less Than 5 Years
Potassium	✓		✓	✓
Choline	✓	✓		
Fiber	✓		✓	✓

NOTES: BF = breastfeeding; FF = formula fed; P = pregnant; PP = postpartum. Table is based on results for WIC-participating individuals in NHANES 2005–2008. Mean intakes of infants 6 to less than 12 months of age fell above the AI.

* Breastmilk intakes were not quantified for breastfed infants.

SOURCES: Intake data were obtained from NHANES 2005–2008 (USDA/ARS, 2005–2008). AIs from Dietary Reference Intake reports (IOM, 1998, 2005).

TABLE 11-2 Micronutrients with Evidence of Intakes Exceeding the Tolerable Upper Intake Level (UL)* in the Diets of WIC Participant Subgroups

Nutrient	P, BF, or PP Women, 19 to 50 Years	FF Infants 6 to Less Than 12 Months	Children 1 to Less Than 2 Years	Children 2 to Less Than 5 Years
Copper				✓
Iron	✓			
Selenium		✓	✓	✓
Sodium	✓		✓	✓

NOTES: BF = breastfeeding; FF = formula fed; P = pregnant; PP = postpartum. Table is based on results for WIC-participating individuals in NHANES 2005–2008. Only nutrients with intakes above recommended levels in more than 5 percent of the population for at least one population subgroup are presented. The committee's literature review found no evidence of excess nutrient intake for breastfeeding infants or formula-fed infants 0 to 6 months of age.

* Nutrients represent those for which 5 percent or more of the population subgroup exceeded the UL.

SOURCES: Intake data are from NHANES 2005–2008 (USDA/ARS, 2005–2008). ULs from Dietary Reference Intake reports (IOM, 1998, 2001, 2005, 2011a).

TABLE 11-3 Food Groups with Evidence of Intakes Below and Above Amounts Recommended in the 2015 DGAC Report in the Diets of WIC Participant Subgroups

Food Group	P, BF, or PP Women, 19 to 50 Years[a]	Children 2 to Less Than 5 Years[b]
Intakes Below Recommended Amounts		
Total fruit	✓	
Total vegetables	✓	✓
Dark green	✓[c]	✓
Red and orange	✓	✓
Beans and peas	✓	✓
Total starchy	✓	✓
Other vegetables	✓	✓
Total grains	✓	
Whole grains	✓	✓
Total protein foods	✓	✓
Seafood	✓	✓
Nuts, seeds, and soy	✓	✓
Total dairy	✓	✓
Oils	✓	✓
Intakes Above Recommended Amounts[d]		
Solid fat	✓	✓
Added sugars	✓	✓

NOTES: BF = breastfeeding; 2015 DGAC = *Scientific Report of the 2015 Dietary Guidelines Advisory Committee*; P = pregnant; PP = postpartum. Food groups and subgroups listed are those for which 50 percent or more of the population subgroup had intakes falling below levels recommended in the 2015 DGAC report, or in the case of food groups to limit, above levels recommended in the 2015 DGAC report. The table is based on results for WIC-participating women and children in NHANES 2005–2008. The USDA food patterns do not apply to infants and children less than 2 years of age; thus, these age groups were omitted from the table. The committee's literature review found no evidence to support that specific food group

TABLE 11-3 Continued

intakes are low among breastfeeding infants, although low intake of iron-containing foods may be of concern.

[a] Based on the 2015 DGAC food pattern for a 2,200 kcal diet, which was the EER calculated for women in this report.

[b] Recommended intakes were generated by weighting the 1,000 and 1,300 (averaged from 1,200 and 1,400 kcal patterns) kcal food patterns in a 1:3 ratio. This results in a food pattern equivalent to approximately 1,225 kcal, slightly under the EER calculated for children 2 to 5 years of age of approximately 1,300 kcal; therefore, intakes for this age group in comparison to recommendations may be slightly overestimated.

[c] Too few individuals in NHANES 2005–2008 for this age group reported consumption to produce population-level estimates of intake, suggesting that intakes may be low.

[d] Indicates usual mean intake levels above the upper limit defined by the 2015 DGAC report food pattern comparisons for each age group.

SOURCES: Intake data are from NHANES 2005–2008 (USDA/ARS, 2005–2008). Reference values are the USDA food patterns from the *Scientific Report of the 2015 Dietary Guidelines Advisory Committee* (USDA/HHS, 2015).

gest that intake of nearly all of the food groups and subgroups are low in comparison to the 2015 DGAC report food patterns (see Chapter 5).

Criterion 3

The packages contribute to an overall diet that is consistent with established dietary recommendations for infants and children less than 2 years of age, including encouragement of and support for breastfeeding. Rationale: Because the DGA do not apply to infants and children less than 2 years of age, WIC food packages should be consistent with guidance from the AAP, the Academy of Nutrition and Dietetics, and the World Health Organization for subgroups within that age group (see Chapters 3 and 9).

Criterion 4

The foods in the packages are available in forms and amounts suitable for low-income persons who may have limited transportation options, storage, and cooking facilities. Rationale: The goal of the WIC food packages to provide food and nutrients lacking in the diets of women, infants, and children cannot be met if transportation, storage, or food preparation barriers prevent redemption or consumption of the issued foods. Considering the degree to which these barriers are present and the means by which the food packages can accommodate the lifestyle of WIC participants is important to attaining the goal of consumption of the issued foods (to be evaluated in phase II).

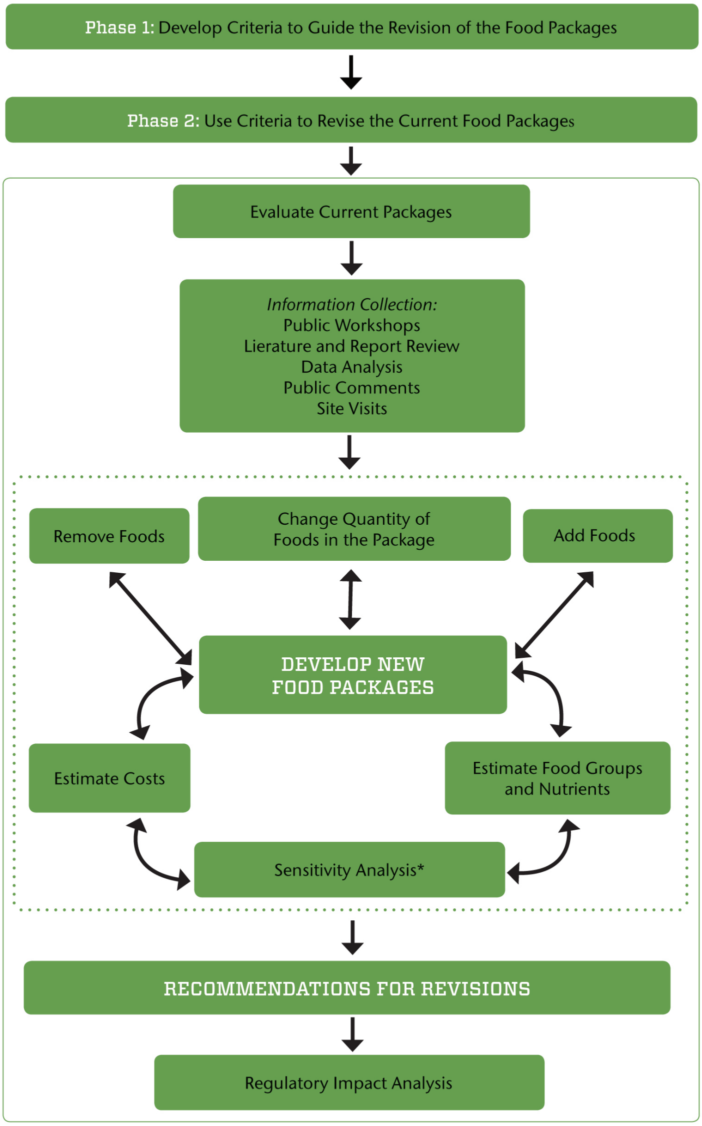

FIGURE 11-1 Process for revising the WIC food packages.
NOTE: The dotted line indicates components of the process that iterate until the criteria for food package revisions are met (see Box S-1).
* The sensitivity analysis includes considerations for maintaining the cost neutrality of the overall WIC food packages.

Criterion 5

The foods in the packages are readily acceptable, commonly consumed, and widely available; take into account cultural food preferences; and provide incentives for families to participate in the WIC program. Rationale: Similar to criterion 4, consumption of WIC foods may be influenced by the acceptability, preferences for, or availability of foods that are issued in the food packages (see Chapters 2, 7, 8, 9, and 10).

Criterion 6

The foods in the packages will take into consideration the effect of changes in the packages on vendors and WIC agencies. Rationale: The WIC program is administered by the USDA-FNS and numerous state and local agencies. At the request of the USDA-FNS, the proposed changes should not unduly add to the administrative burden of these agencies. Additionally, given the central role of the retail food environment on the WIC participant experience (see Figure 2-1), the proposed changes should not unduly add to the administrative burden of WIC vendors (see Chapters 2 and 9).

NEXT STEPS: PROCESS FOR PHASE II

The criteria outlined above will be further explored (and possibly revised) in phase II after consideration of the results of analysis of nutrient and food consumption by WIC participants in NHANES 2011–2012 and limitations related to cost. The committee's proposed process for revising the WIC food packages in phase II is illustrated in Figure 11-1. The objective is to ensure that the revisions fall within the criteria outlined in the previous section. First, the current food packages will be evaluated for the nutrients and food groups provided as well as the challenges faced during implementation. After reviewing this information, the committee will identify priority changes in the food packages and test possible changes in an iterative fashion to align with the criteria and ensure overall program cost neutrality. The committee anticipates that this process will involve trade-offs, with final recommendations guided by the criteria and cost constraints. Once the iterations result in changes that meet the criteria, recommendations will be finalized. A regulatory impact analysis will then be conducted to assess the effect of changes in WIC food packages on program participation, the value of the food packages as selected, and program costs and administration.

CONCLUSIONS AND DEVELOPMENT OF THE APPROACH IN PHASE II

The overall conclusions based on the committee's phase I review are summarized below. The conclusions and supporting evidence will be updated and used in conjunction with additional planned analyses to develop the committee's recommendations in phase II.

1. Participation in WIC has declined recently. The reasons for this are likely multifaceted and cannot be attributed to the initial rollout of the food package changes. Paper vouchers are being replaced by EBT, which may improve program participation as well as redemption of issued benefits.
2. There are some racial and ethnic differences in satisfaction with specific items in the food packages but, aside from the limited availability of Kosher and Halal food options, the packages appear to be broadly culturally suitable.
3. Both women and children (children ages 2 to less than 5 years) WIC participants had low or inadequate intakes of several nutrients that could potentially be addressed with food package changes. These inadequacies may be linked to food intakes that fell below recommendations for specific food groups.
4. Women, infants, and children had excessive intakes of several nutrients. In some cases, these excessive intakes may be addressed with changes to the food packages; in other cases, they may be addressed with nutrition education.
5. Inasmuch as the sample size of low-income women in the NHANES 2011–2012 analysis was small, it was not possible to estimate the proportion of the population with food group intakes that were inadequate or excessive compared to recommended intakes. Small sample sizes for some of the population subgroups are likely to limit further disaggregation into WIC participants and WIC-eligible nonparticipating individuals. Therefore, in phase II, mean intakes can be compared between groups and to recommendations, but a population-level comparison to recommended intakes for women before and after the 2009 food package changes is unlikely to be possible.
6. The committee notes that the NHANES 2005–2008 nutrient and food intake data do not capture the impact of the 2009 food package changes. Results from these survey years are therefore not suitable to serve as the sole basis for final determination of nutrient and food group priorities in phase I. The nutrient and food group gaps identified in this report will be re-evaluated in phase II as the

NHANES 2011–2012 "WIC" identifier is incorporated into the analysis.

7. Breastfeeding promotion and support appear to play a role in the improvement of breastfeeding initiation, duration, and exclusivity among WIC participants. The 2009 changes to the food package to improve support for breastfeeding women were associated with only limited positive changes in breastfeeding behavior. There may be additional possibilities for aligning the food packages with support for breastfeeding women.
8. The current WIC food packages provide adequate options for participants with most major food allergies, celiac disease, and food intolerances, but inclusion of substitutions for eggs and fish may be warranted.
9. Vendors and manufacturers were able to adapt to the 2009 food package changes with some challenges. It is important to consider the feasibility of potential future food package changes from the perspectives of vendors and food manufacturers.

The committee's phase II activities will include an update to the comprehensive scientific literature review that was conducted for this interim report, a re-evaluation of the nutrient and food intake data compared to the 2015 DGA, an evaluation of nationwide costs and distribution of foods to ensure that the recommended new food packages are efficient for nationwide distribution, and sensitivity and regulatory impact analyses. A sensitivity analysis will consider each recommended alternative food item and change in quantity relevant to nutrients, the DRIs, food groups and subgroups, and cost. A regulatory impact analysis will assess the impact of proposed WIC food package changes on program participation, the value of the food packages, and program cost and administration. Additional details of the approaches to be used for the different activities are discussed in Chapter 3. Additionally, the committee will continue its iterative process and modify the criteria described above and the decision-making framework for making changes to the food packages, if deemed necessary.

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Appendix A

Acronyms and Abbreviations

αTOC	α-tocopherol
μg	microgram or micrograms
AAP	American Academy of Pediatrics
ACC	American College of Cardiology
ADA	American Diabetes Association
AHA	American Heart Association
AHRQ	Agency for Healthcare Research and Quality
AI	Adequate Intake
AMDR	Acceptable Macronutrient Distribution Range
AND	Academy of Nutrition and Dietetics
ARA	arachidonic acid
ARS	Agricultural Research Service, U.S. Department of Agriculture
BF	breastfeeding
BLS	U.S. Bureau of Labor Statistics
BMI	body mass index
c	cup or cups
CACFP	Child and Adult Care Food Program
CDC	Centers for Disease Control and Prevention
C.F.R.	Code of Federal Regulations

CNPP	Center for Nutrition Policy and Promotion, U.S. Department of Agriculture
CPI	Consumer Price Index
CPS	Current Population Survey
CVD	cardiovascular disease
CVV	cash value voucher
d	day or days
DASH	Dietary Approaches to Stop Hypertension
DFE	dietary folate equivalent
DGA	*Dietary Guidelines for Americans*
DGAC	Dietary Guidelines Advisory Committee
DGV	dark green vegetables
DHA	docosahexaenoic acid
DRI	Dietary Reference Intake
EAR	Estimated Average Requirement
EBT	electronic benefit transfer
ECLS-B	Early Childhood Longitudinal Study-Birth Cohort
EER	Estimated Energy Requirement
eq	equivalent
ERS	Economic Research Service, U.S. Department of Agriculture
F&V	fruits and vegetables
FDA	U.S. Food and Drug Administration, U.S. Department of Health and Human Services
FF	formula fed
FITS	Feeding Infants and Toddlers Study
FLSA	Fair Labor Standards Act
FNS	Food and Nutrition Service, U.S. Department of Agriculture
FoodAPS	National Household Food Acquisition and Purchasing Survey
FPED	Food Patterns Equivalent Database
g	gram or grams
GAO	U.S. Government Accountability Office
GDM	gestational diabetes mellitus
GI	glycemic index
GRAS	generally recognized as safe
HBW	high birth weight

HEI	Healthy Eating Index
HHS	U.S. Department of Health and Human Services
IFPS II	Infant Feeding Practices Study II
IOM	Institute of Medicine
IRI	Information Resources Incorporated
ISU	Iowa State University
ITO	Indian Tribal Organization
IU	international unit
kcal	kilocalorie or kilocalories
kg	kilogram or kilograms
LBW	low birth weight
LGA	large for gestational age
mg	milligram or milligrams
MIS	management information system
MMA	maximum monthly allowance
N	sample size
NASS	National Agricultural Statistical Service, U.S. Department of Agriculture
NBDQ	Nutrient-Based Diet Quality
NCGS	non-celiac gluten sensitivity
NHANES	National Health and Nutrition Examination Survey
NHIS	National Health Interview Survey
NIS	National Immunization Survey
NPNL	nonpregnant, nonlactating
NSLP	National School Lunch Program
NSWP	National Survey of WIC Participants
NTD	neural tube defect
nutr	nutrients
oz	ounce or ounces
P	pregnant
PC	peer counselor
PC-SIDE	PC Software for Intake Distribution Estimation
PedNSS	Pediatric Nutrition Surveillance System
PIH	pregnancy-induced hypertension
PIM	perceived insufficient milk
PIR	percent income-to-poverty ratio

PNSS	Pregnancy Nutrition Surveillance System
PP	postpartum
PRAMS	Pregnancy Risk Assessment Monitoring System
RAE	retinol activity equivalents
RDA	Recommended Dietary Allowance
Red-Or	red and orange vegetables
RIA	Regulatory Impact Analysis
SE	standard error
SGA	small for gestational age
SNAP	Supplemental Nutrition Assistance Program
SPADE	Statistical Program for Age-adjusted Dietary Assessment
T2D	type 2 diabetes
TANF	Temporary Assistance for Needy Families
tsp	teaspoon or teaspoons
UL	Tolerable Upper Intake Level
USDA	U.S. Department of Agriculture
WHO	World Health Organization
WIC	Special Supplemental Nutrition Program for Women, Infants, and Children
wk	week or weeks
WP	white potatoes
WWEIA	*What We Eat in America* (NHANES)

Appendix B

Glossary

Abruptio placentae	The separation of the placenta from its attachment to the inner wall of the uterus before the baby is delivered
Acceptable Macronutrient Distribution Range (AMDR)	Range of macronutrient intake that is associated with reduced risk of chronic disease, while providing recommended intakes of other essential nutrients
Added sugars	Sugars that are added to foods or beverages when they are processed or prepared, not naturally occurring in foods
Adequate Intake (AI)	The recommended average daily intake level based on observed or experimentally determined estimates of nutrient intake of groups of apparently healthy people that are assumed to be adequate; used when an Estimated Average Requirement (EAR) cannot be determined
Anemia	Condition that occurs when the body does not have enough red blood cells or when the red blood cells do not function properly
Arachidonic acid	A polyunsaturated omega-6 fatty acid found in animal fats that is essential in human nutrition

Bacterial vaginosis	An infection caused when too much of certain bacteria change the normal balance of bacteria in the vagina
Cardiometabolic profile	Factors used to identify individuals at increased risk for cardiovascular disease, including higher blood pressure, greater insulin resistance, lower adiponectin, and higher low-density lipoprotein (LDL) cholesterol
Cash value voucher (CVV)	A monthly voucher in the WIC food package ($11 for women and $8 for children) that allows for the purchase of a variety of fruits and vegetables
Celiac disease	An autoimmune disorder that can occur in genetically predisposed people where the ingestion of gluten leads to damage in the small intestine
Complementary foods	Foods other than breast milk or infant formula introduced to an infant to provide nutrients
DASH Eating Plan	The Dietary Approaches to Stop Hypertension (DASH) diet is a dietary pattern shown to prevent and control hypertension emphasizing vegetables and fruits, whole grains, and lean meats, while limiting sodium and sugar
Docosahexaenoic acid (DHA)	An omega-3 fatty acid found in cold-water, fatty fish
Electronic benefit transfer (EBT) card	An electronic system that allows a recipient to authorize transfer of his or her government benefits from a federal account to a retailer account to pay for products received
Estimated Average Requirement (EAR)	A nutrient intake value that is estimated to meet the requirement of half the healthy individuals in a population
Estimated Energy Requirement (EER)	The average dietary energy intake that is predicted to maintain energy balance in a healthy adult of a defined age, gender, weight, height, and level of physical activity consistent with good health

Fair Labor Standards Act (FLSA)	The FLSA establishes minimum wage, overtime pay, recordkeeping, and youth employment standards affecting employees in the private sector and in federal, state, and local governments
Farm-to-school programs	A program in the United States through which schools buy and feature in their menus locally produced foods such as fruits and vegetables, eggs, honey, meat, and beans
Federal poverty guidelines	Guidelines used by the U.S. government to determine financial eligibility for certain federal programs, issued each year in the *Federal Register* by the U.S. Department of Health and Human Services (HHS)
Final Rule	7 C.F.R. § 246 in the *Federal Register* updated on March 4, 2014, to reflect revisions to the WIC food packages proposed in the 2006 IOM report *WIC Food Packages: Time for a Change*
Food allergy	An adverse health effect arising from a specific immune response that occurs reproducibly on exposure to a given food
Food composition data	Calorie and nutrient content of foods
Food insecurity	Limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways
Food security	The World Food Summit of 1996 defined food security as existing “when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life”
Full-redemption	All foods prescribed in WIC package were purchased in the quantities available using monthly benefits

Fully breastfed	"Exclusive breastfeeding" is defined by the World Health Organzation as giving no other food or drink—not even water—except breast milk. It does, however, allow the infant to receive oral rehydration salts (ORSs), drops, and syrups (vitamins, minerals, and medicines)
Functional ingredient	Nutrient or nonnutrient component added to foods that may provide a health benefit beyond basic nutrition and is considered safe at estimated national levels of consumption
Gestational diabetes	Type of diabetes that is first seen in a pregnant woman who did not have diabetes before she was pregnant
Gestational weight gain	Amount of weight gained during pregnancy
Gluten	Proteins found in wheat, rye, barley, and triticale
Glycemic index	A ranking of carbohydrates on a scale from 0 to 100 according to the extent to which they raise blood sugar levels after eating
Halal	When used in relation to food products, Halal refers to any foods that are allowed to be eaten according to Islamic Sharia law. Foods that are not considered Halal include pork and its byproducts, alcohol, and animals not slaughtered properly according to Islamic law
Healthy Eating Index (HEI)	A measure of diet quality that assesses conformance to the *Dietary Guidelines for Americans*
Healthy People 2020	A set of goals and objectives released by the U.S. Department of Health and Human Services with 10-year targets designed to guide national health promotion and disease prevention efforts to improve the health of all people in the United States
Heme iron	Easily absorbed form of dietary iron that comes primarily from meat
Hydrolyzed protein	Protein that has been broken down into its component amino acids

Hypoglycemia	A condition characterized by an abnormally low level of blood sugar (glucose)
Income-to-poverty ratio	Measurement of the depth of poverty as determined by how close a family's or individual's income is to their poverty threshold. Families and individuals with an income-to-poverty ratio of less than 100 percent are identified as being in poverty. An income-to-poverty ratio of 50 percent indicates a family or person is living in deep poverty
Indian Tribal Organization	Any tribe, band, nation, or other organized group or community, including any Alaska Native village, regional corporation, or village corporation that is recognized by the Secretary of the Interior as eligible for the special programs and services provided by the United States to Indians because of their status as Indians
Interconceptional nutrition	Dietary intake and status of a woman during her reproductive years, between pregnancies, and 6 weeks after delivery
ISU method	Method developed at Iowa State University (ISU) to estimate the distributions of usual intake of nutrients, foods consumed almost daily, and other dietary components
Kosher	When used in relation to food products, "Kosher" means that the item in question meets the dietary requirements of Jewish law. Restrictions include those pertaining to types of animals that can be eaten, the process by which they are slaughtered, and the separation of meat and milk
Lactose intolerance	An inability to digest lactose, which causes symptoms such as bloating, diarrhea, and gas after eating or drinking milk or milk products
Loving Support	The U.S. Department of Agriculture's (USDA's) national breastfeeding promotion and support campaign that provides education, training, and outreach materials for staff of the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). Resources are also available for women and their families and friends and health care providers and community partners

Macronutrient	Dietary components that constitute the bulk of the diet and supply energy and many essential nutrients, including carbohydrates, proteins (including essential amino acids), and fats (including essential fatty acids)
Management information system (MIS)	A computerized database of information organized and programmed in such a way that it produces regular reports on operations for management in an organization
Maximum monthly allowance (MMA)	The maximum amount of a specific food a participant is allowed in WIC food packages
Micronutrient	Dietary component required by the body in small amounts that are vital to development, disease prevention, and well-being. Micronutrients are not produced in the body and must be derived from the diet
Nonceliac gluten sensitivity (NCGS)	A form of gluten intolerance that neither meets the diagnostic criteria for celiac disease nor those for wheat allergy
Nonredemption	No foods prescribed in WIC package were purchased using monthly benefits
Nutrient-Based Diet Quality (NBDQ) Index	An index developed for this report to measure of the adequacy of nutrient intake and diet quality in the WIC population based on the mean probability of adequacy for the nine shortfall nutrients, calculated for each individual, as compared to Dietary Reference Intake (DRI) values
Nutrients of public health concern	According to the Dietary Guidelines Advisory Committee, within the larger category of shortfall nutrients (nutrients inadequately consumed by the U.S. population), nutrients of public health concern are of particular importance because their underconsumption has been linked to adverse health outcomes
Omega-3 fatty acid	An unsaturated fatty acid occurring chiefly in fish oils, reported to benefit cardiovascular health

Partial-redemption	Some amount of foods prescribed in WIC package was purchased with some benefit remaining at the end of the month
Partially breastfed	The World Health Organization definition of partial breastfeeding is: "giving a baby some breastfeeds, and some artificial feeds, either milk or cereal, or other food"
Patient Protection and Affordable Care Act	Comprehensive health insurance reforms enacted to improve access, affordability, and quality of health care for Americans
PC Software for Intake Distribution Estimation (PC-SIDE)	Software for intake distribution estimation developed at Iowa State University
Perceived insufficient milk (PIM)	A state in which a mother has or perceives that she has an inadequate supply of breast milk to meet her infant's needs
Prebiotics	Natural, nondigestible food ingredients that are linked to promoting the growth of helpful bacteria in the gut. They include fructo-oligosaccharides, such as inulin, and galacto-oligosaccharides
Preeclampsia	Pregnancy-induced hypertension that occurs after the 20th week (late 2nd or 3rd trimester) of pregnancy
Pregnancy-induced hypertension	A pregnancy complication characterized by high blood pressure, swelling due to fluid retention, and protein in the urine
Probiotics	Live microorganisms that help change or repopulate intestinal bacteria to balance gut flora. This functional component may boost immunity and overall health, especially gastrointestinal health. Probiotics are available to consumers mainly in the form of dietary supplements and foods
Regional food hubs	A business or organization that actively manages the aggregation, distribution, and marketing of source-identified food products primarily from local and regional producers to strengthen their ability to satisfy wholesale, retail, and institutional demand

Selection bias	A distortion of the measured effect resulting from procedures used to select subjects such that the relation between exposure and disease is different for those who participate and those who would be eligible but do not participate
Sensitivity analysis	Study of how the uncertainty in the output of a model can be attributed to different sources of uncertainty in the model inputs
Shortfall nutrients	Nutrients identified by the Dietary Guidelines Advisory Committee as underconsumed by the U.S. population relative to Dietary Reference Intake (DRI) recommendations
Split tender	Participants may pay the difference out of pocket if their fruit and vegetable purchase exceeds the amount on the cash value voucher
State agency	State agencies administering the WIC program
Statistical Program for Age-adjusted Dietary Assessment (SPADE)	Statistical method for estimating usual dietary intake distributions
Supplemental food	"Those foods containing nutrients determined by nutritional research to be lacking in the diets of pregnant, breastfeeding, and postpartum women, infants, and children, and foods that promote the health of the population served by the WIC Program as indicated by relevant nutrition science, public health concerns, and cultural eating patterns, as prescribed by the Secretary" (Public Law 95-627, § 17)
Tachycardia	A faster than normal heart rate at rest
Temporary Assistance for Needy Families (TANF)	A federal program that provides grant funds to states and territories to provide financial assistance and related support services to pregnant women and families with one or more dependent children. State-administered programs may include childcare assistance, job preparation, and work assistance

Tolerable Upper Level Intake (UL)	The highest average daily nutrient intake level that is likely to pose no risk of adverse health effects to almost all individuals in the general population
Type 2 diabetes	A chronic condition that affects the metabolism of glucose caused by the body's ineffective use of insulin
Universal Product Code (UPC)	A unique 12-digit number assigned to retail goods that identifies both the product and the vendor that sells the product
USDA food pattern	Food patterns grouped by kilocalorie levels developed by the USDA to help individuals carry out *Dietary Guidelines for Americans* recommendations

Appendix C

Comparison of Institute of Medicine 2006 Recommendations and Regulatory Implementation

TABLE C-1 Comparison of IOM 2006 Recommendations and USDA and State Implementation Specific to Meeting Dietary Guidance

2006 IOM Report		USDA Action	
Major Proposed Changes	Specific Recommendation	Federal Regulation[a]	State Option
Include fruits and vegetables for all individuals 6 months and older	Provide a CVV for fruit and vegetable purchases, $8 for children and $10 for women; allow fresh and processed, and jarred infant fruits and vegetables. One pound of fresh bananas may replace 8 oz of baby food	Provide a CVV of $8 for children; $10 for women; fruits and vegetables may be fresh or processed with no added sugars or fats; vendors must stock at least two fruits and two vegetables	States may allow fresh and/or processed; may restrict packaging[b]; may allow farmers' markets to accept vouchers; substitution of a portion of jarred infant fruits and vegetables with a CVV ($4 for partially BF, $6 for fully BF) by individual assessment
Include more whole grain products	Allow only whole grain breakfast cereals[c]	At least one-half of all breakfast cereal on each state agency's authorized food list must have whole grain as the primary ingredient by weight *and* meet labeling requirements for making a health claim as a "whole grain food with moderate fat content"	States may select authorized cereals
	Allow whole grain bread with other possible whole grain substitutions	Allow whole wheat bread, brown rice, bulgur, oats, whole-grain barley, soft corn or whole wheat tortillas, and whole wheat macaroni products	States may select authorized breads and substitutions

Reduce amounts of saturated fat for participants ages 2 years and older (thereby reducing cholesterol and total fat provided)	Reduce quantities of milk Permit whole milk for children 1 to 2 years of age Reduce quantity of cheese Reduce quantity of eggs[d]	Reduce amounts of milk Permit whole milk between 1 and 2 years of age only; for others milk must be skim or 1% only Reduce cheese and limit substitution rate Reduce quantity of eggs	No option to increase milk amounts States may issue reduced-fat milks to infants 1 year of age if weight is a concern No option to increase substitution of cheese for milk No option for eggs
Provide more flexibility for WIC state agencies and more variety and choice for WIC participants	In grain category, allow soft corn or whole wheat tortillas, brown rice, oatmeal, bulgur, and barley, as bread substitutes; allow soy beverage, tofu, and yogurt as milk substitutes; allow canned beans; allow tuna, sardines, mackerel, and salmon	Whole grain tortillas (corn or wheat), brown rice, oatmeal, bulgur, barley, and whole wheat pasta may be substituted for bread; tofu may be substituted for milk; yogurt may be substituted for 1 q milk; dried or canned beans; tuna, salmon, sardines, and jack mackerel permitted as fish options	States must provide bread, milk, dry or canned beans, and at least two fish options; additional substitutions at state option

continued

TABLE C-1 Continued

2006 IOM Report		USDA Action	
Major Proposed Changes	Specific Recommendation	Federal Regulation[a]	State Option
Promote and support breastfeeding, especially full breastfeeding	Provide higher CVV value for breastfeeding mothers	Provide a $10 CVV for all women	No option to change the CVV amount
	Reduce formula to partially breastfed infants	No routine issuance of formula to partially breastfeeding infants	States may tailor amounts of formula up to the maximum allowance
	Infant formula not provided in the first month to breastfeeding infants	Infant formula may be provided to breastfed infants in the first month, but this should not be standardized	No routine issuance in the first month to breastfeeding mothers, or may provide 1 can of powdered infant formula in the first month
	Fully breastfeeding infants receive jarred baby food meats in addition to greater amounts of baby food fruits and vegetables	Individual needs should be assessed and the food quantities issued accordingly	Assess individual needs to tailor packages
	Additional quantities of milk, eggs, and cheese; also fish, whole grains, and cheese for breastfeeding mothers	Additional quantities of milk, eggs, and cheese; also fish, whole grains and cheese for breastfeeding mothers	States may offer various substitutions in the whole grains and fish categories
Address developmental needs of infants and young children	Slightly increase formula amounts for fully formula-fed infants 4 to 5 months of age (and exclusion of juice and cereal)	Fully formula-fed infants 4 to 5 months of age received a slightly increased amount of infant formula	No option
	Reduce formula amounts for infants 6 to 11 months of age; infant foods provided only at 6 months of age or older	Reduced maximum amounts of formula; no infant foods provided from 0 to less than 6 months of age	No option

	Commercial baby food and fresh bananas for infants	From 9 months to less than 1 year, half of jarred foods may be substituted with fresh fruits and vegetables[e]; for infants 6 months to less than 1 year, fresh bananas may be substituted for a limited amount of jarred baby food fruit	State option to allow the infant fruit and vegetable substitutions
Address obesity concerns	Slightly decrease total food energy provided by the packages after 4 months of age (except for fully breastfeeding infants), including reduced milk, cheese, eggs, and juice	Milk, cheese, eggs, and juice quantities were reduced overall	No option
	Limit added sugars in commercial baby food, processed fruits and vegetables, breakfast cereals, and whole grains	Limits placed on added sugars content of breakfast cereals and yogurt	States may further reduce added sugars limits

NOTES: BF = breastfeeding; CVV = cash value voucher; IOM = Institute of Medicine; USDA = U.S. Department of Agriculture.

[a] Federal regulation information is from the final rule issued March 4, 2014. See the documentation for the minimum requirements and specifications for foods, including sugar limits and Standards of Identity.

[b] States may not selectively choose the fruits and vegetables allowable, but may restrict packaging type and packaging sizes. Types may be restricted if vendor or participant confusion is anticipated.

[c] At least 51 percent of the grain in the product was required to be whole grain.

[d] The primary reason for reducing the quantity of eggs was to maintain cost neutrality; fat and cholesterol reduction was a secondary result.

[e] Partially breastfed infants may receive a $4 CVV plus 64 ounces of infant food fruits and vegetables; fully breastfed infants may receive an $8 CVV plus 128 ounces of infant food fruits and vegetables.

SOURCES: IOM, 2006; USDA/FNS, 2014.

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Appendix D

Composition of the WIC Food Packages

TABLE D-1 Full Nutrition Benefit and Maximum Monthly Allowances of Supplemental Foods for Infants in Food Packages I, II, and III

	Fully Formula Fed (FF)		Partially (Mostly) Breastfed (BF/FF)		Fully Breastfed (BF)	
Foods	FP I–FF & III–FF A: 0 Through 3 Months B: 4 Through 5 Months	FP II–FF & III–FF 6 Through 11 Months	FP I–BF/FF & III BF/FF (A: 0 to 1 Month[a,b]) B: 1 Through 3 Months C: 4 Through 5 Months	FP II–BF/FF & III BF/FF 6 Through 11 Months	FP I–BF 0 Through 5 Months	FP II–BF 6 Through 11 Months
WIC Formula[c,d,e,f]	A: FNB = 806 fl oz, MMA = 823 fl oz, reconstituted liquid concentrate or 832 fl oz RTF or 870 fl oz reconstituted powder B: FNB = 884 fl oz, MMA = 896 fl oz, reconstituted liquid concentrate or 913 fl oz RTF or 960 fl oz reconstituted powder	FNB = 624 fl oz, MMA = 630 fl oz, reconstituted liquid concentrate or 643 fl oz RTF or 696 fl oz reconstituted powder	A: 104 fl oz reconstituted powder B: FNB = 364 fl oz, MMA = 388 fl oz, reconstituted liquid concentrate or 384 fl oz RTF or 435 fl oz reconstituted powder C: FNB = 442 fl oz, MMA = 460 fl oz, reconstituted liquid concentrate or 474 fl oz RTF or 522 fl oz reconstituted powder	FNB = 312 fl oz, MMA = 315 fl oz, reconstituted liquid concentrate or 338 fl oz RTF or 384 fl oz reconstituted powder	No formula	No formula

Infant cereal	N/A	24 oz	N/A	24 oz	N/A	24 oz
Infant food fruits and vegetables	N/A	128 oz	N/A	128 oz	N/A	256 oz
Infant food meat	N/A	N/A	N/A	N/A	N/A	77.5 oz

NOTES: BF = fully breastfed; BF/FF = partially (mostly) breastfed; FF = fully formula fed; FNB = full nutrition benefit; FP = food package; MMA = maximum monthly allowance; N/A = the supplemental food is not authorized in the corresponding food package; RTF = ready-to-feed.

[a] State agencies have the option to issue not more than one can of powder infant formula in the container size that provides closest to 104 reconstituted fluid ounces to breastfed infants on a case-by-case basis.

[b] Liquid concentrate and ready-to-feed (RTF) may be substituted at rates that provide comparable nutritive value.

[c] WIC formula means infant formula, exempt infant formula, or WIC-eligible nutritionals. Infant formula may be issued for infants in Food Packages I, II, and III. Medical documentation is required for issuance of infant formula, exempt infant formula, WIC-eligible nutritionals, and other supplemental foods in Food Package III. Only infant formula may be issued for infants in Food Packages I and II.

[d] The full nutrition benefit is defined as the minimum amount of reconstituted fluid ounces of liquid concentrate infant formula as specified for each infant food package category and feeding variation (e.g., Food Package IA-fully formula fed).

[e] The maximum monthly allowance is specified in reconstituted fluid ounces for liquid concentrate, RTF liquid, and powder forms of infant formula and exempt infant formula. Reconstituted fluid ounce is the form prepared for consumption as directed on the container.

[f] State agencies must provide at least the full nutrition benefit authorized to non-breastfed infants up to the maximum monthly allowance for the physical form of the product specified for each food package category. State agencies must issue whole containers that are all the same size of the same physical form. Infant formula amounts for breastfed infants, even those in the fully formula fed category should be individually tailored to the amounts that meet their nutritional needs.

SOURCE: Modified from 7 C.F.R. § 246 (USDA/FNS, 2014).

TABLE D-2 Maximum Monthly Allowances of Supplemental Foods for Children and Women in Food Packages IV, V, VI, VII

	Children		Women	
Foods	FP IV: 1 Through 4 Years	FP V: Pregnant and Partially (Mostly) BF (Up to 1 Year PP)[a]	FP VI: Postpartum (Up to 6 Months PP)[b]	FP VII: Fully Breastfeeding (Up to 1 Year PP)[c,d]
Juice, single strength[e]	128 fl oz	144 fl oz	96 fl oz	144 fl oz
Milk, fluid	16 qt[f,g,h,i,k]	22 qt[f,g,h,i,k]	16 qt[f,g,h,i,k]	24 qt[f,g,h,i,k]
Breakfast cereal[l]	36 oz	36 oz	36 oz	36 oz
Cheese	N/A	N/A	N/A	1 lb
Eggs	1 dozen	1 dozen	1 dozen	2 dozen
Fresh fruits and vegetables[m,n]	$8.00 in CVV	$10.00 in CVV	$11.00 in CVV	$11.00 in CVV
Whole wheat or whole grain bread[o]	2 lb	1 lb	N/A	1 lb
Fish (canned)	N/A	N/A	N/A	30 oz
Legumes, dry[p] and/or peanut butter	1 lb or 18 oz	1 lb and 18 oz	1 lb or 18 oz	1 lb and 18 oz

NOTES: BF = breastfeeding; CVV = cash value voucher; FP = food package; N/A = the supplemental food is not authorized in the corresponding food package; PP = postpartum.

[a] Food Package V is issued to two categories of WIC participants: Women participants with singleton pregnancies; breastfeeding women whose partially (mostly) breastfed infants receive formula from the WIC program in amounts that do not exceed the maximum formula allowances, as appropriate for the age of the infant as described in Table 1 of paragraph (e)(9) of this section.

[b] Food Package VI is issued to two categories of WIC participants: Non-breastfeeding postpartum women and breastfeeding postpartum women whose infants receive more than the maximum infant formula allowances, as appropriate for the age of the infant as described in Table 1 of paragraph (e)(9) of this section.

[c] Food Package VII is issued to four categories of WIC participants: Fully breastfeeding women whose infants do not receive formula from the WIC program; women pregnant with two or more fetuses; women partially (mostly) breastfeeding multiple infants from the same pregnancy; and pregnant women who are also fully or partially (mostly) breastfeeding singleton infants.

[d] Women fully breastfeeding multiple infants from the same pregnancy are prescribed 1.5 times the maximum allowances.

[e] Combinations of single-strength and concentrated juices may be issued provided that the total volume does not exceed the maximum monthly allowance for single-strength juice.

[f] Whole milk is the standard milk for issuance to 1-year-old children (12 through 23 months). At state agency option, fat-reduced milks may be issued to 1-year-old children for whom overweight or obesity is a concern. The need for fat-reduced milks for 1-year-old children must be based on an individual nutritional assessment and consultation with the child's health care provider if necessary, as established by state agency policy. Low-fat (1%) or nonfat milks are the standard milk for issuance to children ≥ 24 months of age and women. Reduced-fat (2%) milk is authorized only for participants with certain conditions, including but not limited to, underweight and maternal weight loss during pregnancy. The need for reduced-fat (2%) milk for children ≥ 24 months of age (Food Package IV) and women (Food Packages V–VII) must be based on an individual nutritional assessment as established by state agency policy.

[g] Evaporated milk may be substituted at the rate of 16 fluid ounces of evaporated milk per 32 fluid ounces of fluid milk or a 1:2 fluid ounce substitution ratio. Dry milk may be substituted at an equal reconstituted rate to fluid milk.

[h] For children and women, cheese may be substituted for milk at the rate of 1 pound of cheese per 3 quarts of milk. For children and women in Food Packages IV–VI, no more than 1 pound of cheese may be substituted. For fully breastfeeding women in Food Package VII, no more than 2 pounds of cheese may be substituted for milk. State agencies do not have the option to issue additional amounts of cheese beyond these maximums even with medical documentation. (No more than a total of 4 quarts of milk may be substituted for a combination of cheese, yogurt, or tofu for children and women in Food Packages IV–VI. No more than a total of 6 quarts of milk may be substituted for a combination of cheese, yogurt, or tofu for women in Food Package VII.)

[i] For children and women, yogurt may be substituted for fluid milk at the rate of 1 quart of yogurt per 1 quart of milk; a maximum of 1 quart of milk can be substituted. Additional amounts of yogurt are not authorized. Whole yogurt is the standard yogurt for issuance to 1-year-old children (12 through 23 months). At state agency option, lowfat or nonfat yogurt may be issued to 1-year-old children for whom overweight and obesity is a concern. The need for lowfat or nonfat yogurt for 1-year-old children must be based on an individual nutritional assessment and consultation with the child's health care provider if necessary, as established by State agency policy. Lowfat or nonfat yogurts are the only types of yogurt authorized for children ≥ 24 months of age and women. (No more than a total of 4 quarts of milk may be substituted for a combination of cheese, yogurt, or tofu for children and women in Food Packages IV–VI. No more than a total of 6 quarts of milk may be substituted for a combination of cheese, yogurt, or tofu for women in Food Package VII.)

[j] For children, issuance of tofu and soy-based beverage as substitutes for milk must be based on an individual nutritional assessment and consultation with the participant's health care provider if necessary, as established by state agency policy. Such determination can be made for situations that include, but are not limited to, milk allergy, lactose intolerance, and vegan diets. Soy-based beverage may be substituted for milk for children on a quart-for-quart basis up to the total maximum allowance of milk. Tofu may be substituted for milk for children at the rate of 1 pound of tofu per 1 quart of milk. (No more than a total of 4 quarts of milk may be substituted for a combination of cheese, yogurt, or tofu for children in Food Package IV.) Additional amounts of tofu may be substituted, up to the maximum allowance for fluid milk for lactose intolerance or other reasons, as established by state agency policy.

continued

TABLE D-2 Continued

[k] For women, soy-based beverage may be substituted for milk on a quart-for-quart basis up to the total maximum allowance of milk. Tofu may be substituted for milk at the rate of 1 pound of tofu per 1 quart of milk. (No more than a total of 4 quarts of milk may be substituted for a combination of cheese, yogurt, or tofu for women in Food Packages V and VI. No more than a total of 6 quarts of milk may be substituted for a combination of cheese, yogurt, or tofu for women in Food Package VII). Additional amounts of tofu may be substituted, up to the maximum allowances for fluid milk, for lactose intolerance or other reasons, as established by state agency policy.

[l] At least one-half of the total number of breakfast cereals on the state agency's authorized food list must have whole grain as the primary ingredient and meet labeling requirements for making a health claim as a "whole grain food with moderate fat content" as defined in Table 4 of paragraph (e)(12) of this section.

[m] Both fresh fruits and fresh vegetables must be authorized by state agencies. Processed fruits and vegetables, i.e., canned (shelf-stable), frozen, and/or dried fruits and vegetables may also be authorized to offer a wider variety and choice for participants. State agencies may choose to authorize one or more of the following processed fruits and vegetables: canned fruit, canned vegetables, frozen fruit, frozen vegetables, dried fruit, and/or dried vegetables. The cash value voucher may be redeemed for any eligible fruit and vegetable (refer to Table 4 of paragraph

(e)(12) of this section and its footnotes). Except as authorized in paragraph (b)(1)(i) of this section, state agencies may not selectively choose which fruits and vegetables are available to participants. For example, if a state agency chooses to offer dried fruits, it must authorize all WIC-eligible dried fruits.

[n] The monthly value of the fruit/vegetable cash value vouchers will be adjusted annually for inflation as described in § 246.16(j).

[o] Whole wheat and/or whole grain bread must be authorized. State agencies have the option to also authorize brown rice, bulgur, oatmeal, whole-grain barley, whole wheat macaroni products, or soft corn or whole wheat tortillas on an equal weight basis.

[p] Canned legumes may be substituted for dry legumes at the rate of 64 oz (e.g., four 16-oz cans) of canned beans for 1 pound dry beans. In

Food Packages V and VII, both beans and peanut butter must be provided. However, when individually tailoring Food Packages V or VII for nutritional reasons (e.g., food allergy, underweight, participant preference), state agencies have the option to authorize the following substitutions: 1 pound dry and 64 oz canned beans/peas (and no peanut butter); or 2 pounds dry or 128 oz canned beans/peas (and no peanut butter); or 36 oz peanut butter (and no beans).

SOURCES: Modified from 7 C.F.R. § 246 (2014), updated with WIC Policy Memorandum #2015-3 and WIC Policy Memorandum #2015-4 (USDA/FNS, 2015a,b).

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USDA/FNS. 2015b. WIC policy memorandum #2015-4 to WIC state agency directors: Increase in the cash value voucher for pregnant, postpartum, and breastfeeding women. Alexandria, VA.

Appendix E

The U.S. Department of Agriculture's Food and Nutrition Service Funded Studies Describing the Effect of the 2009 WIC Food Package Changes

TABLE E-1 USDA-FNS Funded Studies Describing the Effect of the 2009 WIC Food Package Changes

Reference	Study Objective	Population	General Findings
Andreyeva and Luedicke, 2013: Federal food package revisions: Effects on purchases of whole-grain products	Assess how the WIC revisions affected purchases of bread and rice among WIC-participating households in Connecticut and Massachusetts	2,137 WIC-participating households in Connecticut and Massachusetts	2009 WIC revisions significantly increased purchases of whole grain bread and rice among WIC-participating families
Andreyeva and Luedicke, 2014: Incentivizing fruit and vegetable purchases among participants in the Special Supplemental Nutrition Program for Women, Infants, and Children	Examine the impact of the newly implemented CVV on fruit and vegetable purchases	2,137 WIC-participating households in Connecticut and Massachusetts	Fresh and frozen vegetable purchases increased by 17.5 percent and 27.8 percent, respectively, and fresh fruit purchases increased by 28.6 percent
Andreyeva et al., 2011: Changes in access to healthy foods after implementation of the WIC food package revisions	Evaluate the impact of the WIC food package revisions using multiple determinants of access to healthy food	252 (all) convenience stores and non-chain grocery stores in 5 towns of Connecticut, including 33 WIC-authorized stores and 219 non-WIC stores	Strong evidence that stores responded to the food package revisions by improving the availability and variety of healthy foods in urban and suburban settings, especially in WIC-authorized stores
Andreyeva et al., 2012: Positive influence of the revised Special Supplemental Nutrition Program for Women, Infants, and Children food packages on access to healthy foods	Effect of the new WIC food packages on food access	252 (all) convenience stores and non-chain grocery stores in 5 towns of Connecticut including 33 WIC-authorized stores and 219 non-WIC stores	Access to healthy foods improved using a composite score measure mostly due to increased availability and variety of whole grain products

Andreyeva et al., 2013: Effects of reduced juice allowances in food packages for the Women, Infants, and Children program	Describe changes in purchases of 100% juice and other beverages among WIC participants after the WIC revisions	2,137 WIC-participating households in Connecticut and Massachusetts	Purchases of 100% juice among WIC households declined by 25 percent. Little compensation occurred from non-WIC funds for juice or other beverages
Andreyeva et al., 2014: The positive effects of the revised milk and cheese allowances in the Special Supplemental Nutrition Program for Women, Infants, and Children	Examine the effect of the new food packages on milk and cheese, and saturated fat intakes	515 WIC households in Connecticut and Massachusetts	Whole-milk share declined in WIC milk purchases with no change in non-WIC purchases. Total milk volume fell by 14.2 percent, whole milk by half, and WIC-eligible cheese by 37.2 percent. Saturated fat from milk and cheese declined by 85 g/month per household in Connecticut and 107 g/month per household in Massachusetts
Gleason and Pooler, 2011: The effects of changes in WIC food packages on redemptions: Final report	Exploratory study to assess participant satisfaction with the food package changes by monitoring redemptions before and 6, 12, or 18 months after the 2009 food package changes	WIC participants in Wisconsin: 126,850 prior to the food package change and 116,956 after the food package change	Overall positive response to the food package changes. Decreases were noted in redemptions that differed among racial and ethnic subpopulations. Use of the CVV among racial and ethnic subpopulations were also disproportionate

continued

TABLE E-1 Continued

Reference	Study Objective	Population	General Findings
Herman et al., 2006: Choices made by low-income women provided with an economic supplement for fresh fruit and vegetable purchase	Investigate whether supplemental financial support specifically for purchase of fresh fruits and vegetables (bimonthly vouchers at the level of $10/wk for 6 months) would result in high uptake of the supplement, and what the individuals would choose to purchase	602 women enrolled at three WIC sites in Los Angeles, California	Wide variety of items purchased at supermarket and farmers' market sites. Ten most frequently mentioned items: oranges, apples, bananas, peaches, grapes, tomatoes, carrots, lettuce, broccoli, and potatoes. Farmers' market potatoes: 9.1 percent of total fruit and vegetable items reported. Supermarket potatoes: 10.4 percent of total fruit and vegetable items reported
IOM, 2011: Planning a WIC research agenda: Workshop summary	Workshop to guide planning for the use of significant WIC research dollars	Considered the WIC target population	Defined research priorities in the areas of birth outcomes, obesity, breastfeeding, food security, nutritional status, and nutrition education, as well as cost, benefits, and effectiveness of the program
Joyce and Reeder, 2015: Changes in breastfeeding among WIC participants following implementation of the new food package	Analyze changes in breastfeeding among WIC participants before and after the new food package	PRAMS in 19 states 2004–2010, PedNSS in 16 states 2007–2010, NIS from 50 states and DC 2004–2010	Data showed steady upward trends in ever-breastfed infants on WIC but not statistically different from trends in breastfeeding among non-WIC low-income
Kim et al., 2013: Mothers prefer fresh fruits and vegetables over jarred baby fruits and vegetables in the new Special Supplemental Nutrition Program for	Examine WIC participant use and satisfaction with jarred baby foods, preference for CVVs versus jarred baby foods, and variations among ethnic groups	2,996 participants who received WIC in California in 2010 (NEFPI survey) and California WIC redemption data	Participants reported high satisfaction with the CVV and jarred baby foods with significant variations across ethnic groups. About two-thirds of participants preferred CVV over jarred baby foods. Redemption rates for jarred

Women, Infants, and Children food package			foods declined with increasing age of infant across all ethnic groups
Kreider et al., 2016: Identifying the effects of WIC on food insecurity among infants and children	Examine the effects of WIC on the nutritional well-being and food security of infants and young children	4,614 low-income infants and children less than 5 years of age from 1999–2008 NHANES	WIC was estimated to reduce the prevalence of child food insecurity by at least 3.6 percentage points (20 percent)
May et al., 2015: Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) Infant and Toddler Feeding Practices Study 2 (ITFPS-2): Intention to breastfeed	Examine the effects of WIC on attitudes around breastfeeding; comparing data from 1995 to 2013	A nationally representative sample of 2,649 women either pregnant or having a child less than 3 months of age	Overall increase in perceptions of the positive benefits of breastfeeding; overall decrease in the number of women with specific perceived barriers to breastfeeding; increase in number of women reporting that breastfeeding is painful, and no one else can feed the baby
O'Malley et al., 2014: Use of a new availability index to evaluate the effect of policy changes to the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) on the food environment in New Orleans	Assess changes before and after WIC revisions using a new index developed to monitor the retail environment's adoption of these new food supply requirements (WIC-AI)	Supermarkets, medium and small WIC stores, and non-WIC food stores in New Orleans, Louisiana	Median WIC-AI score increased in medium and small stores. In small stores, this increase was mostly attributed to increased availability of cereals and grains, juices and fruit, and infant fruits and vegetables

continued

TABLE E-1 Continued

Reference	Study Objective	Population	General Findings
Ritchie et al., 2014: Satisfaction of California WIC participants with food package changes	Assess California WIC participant satisfaction with the 2009 food package revisions, compare based on language preference and timing of WIC enrollment	2,996 WIC participants in California in 2010	Most (91.3 percent) were satisfied with checks for new WIC foods (fruits/vegetables, whole grains, and lower-fat milk), and 82.7 percent were satisfied with amounts of foods reduced in the new packages (milk, cheese, eggs, juice). A higher percentage of Spanish speakers than English speakers reported satisfaction. A higher percentage of newer enrollees reported satisfaction compared to those participating in WIC before the revisions
Rose et al., 2014: The influence of the WIC food package changes on the retail food environment in New Orleans	Examine the effect of the WIC food package changes on the availability of healthy foods in small stores	102 small stores in New Orleans were visited in 2009 and 91 percent of these revisited in 2010 (27 WIC and 66 non-WIC)	WIC stores were more likely to improve the availability of lower-fat milks than non-WIC stores and more likely to improve the availability of whole grains. WIC stores showed a relative increase in varieties of fresh fruits and shelf length of vegetables
USDA/FNS, 2011: Evaluation of the birth month breastfeeding changes to the WIC food packages	Examine changes in breastfeeding initiation, duration, or intensity that occurred following issuance of the 2007 interim rule for food package changes	A pre/post study collecting data between April 2009 and May 2010 from 17 randomly sampled local WIC agencies, followed by data from 300,000 participants	Notable differences in package assignments were observed, including decreases in the partial breastfeeding package, and increases in the full breastfeeding and full formula packages; infants receiving no formula in the first month increased; the proportion receiving the maximum allowance of formula also increased

			No differences were observed in breastfeeding rates or intensity; a slight increase in duration was observed
USDA/FNS, 2012: Effects of the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC): A review of recent research	Comprehensively review all literature on WIC program impacts between 2002 and 2010 (published research) and 1999 to 2010 ("gray" literature). Report is intended as an update of the review published by Fox et al. in 2004	Peer-reviewed studies focusing on WIC published between 2002 and 2010 or unpublished studies completed between 1999 and 2010	Prenatal WIC participation is consistently positively associated with gestational age and mean birth weight and negatively associated with incidence of low and very low birth weight when not adjusted for gestational age. There is no clear evidence of an association between WIC and adequate weight gain during pregnancy
USDA/FNS, 2013: WIC food package cost report, fiscal year 2010	Estimate the average monthly food costs for each WIC participant subgroup and total dollars spent on 17 major categories of WIC-eligible foods in 2010; data are compared to 2005	National estimates for participation and national average retail prices for each WIC food category were used to generate cost estimates for each food package	The average monthly food cost with rebates in 2010 was $41.44. Costs increased 11 percent compared to 2005, below the Consumer Price Index for food at home. The relative cost of the infant food package increased
USDA/FNS, 2015: WIC food packages policy options II, final report	Examine state agency responses to policy options in the final rule, determine differences in food options and cost-containment measures across state agencies, observe changes in WIC food lists before and after implementation of the final rule	86 state agencies representing 99.98 percent of all WIC participants	WIC participants were offered more options after the implementation of the final rule. WIC participants have access to foods consistent with recommendations made by the *Dietary Guidelines for Americans* and by the American Academy of Pediatrics. State agencies employ a variety of cost-containment strategies while increasing options for participants

continued

TABLE E-1 Continued

Reference	Study Objective	Population	General Findings
Whaley et al., 2012: Revised WIC food package improves diets of WIC families	To explore the impact of the new WIC food package on WIC participant consumption of fruit, vegetables, whole grain food, and lower-fat milk	3,004 California WIC participants in 2009; 2,996 in 2010	Whole grain consumption increased by 17.3 percentage points. Whole milk consumption by caregivers and children who usually consumed whole milk decreased by 15.7 and 19.7 percent, respectively. Lower-fat milk consumption increased accordingly. Small but significant increases in consumption of fruits and vegetables were observed
Wilde et al., 2012: Food-package assignments and breastfeeding initiation before and after a change in the Special Supplemental Nutrition Program for Women, Infants, and Children	Measure changes pre-post WIC package changes in WIC food-package assignments, WIC infant formula amounts, and breastfeeding initiation	National random sample of 17 local WIC agencies. Administrative records for 206,092 dyads with an infant aged 0–5 months in the sampled WIC agencies	After the changes, fewer mothers received the partial breastfeeding package. More mothers received the full breastfeeding package and the full formula package
Zenk et al., 2014: Impact of the revised Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) food package policy on fruit and vegetable prices	Observe changes in fruit and vegetable prices pre-post WIC policy changes	Data from WIC vendors in 7 northern Illinois counties from 2008 to 2010	WIC policy revisions contributed to modest reductions in fruit and vegetable prices. WIC participants' purchasing power can differ depending on type of WIC vendor and neighborhood

NOTES: CDC = Centers for Disease Control and Prevention; CVV = cash value voucher; FNS = Food and Nutrition Service; NIS = National Immunization Survey; PedNSS = Pediatric Nutrition Surveillance System; PRAMS = Pregnancy Risk Assessment Monitoring System; USDA = U.S. Department of Agriculture; WIC-AI = WIC availability index.

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Appendix F

Changes in the WIC Food Packages and Program Participation: Methods

To determine whether regulatory changes made to the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) food packages are associated with coincident changes in program participation, the committee compared the number of WIC participants with data to the number of individuals eligible for program participation at the state level (USDA/FNS, 2015a). The resulting proportion of participants reflects both the program generosity (the income limit for participation in the program) as well as the number of categorically and income-eligible individuals by state and year, with the eligibility calculations including adjustments for income eligibility or eligibility through participation in other programs as well as other adjustments made to the Current Population Survey Annual Social and Economic Supplement data (USDA/FNS, 2015b). The committee plotted these trends and estimated models of these program coverage rates, that is, the number of participants/number eligible by state and year as a function of what share of the year the new package was in effect for, state-fixed effects, and some controls for the state of the economy (the unemployment rate), and, in some specifications, year-fixed effects and program participation rates per person in the state (participation rates in the Temporary Assistance for Needy Families [TANF] and Supplemental Nutrition Assistance Program [SNAP] program and participation rates in the regular, extended, and emergency Unemployment Compensation program [Bitler and Hoynes, 2013]). The state-fixed effects controlled for time invariant differences in state participation among WIC eligibles, and the year-fixed effects controlled for national level shocks. The committee included these in the model because there was variation in the exact month of implementation of the 2009 food package change across states, with Delaware and New York implementing in January and many other states not implementing until the regulatory deadline (dates are reported in Appendix F of USDA/FNS, 2012). The models were estimated by both ordinary least squares and weighted least squares with the eligibility totals used as weights to produce population-representative results. The data span the period from 2006 to 2012. The variance/covariance matrices and associated inference allow for arbitrary within-state correlations of the error terms. Note that the eligibility shares were only available for all WIC participants rather than by eligibility category.

Figure 1-3 from Chapter 1 shows the time series of the aggregate national program coverage rate components—the national total number of participants by calendar year and the national total number of eligibles by calendar year. There is little evidence that the number of participants changes in 2009 any more than the number of eligible persons. Figure F-1 shows coverage rates (take up by eligible individuals) for selected states. Again, coverage does not seem to move systematically in 2009. The raw correlation between the annual coverage rate and the share of the year a state had the new package in place is 0.031 (i.e., holding everything else constant, implementing the new package everywhere would be associated with a 3.1 percentage point increase in the coverage rate relative to a pre-2009 rate of 61 percentage points). However, 2009 marks the end of the Great Recession (using the NBER ending date) and also marks the peak year for the number of WIC eligibles in the data (shown in Figure 1-3), suggesting the importance of adjusting these comparisons for the business cycle. Further, associated with the stimulus, there were expansions in the generosity of SNAP benefits (which ended in November 2013), expansions in the Federal Medical Assistance Percentages matching rate for Medicaid expenditures, and a stimulus-associated TANF emergency fund. Since categorically eligible individuals who participate in any of these programs are automatically eligible for WIC, there is possible concern that failing to control for effects of other programs might bias estimates of the effects of the initial rollout of the new food package. The committee therefore estimated a series of regressions with the unemployment rate and unemployment insurance recipiency per capita as well as SNAP and TANF caseloads per capita as controls in addition to state and year-fixed effects (regression results and controls in Table F-1).

Once controlling for state-fixed differences and time effects, or alternatively, the unemployment rate, the coefficient on the share of the year for which the new package was in effect falls in magnitude and it is no longer statistically significant. This also holds if we add controls for the monthly average of Aid to Families with Dependent Children/TANF and food stamp

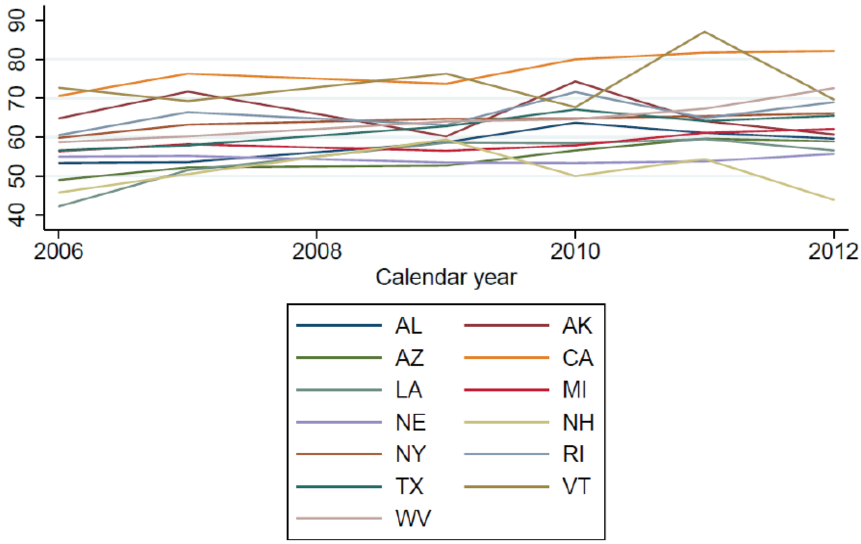

FIGURE F-1 Proportion of individuals participating in WIC of those eligible for WIC by year for selected states.
NOTE: States are indicated in the legend.
SOURCES: USDA/FNS, 2011, 2013, 2014, 2015a; Bitler and Hoynes, 2013.

caseloads per capita. The results suggest no significant difference comparing participation before to participation after implementation of the new food package, with and without the year-fixed effects and other program participation rates. Further, the coefficients on the share of the year the new package was in effect are small in magnitude, with a typical estimate being 0.014 (again, on a pre-2009 baseline mean of 0.61 or 61 percentage points).

TABLE F-1 Regression Results and Controls, Total WIC Participation per Eligible Individual, 2006–2012

	Regression Number						
	1	2	3	4	5	6	7
Regression Results							
Share of Year with New Package	0.031[a] (0.007)	0.032[a] (0.008)	0.013 (0.015)	0.014 (0.017)	0.015 (0.018)	0.013 (0.017)	0.013 (0.017)
Unemployment Rate				0.787 (0.502)	0.971[b] (0.466)	1.52[a] (0.413)	1.21[b] (0.536)
Regression Controls							
Year-Fixed Effects	N	N	Y	Y	Y	Y	Y
State-Fixed Effects	N	Y	Y	Y	Y	Y	Y
TANF Cases per Capita	N	N	N	N	Y	Y	Y
SNAP Cases per Capita	N	N	N	N	Y	Y	Y
Unemployment Insurance Recipiency per Capita	N	N	N	N	N	Y	Y
Births per Capita	N	N	N	N	N	N	Y

NOTES: Each column represents a separate regression, and there is one observation per state-year combination. N = 357. The baseline mean for the participation rate is 0.608, and the baseline mean for the unemployment rate is 0.074. The key dependent variable is the state-by-year count of participants in WIC divided by an estimate of the number of WIC eligibles, using a series of reports on WIC-eligible estimation. The key independent variable is the share of each year during which a state had implemented the new food packages taken from USDA/FNS, 2012. The regressions are weighted by the total number of eligibles, and variance-covariance matrices allow for arbitrary autocorrelation within state.

[a] $P < 0.10$.

[b] $P < 0.05$.

SOURCE: USDA/FNS, 2012.

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Appendix G

Literature Findings on Barriers and Incentives to WIC Participation and Redemption

TABLE G-1 Literature Findings on Barriers and Incentives to WIC Participation and Redemption

Article	Barriers	Incentives/Strategies
Bertmann et al., 2014	Negative interactions in stores: annoyance or anger expressed by cashier or other shoppers Confusion over WIC rules: fluctuation in enforcement of redemption rules store to store and week to week Cashiers lack training: participants have to explain the rules Feeling of embarrassment when using CVV	Find strategic choice of times and locations at which to shop Choose particular cashiers Pool CVV (using multiple vouchers at once)
Christie et al., 2006	Long duration of appointment wait time Dissatisfaction with customer service Dissatisfaction with the physical environment	Decrease wait times by extending clinic hours and/or changing clinic flow High level of satisfaction with WIC personnel
Gleason and Pooler, 2011	Underutilization of infant food benefits	Issue a CVV for F/V for caregivers who prefer preparing own infant foods Implement targeted nutrition education to subpopulations with high non-use of food instruments
Gleason et al., 2011	Maintaining food freshness (small WIC vendors) Availability of products in allowable form (e.g., bread in approved size)	Continue and expand vendor training Continue to engage food suppliers Continue nutrition education of participants Use state WIC data for internal program management, policy making, ongoing monitoring Examine effect of minimum stocking requirements

TABLE G-1 Continued

Article	Barriers	Incentives/Strategies
Gleason et al., 2014	*Participants:* Gaps in knowledge (determining the amount of F/V with CVV) Incorrect information provided by cashier Limited selection of some WIC foods at local vendors and poor-quality produce Lack of transportation (e.g., tribe located 30 minutes from a store) *Vendors:* Delivery of spoiled items Difficulty anticipating demand and maintaining adequate supply of some WIC foods Challenges in serving participants who lack knowledge Challenges in communicating with local WIC agency	*Participants:* Use more than one check at a time when transportation is an issue *Vendors:* Adopt practices that will make it easier for participants to shop *WIC Staff:* Use open-ended question and probing to encourage discussion with participants Expand nutrition education opportunities Inform participants of local vendors *Local WIC Directors:* Establish open lines of communication with vendors Increase cross-program collaboration *State WIC Agencies:* Offer additional training opportunities to staff Expand allowable WIC foods to include frozen and canned vegetables Develop a formalized local vendor liaison (LVL) program (California example: LVL makes visits)
Najjar, 2013	Food package policies (e.g., container size) Negative grocery store experiences and personal misunderstanding and embarrassment	Helpful vendors Vendor and participant understanding about the use of CVV and other WIC benefits

continued

TABLE G-1 Continued

Article	Barriers	Incentives/Strategies
Phillips et al., 2014	Certain individual WIC foods have low rates of full redemption Could not use certain foods (i.e., received too much) Participants or their children disliked the food or did not know how to prepare them Regardless of ethnicity, full redemption of WIC benefits is low	Implement targeted educational efforts to promote full utilization of WIC benefits Tailor nutrition education to include foods that are commonly underused and focus on culturally relevant approaches to incorporating these foods into meals and snacks
USDA/ERS, 2010b	Program requires too much effort, or scheduling, or transportation problems	
USDA/ERS, 2013	Improved national economic conditions generally reduce participation rates for WIC and other national assistance programs	Poorer economic conditions and unemployment rates tend to improve participation rates when the program is fully funded

NOTE: CVV = cash value voucher; F/V = fruits and vegetables; LVL = local vendor liaison; SSI = Supplemental Security Income.

TABLE G-2 Changes in Fruit and Vegetable Availability and Selection Overall and by Vendor Type, Before Compared to After the 2009 WIC Food Package Changes

	Fresh			Canned			Frozen	
Availability or Selection	Commonly Consumed FV	African American FV	Latino FV	Vegetables	Low-sodium Vegetables	Fruits	Vegetables	Fruits
Availability								
Overall change	2.14 (1.31, 3.50)[b]	2.53 (1.31, 5.35)[b]	1.72 (0.84, 3.98)	NE	2.69 (1.17, 6.22)[a]	1.84 (0.91, 3.72)	1.97 (1.05, 3.70)[a]	2.15 (1.06, 4.37)[a]
Change by vendor type								
Large	3.56 (1.22, 10.34)[a]	2.27 (1.31, 5.48)[a]	1.69 (0.94, 5.54)	1.62 (0.81, 3.25)	0.93 (0.25, 3.48)	1.01 (0.41, 2.48)	1.43 (0.91, 2.25)	2.10 (0.86, 5.12)
Small	1.07 (0.51, 2.24)	2.64 (1.09, 6.38)[a]	1.83 (0.65, 5.17)	1.18 (0.47, 2.94)	5.95 (1.74, 20.29)[b]	2.11 (0.95, 4.69)	2.80 (1.13, 6.93)[a]	1.93 (0.68, 5.53)
Pharmacy	NE	1.38 (1.02, 1.88)[a]	1.25 (0.92, 1.69)	NE	0.71 (0.12, 4.18)	1.06 (0.04, 25.53)	1.34 (0.34, 5.24)	2.24 (0.19, 25.74)
Selection								
Overall change	1.67 (1.14, 2.47)[b]	1.14 (1.01, 1.42)	1.17 (1.02, 1.33)	1.22 (1.07, 1.40)[b]	1.13 (0.98, 1.30)	0.96 (0.77, 1.20)	1.09 (0.82, 1.46)	0.92 (0.69, 1.21)
Change by vendor type								
Large	1.67 (1.03, 2.69)[a]	1.13 (1.01, 1.43)	1.22 (1.06, 1.36)[a]	0.84 (0.68, 1.04)	1.05 (0.91, 1.20)	0.88 (0.71, 1.09)	1.02 (0.74, 1.40)	0.93 (0.69, 1.25)
Small	1.71 (1.06, 2.76)[a]	1.17 (0.78, 2.19)	1.05 (0.73, 1.58)	1.32 (0.95, 1.85)	2.01 (1.03, 3.84)[a]	1.05 (0.53, 2.07)	1.34 (0.79, 2.29)	0.80 (0.33, 1.93)
Pharmacy	NE	1.04 (0.93, 1.20)	1.09 (0.95, 1.21)	1.58 (1.31, 1.91)[b]	1.17 (0.18, 7.45)	1.35 (0.06, 30.18)	0.81 (0.32, 2.08)	NE

NOTES: Data presented as odds ratio (95% confidence interval); an odds ratio of 1.0 for this contrast indicates that the post-policy change from 2009 to 2010 was greater than the pre-policy change from 2008 to 2009; NE = odds ratio not estimated due to lack of variability in outcome by year. FV = fruits and vegetables.

[a] $P < 0.05$.

[b] $P < 0.01$.

SOURCE: Zenk et al., 2012 (used with permission).

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Appendix H

Workshop Agendas

Examining Evidence on a Role for White Potatoes in WIC Food Packages
Committee to Review WIC Food Packages
October 14, 2014

8:30 am Registration

Introduction and Opening Remarks

9:00 Welcome
Kathleen Rasmussen, Chair, Committee to Review WIC Food Packages

9:10 Opening Remarks
Jay Hirschman, USDA/Food and Nutrition Service

Session 1: Trends in Market Availability and Consumption of White Potatoes
Moderated by Mary Kay Fox, Mathematica Policy Research

9:20 Trends in the Production and Pricing of White Potatoes
Jennifer Bond, USDA/Economic Research Service

9:40 Potato Consumption Trends: Data from the Economic Research Service
Joanne Guthrie, USDA/Economic Research Service
Elizabeth Frazao, USDA/Economic Research Service

10:00 WIC Voucher Purchase Patterns for Fresh Fruits and Vegetables
Stacy Gleason, Altarum Institute

10:20 Panel Discussion with Speakers

Session 2: Products, Processing, and Composition of White Potatoes
Moderated by Rachel Johnson, University of Vermont

10:50 White Potato Products and Processing—Healthy Options
Maureen Storey, Alliance for Potato Research and Education

11:10 Nutrient Content and Bioavailability of White Potatoes
Connie Weaver, Purdue University

11:30 Carbohydrates, Fiber, and Resistant Starch in White Potatoes—Links to Health Outcomes
Joann Slavin, University of Minnesota

11:50 Panel Discussion with Speakers

12:15 pm Lunch

1:00 Public Comments

4:00 Adjourn

Phase I Data-Gathering Workshop
Methods and Approaches to the Assessment of WIC Food Packages
Committee to Review WIC Food Packages
March 12, 2015

8:00 am Registration

Introduction and Opening Remarks

8:30 Welcome
Kathleen Rasmussen, Chair, Committee to Review WIC Food Packages

8:35 Opening Remarks
Jay Hirschman, USDA/Food and Nutrition Service

Session 1: DGAC 2015 and Assessing Food and Nutrient Intakes of the WIC Population
Moderated by Patsy Brannon

8:45 Key Findings from the 2015 DGAC Report with Potential Relevance to the Review of WIC Food Packages
Alice H. Lichtenstein, Tufts University

9:05 USDA Food Patterns Update from the DGAC 2015 Report
Trish Britten, USDA/Center for Nutrition Policy and Promotion

9:25 Proposed Revision of Dietary Reference Intakes for Energy in Preschool-Age Children
Nancy Butte, Baylor College of Medicine

9:45 Dietary Guidance Development Project for Children Birth to 24 Months and Pregnant Women
Joanne Spahn, USDA/Center for Nutrition Policy and Promotion

10:05 Panel Discussion with Speakers

10:25 Break

Session 2: Breastfeeding, Formula Feeding, and Complementary Feeding
Moderated by Susan Baker

10:45 The Impact of the 2009 Food Package Revisions on Breastfeeding in the WIC Population—Lessons Learned
Parke Wilde, Tufts University

11:05 Key Breastfeeding Needs and the Role of WIC Food Packages in Supporting Breastfeeding
Rafael Pérez-Escamilla, Yale University

11:25 Transitioning to Foods
Virginia Stallings, Children's Hospital of Philadelphia

11:45 Panel Discussion with Speakers

12:05 pm Lunch

Session 3: Barriers and Incentives for WIC Participants
Moderated by Shannon Whaley

1:00 Administrative and Participant Experience
Geraldine Henchy, Food Research & Action Center

1:15 Rewards-Based Incentive Programs on Fruit and Vegetable Purchases
Etienne (Tina) Phipps, Einstein Healthcare Network

1:30 Barriers and Incentives from a State Perspective
Stan Bien, Michigan WIC Program

1:45 Panel Discussion with Speakers

Session 4: Characterizing the WIC Population: Health Status and Cultural Food Preferences
Moderated by Tamera Hatfield

2:00 Characterization of Nutrition and Health of Low-Income Populations and Changes Over Time
Jackson Sekhobo, New York State Department of Health

2:20 Food Preferences of Racial/Ethnic Groups Represented in the WIC Population
Lucia Kaiser, University of California, Davis

2:40 Considerations for Medically Fragile Participants
Virginia Stallings, Children's Hospital of Philadelphia

3:00 Panel Discussion with Speakers

3:15 Break

Session 5: The WIC Food Package: Economic and Regulatory Considerations

Moderated by Marianne Bitler

3:30 The Store Environment
Annemarie Kuhns, USDA/Economic Research Service

3:50 Impact of the Infant Formula Market on WIC
Victor Oliveira, USDA/Economic Research Service

4:10 Vendor Response to the 2009 Food Package Revisions
Tatiana Andreyeva, University of Connecticut

4:30 Regulatory Impact Analyses
Edward Harper, USDA/Food and Nutrition Service

4:50 Panel Discussion with Speakers

5:15 Adjourn

Methods and Approaches to the Assessment of WIC Food Packages
Committee to Review WIC Food Packages: Public Comment Session
March 13, 2015

8:30 am Registration

Introduction and Opening Remarks

9:00 Welcome
Kathleen Rasmussen, Chair, Committee to Review WIC Food Packages

Public Comments

9:15 Open Comments

Appendix I

Evidence Review Strategy

TABLE I-1 Evidence Review Key Questions and Study Eligibility Criteria

Key Question (KQ)	Study Eligibility Criteria
1. Nutritional Status of WIC Populations	
1a. Are there differences in the status of nutrients of concern, dietary quality, or dietary patterns comparing WIC participants with nonparticipants? 1b. Are there differences in the status of nutrients of concern, dietary quality, or dietary patterns that are associated with the 2009 WIC food package revisions among WIC populations? 1c. Are 2009 WIC food package revisions associated with differences in food package redemption rates? 1d. Are there geographical differences in the status of nutrients of concern, dietary quality, or dietary patterns in the WIC populations?	**Populations of interest:** WIC participants **Exposures of interest:** For KQ 1a, WIC participants versus any definition of nonparticipants For KQ 1b, any definition of pre- and post-2009 WIC food package revisions For KQ 1c, food package redemption rates (WIC benefits redeemed) For KQ 1d, different geographical area (e.g., urban versus rural) **Outcomes of interest:** Intake or biomarker levels of the nutrients of concern, including at least one of the following: vitamin D, vitamin C, iron, folate, potassium, calcium, and dietary fiber WIC food intake levels, and fruits and vegetables or whole grain intake levels Any dietary pattern/index Any measure of diet quality **Study designs of interest:** Any

continued

TABLE I-1 Continued

Key Question (KQ)	Study Eligibility Criteria
2. Health status of WIC populations	
2a. What is the prevalence of health outcomes among WIC participants? 2b. Are there differences in health outcomes comparing WIC participants with nonparticipants? 2c. Are there differences in health outcomes that are associated with the 2009 WIC food package revisions among WIC populations? 2d. What is the relationship between the status of nutrients of concern, dietary quality, or dietary patterns and health outcomes in the WIC population?	**Populations of interest:** WIC participants **Exposures of interest:** For KQ 2b, WIC participants versus any definition of nonparticipants For KQ 2c, any definition of pre- and post-2009 WIC food package revisions For KQ 2d, nutrients of concern includes at least one of the following: vitamin D, vitamin C, iron, folate, potassium, calcium, and dietary fiber; any measure of dietary pattern/index or diet quality **Health outcomes of interest:** Child overweight and obesity Maternal/postpartum overweight and obesity Maternal BMI Gestational weight gain Postpartum weight retention Diabetes control Growth outcomes: failure to thrive (rare), underweight, stunting Cognitive development Visual acuity Anemia Iron status Folate status Pregnancy outcomes: birth weight, preterm birth, infant mortality, neural tube defect **Study designs of interest:** Any (except for KQ 2a, see exclusion criteria below) Exclusion criteria for KQ 2a and 2b: Case-control study and intervention studies (any design) Not analyses of population-based datasets at the national or state level (such as NHANES, PRAMS, PNSS, or the WIC Minimum Data Set)

TABLE I-1 Continued

Key Question (KQ)	Study Eligibility Criteria
3. Breastfeeding promotion and incentivizing	
3a. Is participation in WIC associated with breastfeeding initiation, longer duration, and exclusivity (compared with non-WIC participants)? 3b. What are the factors associated with breastfeeding initiation, duration, and exclusivity among WIC participants? 3c. What are the associations between breastfeeding and health outcomes among WIC participants? 3d. What are the effects of breastfeeding promotion on breastfeeding initiation, duration, and exclusivity among WIC participants and among WIC-eligible or low-income populations?* 3e. Are there differences in breastfeeding initiation, duration, or exclusivity that are associated with the 2009 WIC food package revisions among WIC populations?	**Populations of interest:** WIC participants For KQ 3d, WIC participants, and WIC-eligible or low-income populations **Exposures of interest:** For KQ 3c, exposures of interest are breastfeeding initiation, duration, or exclusivity For KQ 3e, any definition of pre- and post-2009 WIC food package revisions **Outcomes of interest:** Breastfeeding initiation, duration, and exclusivity Any barriers to breastfeeding For KQ 3c, outcomes of interest are described in "Health outcomes of interest" above under KQ 2 **Study designs of interest:** Any (except for KQ 3d, see below) For KQ 3d, include only interventional studies or programmatic studies with active intervention to promote breastfeeding
4. The role of WIC food packages in preventing food insecurity	
4a. Is food insecurity associated with WIC participation? 4b. What are the associations between food insecurity and health outcomes of WIC populations? 4c. Are there differences in food insecurity that are associated with the 2009 WIC food package revisions among WIC households?	**Population of interest:** WIC participants **Exposures of interest:** For KQ 4a, WIC participants versus any definition of nonparticipants For KQ 4b, exposures of interest are any measure of food insecurity/security, and outcomes of interest are described in "Health outcomes of interest" under KQ 2 For KQ 4c, any definition of pre- and post-2009 WIC food package revisions **Outcomes of interest:** For KQ 4a, any measure of food insecurity/security **Study designs of interest:** Any

continued

TABLE I-1 Continued

Key Question (KQ)	Study Eligibility Criteria
5. Racial or ethnic differences in infant/child feeding practices and food intake patterns	
5a. Among caregivers of WIC participants, nonparticipants, or low-income infants or children, are there racial or ethnic differences in their practices or beliefs regarding infant/child feeding and food intake patterns? 5b. Among WIC participants, nonparticipants, or low-income women, are there racial or ethnic differences in their personal food intake patterns, eating practices, or beliefs?	**Populations of interest:** For KQ 5a, caregivers of WIC participants, nonparticipants, or low-income infants or children For KQ 5b, WIC participants, nonparticipants, or low-income women **Exposures of interest:** Different racial or ethnic groups **Outcomes of interest:** Assessment of diet quality in WIC participants or low-income women and/or children comparing race/ethnicities or focusing on one race/ethnicity Breastfeeding behaviors, perceptions, intentions, cultural factors, and experiences in WIC participants or low-income women comparing race/ethnicities or focusing on one race/ethnicity Parental feeding practices, beliefs, and behaviors comparing race/ethnicities or focusing on one race/ethnicity Diet and overweight/obesity comparing race/ethnicities or focusing on one race/ethnicity Food purchasing and preparation among different race/ethnicities or focusing on one race/ethnicity Ethnic differences in home food environment among WIC or low-income families Perceptions of eating healthy among low-income mothers and children **Exclusion criteria:** Not relevant to low-income mothers and children Not in the United States Not related to food and nutrition

TABLE I-1 Continued

Key Question (KQ)	Study Eligibility Criteria
6. Market availability of current WIC foods	
6a. What are the availability, costs, or purchase patterns of WIC foods among WIC vendors or vendors in low-income neighborhoods nationwide? 6b. What is the accessibility of WIC participants (or low-income individuals) to WIC foods? 6c. What are the determinants of store choice for WIC participants (or low-income consumers)? 6d. Were there changes in WIC food purchase patterns or availability associated with the 2009 WIC food package changes?	**Inclusion criteria:** Economics of food choices and availability in low-income neighborhoods Retail food environment and healthy food availability in low-income neighborhoods Geographic, racial, ethnic, and socioeconomic disparities in the availability of food stores among low-income women Fruit and vegetable availability and selection Regional food price variations in low-income neighborhoods **Exclusion criteria:** Not relevant to low-income mothers and children Not in the United States Not related to food and nutrition
7. Administrative feasibility and efficiency for vendors	
7a. Are there differences in sales or other concerns that are associated with the 2009 WIC food package revisions among WIC-authorized vendors?	**Inclusion criteria:** Qualitative interviews of WIC vendor store owners or employees Any study comparing sales between pre- and post-2009 WIC food package revisions among WIC vendors
8. Barriers and incentives for WIC participants, potential participants, and their families	
8a. What are the barriers and incentives to WIC program participation or acceptance of WIC food packages?	**Inclusion criteria:** Any relevant data related to barriers and incentives to WIC program participation or acceptance of WIC food packages

NOTE: KQ = key question.

* A supplemental search on MEDLINE was conducted to identify interventional studies of breastfeeding promotion or support in low-income populations for this key question.

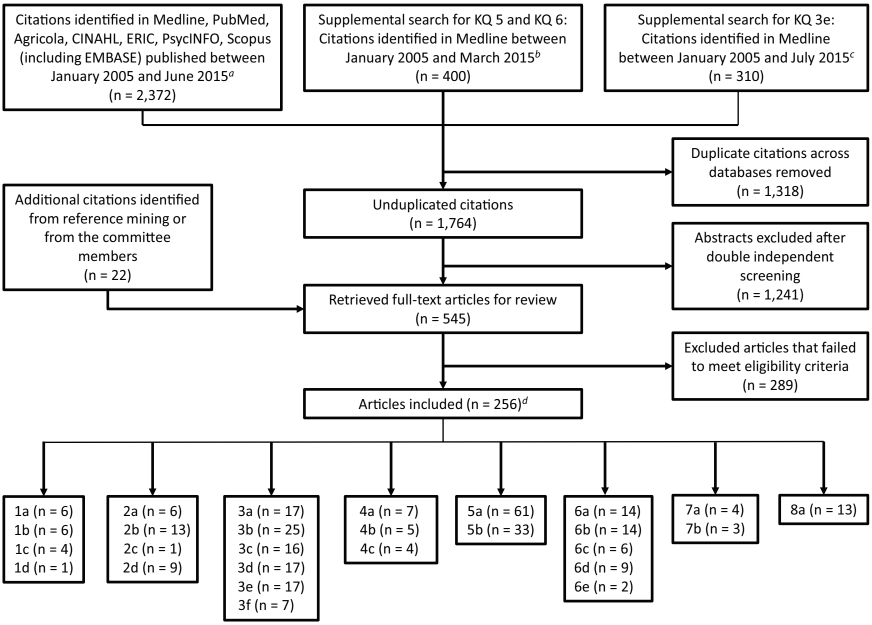

FIGURE I-1 Literature search and study selection flow.
NOTE: KQ = key question.

[a] Search strategy was designed for identifying all studies conducted in WIC programs or WIC populations without restriction to any outcome or study design (referred to as "WIC search" herein).

[b] For KQ 5 and KQ 6, a separate search strategy was developed for identifying studies conducted among low-income populations living in the United States using a combination of MeSH or search terms for Medicaid, poverty, and low income (referred to as *low-income search* herein). The low-income search was then combined with search terms relating to culture or race/ethnicity and diet or feeding behavior (KQ 5), as well as terms relating to food access or accessibility, food environment, food costs, store, and vendor (KQ 6).

[c] A supplemental search of MEDLINE was developed for identifying breastfeeding interventional studies conducted among low-income populations living in the United States using a combination of the low-income search with additional MeSH terms for Culture and Continental Population Groups and a broad search for breastfeeding, infant nutrition, and breast milk (KQ 3e).

[d] Sum of the total number of articles across all KQs is greater than the total number of articles included because one article can provide data relevant to more than one KQ.

TABLE I-2 MEDLINE Search Strategy to Identify Relevant Literature

Search No.	Search Terms
	WIC search
1	"Women, Infants, and Children".af. [af=all fields]
2	WIC.af.
3	"Special Supplemental Nutrition Program".af.
4	1 or 2 or 3
5	limit 4 to (english language and yr="2005 -Current")
	Supplemental low-income search for KQ 5 and KQ 6
1	exp Medicaid or exp Poverty [exp=search for requested subject heading and terms related to subject heading]
2	("low income" or "low-income").mp. [mp=search title, abstract, original title, name of substance word, subject heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier]
3	1 or 2
4	United States.cp. [cp=country of publication]
5	3 and 4
6	exp Food
7	(access or accessibility).mp.
8	exp Environment or environment.mp.
9	costs.mp. or exp "Costs and Cost Analysis"
10	"purchase pattern".tw. [tw = search title, abstract, MeSH headings, other terms, chemical names, secondary source identifier, person name as subject]
11	store.mp.
12	vendor.mp.
13	or/7-12
14	6 and 13
15	5 and 14
16	exp Diet
17	exp Breast Feeding/ or exp Bottle Feeding/ or exp Feeding Behavior
18	16 or 17
19	exp Culture
20	exp Continental Population Groups
21	ethnicity.mp.
22	or/19-21
23	18 and 22

continued

TABLE I-2 Continued

Search No.	Search Terms
24	5 and 23
25	15 or 24
	Supplemental breastfeeding intervention search for KQ 3e
1	infant nutrition.mp. or exp Milk, Human/
2	human milk.mp.
3	(human adj2 milk).tw.
4	breast milk.mp.
5	breastmilk.mp.
6	breast feeding.mp.
7	breastfeeding.mp.
8	breastfeed$.mp.
9	breast fed.mp.
10	breastfed.mp.
11	(breast adj2 fed).tw.
12	exp lactation/
13	(lactating or lactation).mp.
14	or/1-13
15	limit 14 to english language
16	follow-up studies/
17	(follow-up or followup).tw.
18	exp Case-Control Studies/
19	(case adj20 control).tw.
20	exp Longitudinal studies/
21	longitudinal.tw.
22	exp Cohort Studies/
23	cohort.tw.
24	(random$ or rct).tw.
25	exp randomized controlled trials/
26	exp random allocation/
27	exp double-blind method/
28	exp single-blind method/
29	randomized controlled trial.pt.
30	clinical trial.pt.
31	controlled clinical trials/

TABLE I-2 Continued

Search No.	Search Terms
32	(clin$ adj trial$).tw.
33	((singl$ or doubl$ or trebl$ or tripl$) adj (blind$ or mask$)).tw. (82507)
34	exp PLACEBOS/ (14540)
35	placebo$.tw. (110224)
36	exp Research Design/ (250000)
37	exp Evaluation Studies/ (203532)
38	exp Prospective Studies/ (311403)
39	exp Comparative Study/ (979477)
40	or/16-39 (3077255)
41	15 and 40 (16311)
42	limit 41 to (addresses or bibliography or biography or case reports or congresses or consensus development conference or consensus development conference, NIH or dictionary or directory or editorial or festschrift or government publications or interview or lectures or legal cases or legislation or letter or news or newspaper article or overall or patient education handout or periodical index)
43	limit 41 to comment and (letter or editorial).pt.
44	41 not (42 or 43)
45	limit 44 to humans
46	exp Medicaid/ or exp Poverty/
47	(“low income” or “low-income”).mp.
48	46 or 47
49	United States.cp.
50	48 and 49
51	45 and 50 (190)
52	limit 51 to yr=”2005 -Current” (113)
53	exp Culture/
54	exp Continental Population Groups/
55	ethnicity.mp.
56	or/53-55
57	45 and 56 (590)
58	United States.cp. (5211762)
59	57 and 58 (337)
60	limit 59 to yr=”2005 -Current” (225)
61	52 or 60 (310)

Appendix J

Dietary Reference Intake Values and Nutrients and Foods Analyzed

TABLE J-1a Dietary Reference Intakes Used for Assessing Nutrient Intakes of WIC-Eligible Subgroups

	Nutrient								
	Calcium (mg/d)	Copper (µg/d)	Iron (mg/d)	Magnesium (mg/d)	Phosphorus (mg/d)	Selenium (µg/d)	Zinc (mg/d)	Potassium (mg/d)	Sodium (mg/d)
Infants 0 to 6 mo									
EAR/AI	200*	200*	0.27*	30*	100*	15*	2*	400*	120*
UL	1,000	ND	40	ND	ND	45	4	NA	ND
Infants 6 to 12 mo									
EAR/AI	260*	220*	6.9	75*	275*	20*	2.5	700*	370*
UL	1,500	ND	40	ND	ND	60	5	NA	ND
Children 1–3 y									
EAR/AI	500	260	3	65	380	17	2.5	3,000*	1,000*
UL	2,500	1,000	40	65	3,000	90	7	NA	1,500
Children 4–8 y									
EAR/AI	800	340	4.1	110	405	23	4	3,800*	1,200*
UL	2,500	3,000	40	110	3,000	150	12	NA	1,900
Females 19–30 y									
EAR/AI	800	700	8.1	255	580	45	6.8	4,700*	1,500*
UL	2,500	10,000	45	350	4,000	400	40	NA	2,300
Females 31–50 y									
EAR/AI	800	700	8.1	265	580	45	6.8	4,700*	1,300*
UL	2,500	10,000	45	350	4,000	400	40	NA	2,300

Pregnancy 19–30 y									
EAR/AI	800	800	22	290	580	49	9.5	4,700*	1,500*
UL	2,500	10,000	45	350	3,500	400	40	NA	2,300
Pregnancy 31–50 y									
EAR/AI	800	800	22	300	580	49	9.5	4,700*	1,500*
UL	2,500	10,000	45	350	3,500	400	40	NA	2,300
Lactation 19–30 y									
EAR/AI	800	1,000	6.5	255	580	59	10.4	5,100*	1,500*
UL	2,500	10,000	45	350	4,000	400	40	NA	2,300
Lactation 31–50 y									
EAR/AI	800	1,000	6.5	265	580	59	10.4	5,100*	1,500*
UL	2,500	10,000	45	350	4,000	400	40	NA	2,300

NOTES: AI = Adequate Intake, used when necessary, followed by an asterisk (*); EAR = Estimated Average Requirement, used when available; NA = Not Applicable; ND = not determined due to lack of data; UL = Tolerable Upper Intake Level.

The UL for magnesium represents intake from pharmacological agents only and does not include intake from food.

The AIs for calcium for infants are based on the calcium content of human milk. The UL values for phosphorous and sodium in this table were corrected to mg units from the values in the originally posted prepublication, which were in g units.

DATA SOURCES for Tables J-1a to J-1c are listed after Table J-1c.

TABLE J-1b Dietary Reference Intakes Used for Assessing Nutrient Intakes of WIC-Eligible Subgroups

	Nutrient				
	Vitamin A (µg/d)	Vitamin D (IU/d)	Vitamin E (mg/d)	Vitamin C (mg/d)	Thiamin (mg/d)
Infants 0 to 6 mo					
EAR/AI	400*	400*	4*	40*	0.2*
UL	600	1,000	ND	ND	ND
Infants 6 to 12 mo					
EAR/AI	500*	400*	5*	50*	0.3*
UL	600	1,500	ND	ND	ND
Children 1–3 y					
EAR/AI	210	400	5	13	0.4
UL	600	2,500	200	400	ND
Children 4–8 y					
EAR/AI	275	400	6	22	0.5
UL	900	3,000	300	650	ND
Females 19–30 y					
EAR/AI	500	400	12	60	0.9
UL	3,000	4,000	1,000	2,000	ND
Females 31–50 y					
EAR/AI	500	400	12	60	0.9
UL	3,000	4,000	1,000	2,000	ND
Pregnancy 19–30 y					
EAR/AI	550	400	12	70	1.2
UL	3,000	4,000	1,000	2,000	ND
Pregnancy 31–50 y					
EAR/AI	550	400	12	70	1.2
UL	3,000	4,000	1,000	2,000	ND
Lactation 19–30 y					
EAR/AI	900	400	16	100	1.2
UL	3,000	4,000	1,000	2,000	ND
Lactation 31–50 y					
EAR/AI	900	400	16	100	1.2
UL	3,000	4,000	1,000	2,000	ND

Riboflavin (mg/d)	Niacin (mg/d)	Vitamin B6 (mg/d)	Folate (µg DFE/d)	Vitamin B12 (mg/d)	Choline (mg/d)
0.3*	2*	0.1*	65*	0.4*	125*
ND	ND	ND	ND	ND	ND
0.4*	4*	0.3*	80*	0.5*	150*
ND	ND	ND	ND	ND	ND
0.4	5	0.4	120	0.7	200*
ND	10	30	300	ND	1,000
0.5	6	0.5	160	1.0	250*
ND	15	40	400	ND	1,000
0.9	11	1.1	320	2.0	425*
ND	35	100	1,000	ND	3,500
0.9	11	1.1	320	2.0	425*
ND	35	100	1,000	ND	3,500
1.2	14	1.6	520	2.2	450*
ND	35	100	1,000	ND	3,500
1.2	14	1.6	520	2.2	450*
ND	35	100	1,000	ND	3,500
1.3	13	1.7	450	2.4	550*
ND	35	100	1,000	ND	3,500
1.3	13	1.7	450	2.4	550*
ND	35	100	1,000	ND	3,500

continued

TABLE J-1b Continued

NOTES: AI = Adequate Intake, used when necessary, followed by an asterisk (*); EAR = Estimated Average Requirement, used when available; NA = Not Applicable; ND = not determined due to lack of data; UL = Tolerable Upper Intake Level.
The UL for vitamin A refers to preformed vitamin A only.
The UL for vitamin E applies to synthetic forms obtained from dietary supplements, and fortified foods, not from vitamin E naturally occurring in foods.
DATA SOURCES for Tables J-1a to J-1c are listed after Table J-1c.

TABLE J-1c Macronutrient Intake Recommendations for WIC-Eligible Subgroups

	Recommended Intake				
Macronutrient	Infants 0 to Less Than 6 Months	Infants 6 to Less Than 12 Months	Children 1–3 Years	Children and Adolescents 4–18 Years	Adults
Fat (% of kcal AMDR)	31g/d	30 g/d	30–40	25–35	20–35
Carbohydrate (% of kcal AMDR)[a]	60 g/d	95 g/d	45–65	45–65	45–65
Protein (% of kcal AMDR)	ND	ND	5–20	10–30	10–35
Protein (g/kg/d EAR)	1.52[b]	1.0	1.1	0.95	0.88

NOTES: AMDR = Acceptable Macronutrient Distribution Range; EAR = Estimated Average Requirement.

[a] Units are % of kcal except where noted.

[b] Adequate intake (AI).

DATA SOURCES for Tables J-1a to J-1c: Nutrients of concern are as presented in the *Scientific Report of the 2015 Dietary Guidelines Advisory Committee* (USDA/HHS, 2015). Dietary Reference Intake values are from Institute of Medicine reports (IOM, 1997, 1998, 2000, 2001, 2002/2005, 2005, 2011).

TABLE J-2 Nutrients Selected for Intake Analysis

Nutrients Available in WWEIA	Include in Analyses	Rationale for Exclusion in Current Report
Food energy (kcal)	✓	
Protein (g)	✓	
Carbohydrate (g)	✓	
Fat, total (g)	✓	
Dietary fiber, total (g)	✓	
Saturated fatty acids, total (g)	✓	
Monounsaturated fatty acids, total (g)		No DRI
Polyunsaturated fatty acids, total (g)		No DRI
Cholesterol (mg)		No DRI or DGAC recommendation
Linoleic 18:2 (g)		Used USDA food pattern “oils” as a proxy
Linolenic 18:3 (g)		Used USDA food pattern “oils” as a proxy
EPA 20:5 (g)		No DRI, seafood intake as proxy
DHA 22:6 (g)		No DRI, seafood intake as proxy
Vitamin A as RAE (μg)	✓	
Retinol (μg)	✓	
Vitamin E as alpha-tocopherol (mg)	✓	
Added vitamin E (mg)	✓	
Vitamin D (D2 + D3)(μg)	✓	Only infants 0 to less than 12 months
Vitamin D, 25-Hydroxy	✓	
Vitamin K as phylloquinone (μg)		Inadequacy is extremely rare
Vitamin C (mg)	✓	
Thiamin (mg)	✓	
Riboflavin (mg)	✓	
Niacin (mg)	✓	
Vitamin B6 (mg)	✓	
Folate as DFE (μg)	✓	
Folic acid (μg)	✓	
Vitamin B12 (μg)	✓	

TABLE J-2 Continued

Nutrients Available in WWEIA	Include in Analyses	Rationale for Exclusion in Current Report
Calcium (mg)	✓	
Iron (mg)	✓	
Magnesium (mg)	✓	
Phosphorus (mg)	✓	
Potassium (mg)	✓	
Sodium (mg)	✓	
Zinc (mg)	✓	
Copper (mg)	✓	
Selenium (µg)	✓	
Choline (mg)	✓	

NOTES: DGAC = *Scientific Report of the 2015 Dietary Guidelines Advisory Committee*; DRI = Dietary Reference Intake; WWEIA = What We Eat in America.

TABLE J-3 Food Groups for Analyses Based on Food Pattern Components in FPID and FPED

Main Components	FPID/FPED Components (2011–2012)
Fruit	Total fruit
Vegetables	Total vegetables
	Dark green vegetables
	Total red and orange vegetables
	Total starchy vegetables
	Other vegetables
	Beans and peas computed as vegetables
Grains	Total grains
	Whole grains
	Refined grains
Protein Foods	Total protein foods
	Total meat, poultry, and seafood
	Meat, poultry, and eggs (not seafood)
	Seafood
	Nuts, seeds, soy (nuts and seeds and soybean products)
Dairy	Total dairy (milk, yogurt, cheese, whey)
Oils	Oils
Solid Fats	Solid fats
Added Sugars	Added sugars

NOTES: FPED = Food Patterns Equivalents Database; FPID = Food Patterns Ingredients Database.
SOURCE: USDA/ARS, 2014.

REFERENCES

IOM (Institute of Medicine). 1997. *Dietary reference intakes for calcium, phosphorus, magnesium, vitamin D, and fluoride*. Washington, DC: National Academy Press.

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IOM. 2000. *Dietary reference intakes for vitamin C, vitamin E, selenium, and carotenoids*. Washington, DC: National Academy Press.

IOM. 2001. *Dietary reference intakes for vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium, and zinc*. Washington, DC: National Academy Press.

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Appendix K

Diet Quality Indexes

As described in the 2015 Institute of Medicine (IOM) report *Review of WIC Food Packages: An Evaluation of White Potatoes in the Cash Value Voucher: Letter Report,* options for a second index were considered by the committee based on its evaluation of the literature on existing diet quality indexes other than the Healthy Eating Index-2010 (HEI-2010) and with consideration to three criteria: (1) the index can be applied to adults and children, (2) 24-hour recall data are applied, and (3) the index is based on a metric other than comparison to the *Dietary Guidelines for Americans* (DGA). After reviewing potential indexes, the committee determined that responding to the task would require an index that focuses mainly on nutrient content to provide a contrast to the food-group focus of the HEI-2010. However, the committee found that existing nutrient-based indexes could not be applied directly for two reasons. First, they could not be applied because they use Daily Values based on a 2,000-calorie diet as reference standards for nutrient intake rather than age-appropriate Dietary Reference Intake (DRI) values. Second, they do not necessarily include all of the nutrients and dietary components the committee was interested in assessing, based on current knowledge about nutrients of concern in the diets of young children and women of childbearing age (the 2010 DGA) and the committee's assessment of the nutrient intakes of the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC)-eligible populations. The committee developed an adapted nutrient-based diet quality index to be scored by comparison to DRI values. The components of this index are described here.

The index examined the following "positive" nutrients included in the

2015 Dietary Guidelines Advisory Council (DGAC) as shortfall nutrients and nutrients of concern, to be updated upon release of the 2015 DGA:

1. Potassium
2. Dietary fiber
3. Calcium
4. Iron
5. Vitamin C
6. Folate
7. Vitamin A
8. Vitamin E
9. Magnesium

The index is the mean percentage adequacy for these nine nutrients, calculated for each individual. The possible range is from 0 to 100.

- For nutrients with an Estimated Average Requirement (EAR): the **percentage adequacy** was calculated for each individual for each day. To do this, the method described in IOM (2000) was applied using the DRI for assessment of intake of individuals and groups and z-scores were computed for each respondent as follows:
  a. Usual intake at the individual level was first estimated as the best linear unbiased predictor of intake (BLUP). The BLUP has the smallest prediction error variance among all linear predictors.
  b. The difference between the individual's estimated usual intake of the nutrient and the EAR for the nutrient was then computed.
  c. A z-score was computed as the ratio of the difference to the standard error of that difference.
  d. Finally, the probability of observing a z-value that was at least as large as the one observed for the individual was computed and multiplied by 100. These calculations were repeated for all the nutrients included in the index. The possible range is from 0 to 100.
- For the nutrients with an Adequate Intake (AI) value (potassium and dietary fiber), reasonable intake ranges based on the AI were applied, to assign 0, 25, 50, and 100 percent adequacy as follows:
  a. Intake equal to or above the AI, percentage adequacy = 100.
  b. Intake below the AI but equal to or above 75 percent of the AI, percentage adequacy = 75.
  c. Intake below 75 percent of the AI but equal to or above 50 percent of the AI, percentage adequacy = 50.

d. Intake below 50 percent of the AI but equal to or above 25 percent of the AI, percentage adequacy = 25.
e. Intake below 25 percent of the AI, percentage adequacy = 0.

- The mean percentage adequacy for each individual was calculated by averaging the nutrient-wise percentage adequacy.
- The mean percentage adequacy for population subgroups was then calculated using individual survey weights. Initial descriptive statistics generated to validate the index:

a. As a first step, the mean and standard deviation of the index was evaluated.
b. Second, the association of the index with energy intake was examined.
c. Finally, the association with the HEI-2010 was examined.

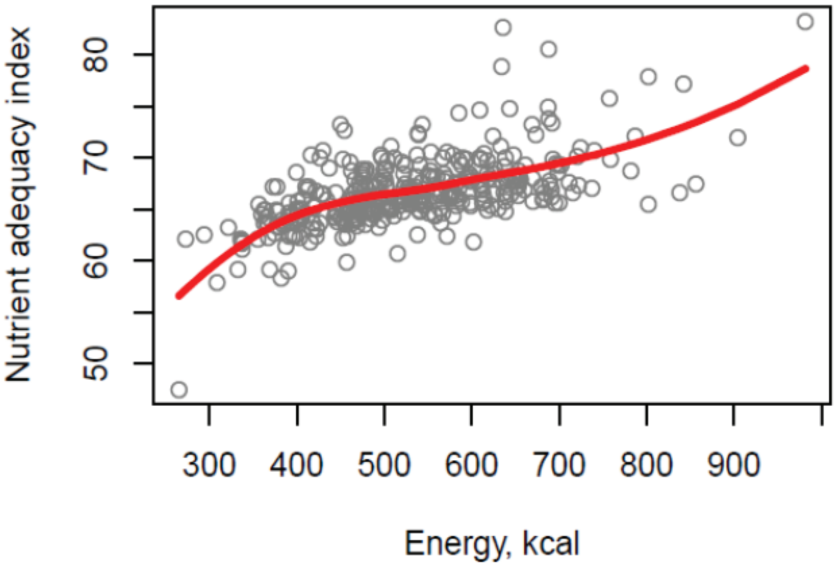

FIGURE K-1 Nutrient adequacy index distributions of WIC children ages 1 to less than 2 years, 2005–2008.

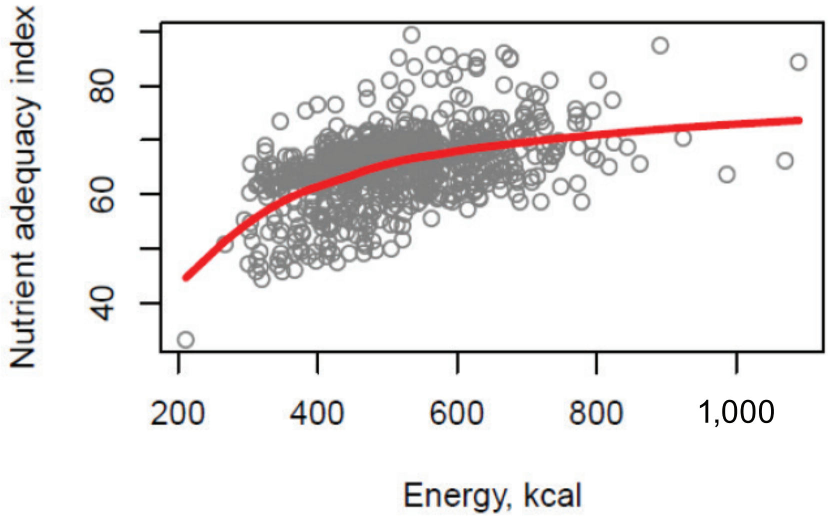

FIGURE K-2 Nutrient adequacy index distributions of WIC children ages 2 to less than 5 years, 2005–2008.

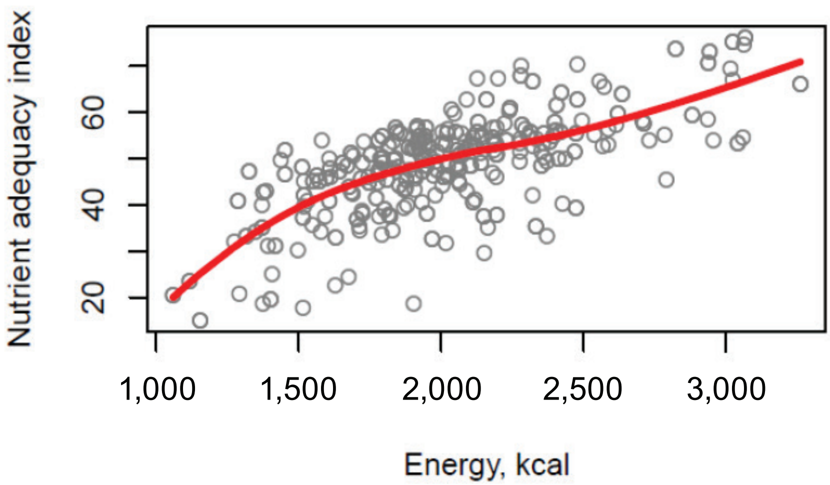

FIGURE K-3 Nutrient adequacy index distributions of WIC women ages 19 to less than 50 years.

TABLE K-1 HEI-2010 Components and Scoring System

HEI-2010 Component[a]	Maximum	Standard for Maximum Score	Standard for Minimum Score of Zero
		Adequacy	
Total Fruit[b]	5	≥ 0.8 c-eq / 1,000 kcal	No fruit
Whole Fruit[c]	5	≥ 0.4 c-eq / 1,000 kcal	No whole fruit
Total Vegetables[d]	5	≥ 1.1 c-eq / 1,000 kcal	No vegetables
Greens and Beans[d]	5	≥ 0.2 c-eq / 1,000 kcal	No dark green vegetables, beans, or peas
Whole Grains	10	≥ 1.5 c-eq / 1,000 kcal	No whole grains
Dairy[e]	10	≥ 1.3 c-eq / 1,000 kcal	No dairy
Total Protein Foods[f]	5	≥ 2.5 c-eq / 1,000 kcal	No protein foods
Seafood and Plant Proteins[f,g]	5	≥ 0.8 c-eq / 1,000 kcal	No seafood or plant proteins
Fatty Acids[h]	10	(PUFAs + MUFAs) / SFAs ≥ 2.5	(PUFAs + MUFAs) / SFAs ≤ 1.2
		Moderation	
Refined Grains	10	≥ 1.8 oz-eq / 1,000 kcal	≥ 4.3 oz-eq / 1,000 kcal
Sodium	10	≥ 1.1 g / 1,000 kcal	≥ 2.0 g / 1,000 kcal
Empty Calories[i]	20	≥ 19 percent of energy	≥ 50 percent of energy

NOTES: c-eq = cup-equivalent; HEI = Healthy Eating Index; kcal = kilocalorie; oz-eq = ounce-equivalent; MUFA = monounsaturated fatty acid; PUFA = polyunsaturated fatty acid; SFA = saturated fatty acid.

[a] Intakes between the minimum and maximum standards are scored proportionately.
[b] Includes 100% fruit juice.
[c] Includes all forms except juice.
[d] Includes any beans and peas not counted as Total Protein Foods.
[e] Includes all milk products such as fluid milk, yogurt, and cheese, and fortified soy beverages.
[f] Beans and peas are included here (not with vegetables) when the Total Protein Foods standard is otherwise not met.
[g] Includes seafood, nuts, seeds, soy products (other than beverages) as well as beans and peas counted as Total Protein Foods.
[h] Ratio of poly- and monounsaturated fatty acids (PUFAs and MUFAs) to saturated fatty acids (SFAs).
[I] Calories from solid fats, alcohol, and added sugars; threshold for counting alcohol is > 13 grams / 1,000 kcal.

SOURCE: Guenther et al., 2013.

REFERENCES

Guenther, P. M., K. O. Casavale, J. Reedy, S. I. Kirkpatrick, H. A. Hiza, K. J. Kuczynski, L. L. Kahle, and S. M. Krebs-Smith. 2013. Update of the Healthy Eating Index: HEI-2010. *Journal of the Academy of Nutrition and Dietetics* 113(4):569-580.

IOM (Institute of Medicine). 2000. *Dietary reference intakes: Applications in dietary assessment*. Washington, DC: National Academy Press.

IOM. 2015. *Review of WIC food packages: An evaluation of white potatoes in the cash value voucher: Letter report*. Washington, DC: The National Academies Press.

USDA/HHS (U.S. Department of Agriculture/U.S. Department of Health and Human Services). 2015. *The report of the Dietary Guidelines Advisory Committee on the Dietary Guidelines for Americans, 2015, to the Secretary of Agriculture and the Secretary of Health and Human Services*. Washington, DC: USDA/HHS. http://www.health.gov/dietaryguidelines/2015-scientific-report/PDFs/Scientific-Report-of-the-2015-Dietary-Guidelines-Advisory-Committee.pdf (accessed May 24, 2015).

Appendix L

Household Food Expenditure Analysis

RESEARCH QUESTIONS

This activity is designed to provide data and analytic support for the review of the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) food packages through analysis of food expenditures, expenditure patterns (total and on food groups) by low-income households, and households participating in the WIC program. The information will be used to estimate the total food expenditures and expenditures on food groups for WIC households to assess the relative contribution of the WIC food packages to their food expenditures. Comparative groups for analysis are (a) WIC households, (b) other households with low income (less than or equal to 185 percent poverty income), and (c) households with income greater than or equal to 185 percent poverty income.

Questions examined in Phase I:

1. How much do households spend for food in total, food at home, and food away from home? (in total, and by household composition)
2. For households receiving WIC, what share of total at-home expenditures is contributed by the WIC benefit (value of the voucher or electronic benefit transfer card)?

Questions to be examined in Phase II:

3. For specific food groups (both food groups in the *Dietary Guidelines for Americans* and food item groups in the current WIC food

package), what share of the total at-home food expenditures are represented by each specific food group?

4. For households receiving WIC: for specific food groups (food categories in the current WIC food package), what share of the specified food group comes from purchases made with the WIC benefit?

The WIC foods will be identified based on (a) an acquisition "event," including a WIC payment and (b) by food code description (through the Information Resources Incorporated food item classification variables). Identification and classification of foods and food group acquisitions and purchases will be done in phase II as feasible based on available food codes.

Household or Individual Subgroups to Be Examined

1. Households receiving WIC benefits (i.e., those who report receiving WIC) or making a purchase with a WIC voucher
2. Non WIC, income less than or equal to 185 percent poverty
3. Non WIC, income greater than or equal to 185 percent poverty

Sample Weights and Procedures

All descriptive tables and bivariate comparisons use sample weights and procedures that account for the complex sample design used for National Household Food Acquisition and Purchase Survey (FoodAPS) data.

Analysis

For the phase I analysis of food expenditures and expenditures using WIC vouchers, data were developed and presented in bivariate tables and include mean and standard errors of food expenditures in total, food at home, food away from home, percentage of households reporting WIC food expenditure/redemption in a week, value of WIC benefits used in a week, and share of the total week's expenditures that comes from WIC benefits (for WIC households). For phase II, redemption of WIC, additional analysis will analyze expenditures by food groups purchased and acquired by WIC households and the other comparison groups. The phase 1 analyses will also compare demographic and food security information on the WIC and non-WIC groups. Demographic groups considered include households with infants and young children (less than 5 years old) and those with a pregnant woman.

REFERENCE

USDA/ERS (U.S. Department of Agriculture/Economic Research Service). 2015. *FoodAPS National Household Food Acquisition and Purchase Survey*. Washington, DC: USDA/ERS. http://www.ers.usda.gov/data-products/foodaps-national-household-food-acquisition-and-purchase-survey.aspx (accessed August 26, 2015).

Appendix M

Regulatory Impact Analysis Approach

The U.S. Department of Agriculture's Food and Nutrition Service (USDA-FNS) requested that the committee develop the approach for a regulatory impact analysis (RIA) based on that published by USDA in support of the proposed, interim final rule. The final report will include an RIA conducted according to the approach detailed in the document, "Regulatory Impact Analysis: A Primer" provided by the Office of Information and Regulatory Analysis (OIRA, Circular A-4). In accord with that document, the RIA will include the following elements with the objective to model the impact of changes in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) food packages on program participation, value of food packages as selected, and program cost and administration. Details of the proposed RIA approach are presented here.

1. A statement of the need for the regulatory action.

   The statement of need for the recommended actions will describe needed changes in WIC food packages based on the current supplemental nutritional needs of the participating WIC population and advances in nutrition science.
2. A summary of the consequences of the proposed recommendations.

   The RIA will develop a baseline that will describe the WIC program as it currently exists, and forecast how the current program is likely to change in the future. In this case, the baseline will describe current WIC food packages (the same as applied in the sensitivity analysis), calculate the cost of each food package, and forecast future changes in costs based on expected changes in participation and food prices.

The RIA will also define the appropriate time horizon for analyzing future changes (anticipated to be 5 years).

The RIA will summarize the recommended changes to the current program and describe how the recommended changes translate into changes in each of the WIC food packages, the rationale for each change, and expected (e.g., nutritional) effects.

The RIA will summarize the benefits of the recommended changes. Benefits will be quantified and monetized to the extent possible.

The RIA will demonstrate that recommended changes are projected to be cost neutral when compared to the baseline. Program administrative costs, vendor costs, and market effects will also be considered.

It is anticipated that the largest changes in program costs will come from recommended changes in WIC food packages. The methodology to estimate these costs will use prescription and redemption data (as available) to guide the committee's assumptions and describe current quantities of foods prescribed to participants. Total food item costs will be derived by multiplying food quantities by food item prices from scanner data. Total food costs will be estimated by multiplying food item costs times the average number of participants purchasing that food item.

The same cost methodology will be applied to the baseline food packages and to the revised food packages. Costs will be forecasted for the appropriate time horizon. Future costs (and benefits) will be discounted to their present value.

The RIA will characterize uncertainties in costs and benefits and evaluate the sensitivity of costs and benefits to potential alternative scenarios.

REFERENCE

OIRA (Office of Information and Regulatory Affairs). 2011. *Regulatory impact analysis: A primer*. Washington, DC: Office of Management and Budget, The White House. https://www.whitehouse.gov/sites/default/files/omb/inforeg/regpol/circular-a-4_regulatory-impact-analysis-a-primer.pdf (accessed September 8, 2015).

Appendix N

Committee Perceptions of the WIC Experience

As noted in Chapter 3, committee members were required to visit one or more Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) sites. The plan was designed to ensure national coverage both geographically and with respect to racial and ethnic diversity. Committee members prepared and shared reports in a closed session.[1] The most outstanding comment from committee members was the variability across WIC sites in several programmatic aspects, as summarized in Box N-1. Previously in this report, the difficulties finding a 1-pound loaf of whole wheat bread were described. Similarly, in states where whole wheat pasta is permitted for purchase, finding a product meeting the 1-pound specification was difficult. Other whole grain products in a 1-pound size but not currently permitted for purchase included whole grain corn pasta and whole grain brown rice pasta. These two versions may also be suitable for gluten-free diets, although the cost is significantly greater. Checkout efficiency although not quantifiable appeared to be qualitatively improved with the electronic benefit transfer instrument.

Similarly, some WIC personnel with whom the committee met on site visits expressed concern about the 18-ounce container of peanut butter, because not all peanut butter vendors offer this size. They and also public commenters expressed concern that manufacturers frequently change package sizes. These changes can affect availability to participants when WIC state agencies define the allowable package sizes to contain costs, which

[1] A summary of the committee reports is accessible through the National Academies Public Access File. Email: paro@nas.edu.

may not align with package size revisions. WIC participants are an important customer base, and it benefits manufacturers to be cognizant of WIC rules, particularly considering potential variation across states.

BOX N-1
Committee Site Visits: Key Perceptions

A key take-away for committee members was that states vary widely in their structure and program implementation. The U.S. Department of Agriculture's Food and Nutrition Service offers states a variety of implementation options. A summary of the points of variability is provided here with examples.

Program Component	*Variation*
Services offered in conjunction with WIC	Medical, dental, sexually transmitted disease testing, immunization check, voter registration; other sites offer exclusively WIC-based services
Clinic flow	Depends on the size of the staff; the process may be handled largely by one or a different staff person for each stage.
Breastfeeding support	Breastfeeding support offered via peer counseling or colocated breastfeeding clinic paid for by WIC funds. Some sites have International Board-Certified Lactation Consultants (IBCLCs) on staff. Time spent talking to prenatal participants about breastfeeding plans varies. Provision of materials and supplies (including pumps, educational pamphlets, and incentives to breastfeed) varies
Education	Group classes, one-on-one instruction, and/or online instruction. Detail of food guides vary (with or without photos, multiple languages)
Vendors	WIC-only vendors, WIC-authorized grocery and corner stores, home delivery (Vermont only)
State food options	Forms of produce permitted for purchase with the cash value voucher vary widely, with some states offering fresh only. States vary in the number of options and brands as well as in the availability of state-approved foods at each vendor. Choices may sometimes be made at the store or, alternatively, must be made before the food package is issued.

BOX N-1 Continued

Cost-containment practices	These include “Least Expensive Brand” policies and offering of regular-sodium, or regular-fat only options
In-store labeling	All WIC foods labeled, specific foods labeled, or no WIC foods labeled
Checkout process	The elecronic benefit transfer process is faster and less noticeable to other shoppers than the paper voucher process; the ease of the transaction depends on staffing and staff knowledge, food labeling, consumer knowledge, accuracy of store databases, and other factors

Other notes:

Participant racial and ethnic diversity is wide overall, but varies by state. The staff is typically attuned to the needs of participants in their region, providing education accordingly. Mechanisms were usually in place to deal with language differences. There was positive feedback from users of mobile-based applications when available in the state.

WIC foods that were difficult to find on more than one occasion include the 16-oz loaf of bread or whole wheat pasta and yogurt with the required sugar limits.

Appendix O

Summary Results from the Diet Quality of American Young Children by WIC Participation Status

TABLE O-1 FNS Reported Prevalence of Inadequacy of Vitamins and Minerals for Children Ages 1 to 4 Years, NHANES 2005–2008, % Inadequacy

	% Inadequacy				
Nutrient	EAR (Ages 1–3/Age 4) (per Day)	All Children (N = 1,956)	WIC Participants (N = 791)	Income-Eligible Nonparticipants (N = 496)	Higher-Income Nonparticipants (N = 606)
Calcium	500/800 mg	14.7	13.4	15.6	13.7
Iron	3.0/4.1 mg	0.1	0.0	0.0	0.2
Magnesium	65/110 mg	0.8	0.8	1.0	0.8
Phosphorus	380/405 mg	0.1	0.1	0.2	0.1
Zinc	2.5/4.0 mg	0.2	0.2	0.1	0.2
Vitamin A	210/275 µg RAE	1.7	2.0	1.8	1.1
Vitamin E	5/6 mg αTOC	82.9	78.5	81.9	89.8
Vitamin C	13/22 mg	0.6	0.4	0.5	0.6
Thiamin	0.4/0.5 mg	0.1	0.0	0.2	0.1
Riboflavin	0.4/0.5 mg	0.0	0.0	0.0	0.0
Niacin	5/6 mg	0.3	0.2	0.6	0.4
Vitamin B6	0.4/0.5 mg	0.0	0.0	0.2	0.0
Folate	120/160 µg DFE	0.2	0.1	0.6	0.1
Vitamin B12	0.7/1.0 mg	0.0	0.0	0.0	0.0

NOTES: αTOC = α-tocopherol; DFE = dietary folate equivalents; EAR = Estimated Average Requirement; FNS = Food and Nutrition Service; N = sample size; RAE = retinol activity equivalents; % Inadequacy = percentage of individuals with usual intake below the EAR. Usual intake was estimated using the National Cancer Institute (NCI) method.

SOURCE: Adapted from USDA/FNS, 2015.

TABLE O-2 FNS Reported Usual Intakes of Macronutrients for Children Ages 1 to 4 Years, NHANES 2005–2008

Nutrient	Recommended Intake (Ages 1–3/Age 4)	All Children (N = 1,956)	WIC Participants (N = 791)	Income-Eligible Nonparticipants (N = 496)	Higher-Income Nonparticipants (N = 606)
Protein (% of kcal)					
% below AMDR	< 5/10% of kcal	0.3	0.1	0.1	0.7
% above AMDR	> 20/30% of kcal	1.0	0.6	0.2	2.1
Carbohydrate (% of kcal), total					
% below AMDR	< 45% of kcal	3.3	4.1	3.5	3.3
% above AMDR	> 65% of kcal	2.3	3.8	1.8	2.4
Fat (% of kcal), total					
% below AMDR	< 30/25% of kcal	23.3	26.5	21.1	22.3
% above AMDR	> 40/35% of kcal	6.9	9.8	9.4	4.1
Fat, saturated (% of kcal)					
Median	< 10% of kcal	17.1	19.2	10.6	NR
Fiber (g/d)					
% of AI	19/25 g/d	48.0	48.0	48.0	48.0

NOTES: AI = adequate intake; AMDR = Acceptable Macronutrient Distribution Range; FNS = Food and Nutrition Service; kcal = kilocalories; NR = not reliable. Usual intake was estimated using the National Cancer Institute (NCI) method.
SOURCE: Adapted from USDA/FNS, 2015. Intake data from NHANES 2005–2008.

REFERENCE

USDA/FNS (U.S. Department of Agriculture/Food and Nutrition Service). 2015. *Diet quality of American young children by WIC participation status: Data from the National Health and Nutrition Examination Survey, 2005–2008*. Alexandria, VA: USDA/FNS. http://www.fns.usda.gov/sites/default/files/ops/NHANES-WIC05-08.pdf (accessed September 8, 2015).

Appendix P

Nutrient Intake of WIC and WIC-Eligible Populations

DEFINITIONS FOR TABLE SUBGROUPS

Subgroup definitions are as follows:

1. WIC = All individuals reporting participation in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) regardless of income level.
2. Eligible Non-WIC = Low-income individuals who did not report participation in WIC.
3. All Low-Income = All individuals at less than or equal to 185 percent of poverty. At the time of analysis, the WIC indicator was not available for the National Health and Nutrition Examination Survey (NHANES) 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.

LIST OF TABLES

TABLE P-1 Usual Intake Distributions of Selected Micronutrients for Women Ages 19 to 50 Years: All Low-Income, NHANES 2011–2012

	Intake Distribution (percentiles and mean) (SE)			
Nutrient	10th	25th	Median	Mean
Calcium (mg/d)	725 (120)	851 (90.4)	1,000 (76.4)	1,012 (39.4)
Copper (mg/d)	0.9 (0.11)	1.0 (0.09)	1.2 (0.08)	1.2 (0.05)
Iron (mg/d)	11.9 (1.73)	14.0 (1.45)	16.8 (1.38)	17.5 (0.83)
Magnesium (mg/d)	212 (22.8)	244 (19.2)	287 (18.7)	299 (13.28)
Phosphorus (mg/d)	986 (127)	1,137 (99.5)	1,326 (87.9)	1,350 (51.46)
Selenium (μg/d)	88 (11.3)	100 (9.39)	116 (8.93)	120 (4.82)
Zinc (mg/d)	8.3 (1.13)	9.5 (0.87)	10.9 (0.76)	11.0 (0.38)
Potassium (mg/d)	1,864 (221)	2,153 (171)	2,505 (147)	2,544 (94.9)
Sodium (mg/d)	2,514 (365)	2,972 (295)	3,564 (267)	3,676 (169.1)
Vitamin A (μg RAE/d)	360 (77.3)	455 (59.9)	572 (51.0)	585 (31.17)
Retinol (μg/d)	278 (65.1)	355 (50.5)	451 (43.6)	461 (25.5)
Vitamin E (mg αTOC/d)	5.3 (1.12)	6.7 (0.92)	8.5 (0.85)	8.8 (0.51)
Vitamin C (mg/d)	45 (15.9)	65 (13.9)	93 (13.4)	99 (8.0)
Thiamin (mg/d)	1.3 (0.17)	1.5 (0.13)	1.7 (0.11)	1.7 (0.06)
Riboflavin (mg/d)	1.5 (0.20)	1.7 (0.15)	2.0 (0.13)	2.0 (0.07)
Niacin (mg/d)	20.1 (2.40)	22.7 (1.98)	26.2 (1.87)	26.9 (1.01)
Vitamin B6 (mg/d)	1.5 (0.22)	1.7 (0.18)	2.0 (0.17)	2.1 (0.09)
Folate (μg DFE/d)	516 (96.9)	594 (76.9)	692 (68.8)	706 (27.0)
Vitamin B12 (mg/d)	3.4 (0.70)	4.1 (0.57)	5.0 (0.53)	5.1 (0.26)
Choline (mg/d)	213 (34.1)	254 (24.8)	301 (19.7)	302 (12.0)

NOTES: N = 34. Asterisk (*) indicates AI (used when EAR could not be determined). All women were pregnant, breastfeeding, or postpartum. For % inadequate calculations, the approach of the Institute of Medicine (2000) was applied in which, when combining groups with different EARs, intakes in one of the groups are rescaled so they can be compared to the EAR of the other group. One value indicates that the EAR is the same across groups.

See additional notes following Table P-15.

75th	90th	EAR or AI* (NPNL/P/BF)	% Inadeq (SE)	UL	% > UL (SE)
1,160 (104)	1,313 (154)	800	18.0 (19.88)	2,500	0
1.4 (0.12)	1.6 (0.20)	0.7/0.8/1.0	7.2 (14.23)	10	0
20.2 (2.15)	23.9 (3.63)	8.1/22.0/6.5	38.5 (12.09)	45	13.3 (14.16)
341 (30.2)	401 (52.4)	255/290/255	46.7 (10.29)	350	—
1,537 (125)	1,747 (195)	580	0	3,500	0
136 (13.8)	157 (23.1)	45/49/59	0	400	0
12.4 (1.05)	14.0 (1.61)	6.8/9.5/10.4	28.8 (19.98)	40	0
2,893 (207)	3,273 (319)	4,700/4,700/5,100*	—	ND	—
4,258 (404)	4,981 (665)	1,500*	—	2,300	94.5 (10.3)
701 (72.1)	825 (111)	500/550/900	59.8 (12.01)	—	—
556 (61.1)	658 (93.1)	—	—	3,000	0
10.6 (1.27)	12.8 (2.06)	12/12/16	88.4 (14.46)	1,000	0
127 (20.6)	162 (33.8)	60/70/100	35.5 (13.44)	2,000	0
1.9 (0.16)	2.2 (0.24)	0.9/1.2/1.2	5.4 (13.43)	ND	—
2.3 (0.18)	2.6 (0.28)	0.9/1.2/1.2	1.7 (6.39)	ND	—
30.3 (2.86)	34.8 (4.75)	11/14/13	0.1 (0.54)	35	11.2 (18.17)
2.4 (0.25)	2.8 (0.40)	1.1/1.6/1.7	18.9 (18.17)	100	0
803 (99.0)	915 (155)	320/520/450	15.1 (21.09)	1,000	0
6.1 (0.78)	7.1 (1.26)	2.0/2.2/2.4	0.6 (3.86)	ND	—
349 (26.1)	393 (38.2)	425/450/550	—	3,500	0

TABLE P-2 Usual Intake Distributions of Selected Micronutrients for Women Ages 19 to 50 Years: WIC, NHANES 2005–2008

	Intake Distribution (percentiles and mean) (SE)			
Nutrient	10th	25th	Median	Mean
Calcium (mg/d)	576 (44.0)	744 (36.8)	965 (34.3)	1,005 (22.4)
Copper (mg/d)	0.7 (0.04)	0.9 (0.03)	1.1 (0.03)	1.1 (0.02)
Iron (mg/d)	9.0 (0.61)	11.3 (0.49)	14.4 (0.48)	15.5 (0.38)
Magnesium (mg/d)	156 (9.57)	196 (8.02)	248 (7.60)	260 (5.52)
Phosphorus (mg/d)	815 (50.2)	1,004 (38.9)	1,237 (34.5)	1,272 (23.69)
Selenium (µg/d)	71 (4.21)	84 (3.35)	101 (3.00)	103 (1.66)
Zinc (mg/d)	6.8 (0.46)	8.5 (0.38)	10.7 (0.35)	11.1 (0.22)
Potassium (mg/d)	1,426 (95.3)	1,811 (78.7)	2,312 (72.7)	2,402 (50.89)
Sodium (mg/d)	2,200 (128)	2,625 (99.1)	3,140 (86.7)	3,197 (50.53)
Vitamin A (µg RAE/d)	293 (27.7)	396 (24.0)	536 (23.4)	570 (14.97)
Retinol (µg/d)	219 (23.2)	307 (20.1)	427 (19.5)	453 (12.4)
Vitamin E (mg αTOC/d)	3.5 (0.25)	4.6 (0.22)	5.9 (0.22)	6.3 (0.15)
Vitamin C (mg/d)	36 (5.06)	56 (5.31)	89 (6.15)	102 (3.80)
Thiamin (mg/d)	1.0 (0.06)	1.2 (0.05)	1.5 (0.05)	1.6 (0.03)
Riboflavin (mg/d)	1.3 (0.09)	1.6 (0.07)	2.0 (0.06)	2.1 (0.04)
Niacin (mg/d)	14.1 (0.81)	17.1 (0.64)	20.9 (0.62)	21.7 (0.40)
Vitamin B6 (mg/d)	1.0 (0.08)	1.3 (0.06)	1.8 (0.06)	1.9 (0.05)
Folate (µg DFE/d)	314 (23.5)	396 (19.9)	508 (20.3)	541 (12.53)
Vitamin B12 (mg/d)	2.7 (0.25)	3.6 (0.23)	5.0 (0.27)	5.7 (0.19)
Choline (mg/d)	191 (11.6)	229 (9.36)	279 (9.06)	290 (5.25)

NOTES: N = 260. Asterisk (*) indicates AI (used when EAR could not be determined). All women were pregnant, breastfeeding, or postpartum. For % inadequate calculations, the approach of the Institute of Medicine (2000) was applied in which, when combining groups with different EARs, intakes in one of the groups are rescaled so they can be compared to the EAR of the other group. One value indicates that the EAR is the same across groups.

See additional notes following Table P-15.

75th	90th	EAR or AI* (NPNL/P/BF)	% Inadeq (SE)	UL	% > UL (SE)
1,222 (50.2)	1,486 (79.6)	800	31.1 (4.57)	2,500	0.1 (0.17)
1.3 (0.05)	1.6 (0.08)	0.7/0.8/1.0	19.4 (5.06)	10	0
18.4 (0.81)	23.2 (1.57)	8.1/22.0/6.5	66.2 (3.55)	45	6.0 (2.44)
312 (11.6)	378 (19.0)	255/290/255	65.3 (3.86)	350	—
1,501 (50.0)	1,772 (81.0)	580	1.7 (1.51)	3,500	0
119 (4.23)	138 (6.58)	45/49/59	1.0 (1.47)	400	0
13.3 (0.51)	15.9 (0.80)	6.8/9.5/10.4	37.3 (4.30)	40	0
2,895 (107)	3,493 (170)	4,700/4,700/5,100*	—	ND	—
3,707 (120)	4,267 (184)	1,500*	—	2,300	87.1 (5.54)
706 (35.9)	890 (59.8)	500/550/900	60.1 (4.43)	—	—
571 (29.5)	722 (47.6)	—	—	3,000	0
7.6 (0.33)	9.5 (0.56)	12/12/16	98.0 (1.69)	1,000	0
135 (10.2)	186 (16.9)	60/70/100	39.1 (4.57)	2,000	0
1.8 (0.07)	2.2 (0.10)	0.9/1.2/1.2	22.0 (5.41)	ND	—
2.5 (0.09)	2.9 (0.15)	0.9/1.2/1.2	7.9 (4.07)	ND	—
25.5 (0.96)	30.4 (1.49)	11/14/13	9.0 (4.24)	35	4.0 (2.84)
2.3 (0.10)	2.9 (0.16)	1.1/1.6/1.7	41.7 (3.70)	100	0
652 (32.7)	811 (54.4)	320/520/450	50.0 (4.27)	1,000	0
7.1 (0.48)	9.6 (0.87)	2.0/2.2/2.4	4.7 (3.60)	ND	—
339 (13.8)	403 (21.8)	425/450/550	—	3,500	0

TABLE P-3 Usual Intake Distributions of Selected Micronutrients for Women Ages 19 to 50 Years: Eligible Non-WIC, NHANES 2005–2008

	Intake Distribution (percentiles and mean) (SE)			
Nutrient	10th	25th	Median	Mean
Calcium (mg/d)	585 (79.5)	740 (67.0)	937 (58.9)	968 (33.9)
Copper (mg/d)	0.8 (0.09)	1.0 (0.07)	1.2 (0.06)	1.3 (0.05)
Iron (mg/d)	11.0 (0.99)	12.8 (0.78)	15.1 (0.71)	15.5 (0.41)
Magnesium (mg/d)	168 (19.9)	214 (15.4)	270 (13.2)	275 (9.17)
Phosphorus (mg/d)	787 (96.9)	1,000 (76.6)	1,265 (66.9)	1,296 (43.66)
Selenium (μg/d)	75 (7.52)	90 (5.86)	109 (5.08)	111 (3.03)
Zinc (mg/d)	7.7 (0.77)	9.3 (0.62)	11.2 (0.58)	11.7 (0.36)
Potassium (mg/d)	1,465 (193)	1,913 (151)	2,472 (132)	2,540 (92.33)
Sodium (mg/d)	2,071 (243)	2,566 (192)	3,178 (168)	3,249 (101.2)
Vitamin A (μg RAE/d)	281 (51.3)	390 (45.9)	544 (45.7)	586 (28.46)
Retinol (μg/d)	197 (40.7)	289 (38.1)	424 (39.4)	469 (26.1)
Vitamin E (mg αTOC/d)	4.2 (0.49)	5.1 (0.40)	6.4 (0.39)	6.8 (0.26)
Vitamin C (mg/d)	47 (10.7)	68 (10.1)	100 (10.8)	111 (6.31)
Thiamin (mg/d)	1.1 (0.11)	1.3 (0.09)	1.6 (0.08)	1.6 (0.05)
Riboflavin (mg/d)	1.3 (0.16)	1.6 (0.13)	2.0 (0.12)	2.1 (0.07)
Niacin (mg/d)	15.4 (1.67)	18.8 (1.36)	23.5 (1.30)	24.8 (0.90)
Vitamin B6 (mg/d)	1.2 (0.14)	1.5 (0.12)	1.9 (0.11)	2.0 (0.08)
Folate (μg DFE/d)	348 (41.2)	420 (32.5)	509 (28.7)	520 (14.76)
Vitamin B12 (mg/d)	3.4 (0.53)	4.3 (0.45)	5.4 (0.43)	5.7 (0.20)
Choline (mg/d)	185 (22.7)	237 (19.1)	305 (18.0)	320 (12.2)

NOTES: N = 90. Asterisk (*) indicates AI (used when EAR could not be determined). All women were pregnant, breastfeeding, or postpartum. For % inadequate calculations, the approach of the Institute of Medicine (2000) was applied in which, when combining groups with different EARs, intakes in one of the groups are rescaled so they can be compared to the EAR of the other group. One value indicates that the EAR is the same across groups.

See additional notes following Table P-15.

75th	90th	EAR or AI* (NPNL/P/BF)	% Inadeq (SE)	UL	% > UL (SE)
1,156 (82.5)	1,381 (139)	800	32.2 (9.50)	2,500	0.1 (0.36)
1.5 (0.10)	1.9 (0.20)	0.7/0.8/1.0	12.6 (8.08)	10	—
17.8 (1.08)	20.6 (1.82)	8.1/22.0/6.5	53.3 (6.01)	45	5.8 (4.97)
331 (18.6)	390 (28.3)	255/290/255	55.0 (6.07)	350	—
1,558 (93.8)	1,844 (144)	580	2.5 (3.49)	3,500	0
129 (7.05)	148 (10.7)	45/49/59	0.9 (2.09)	400	0
13.6 (0.89)	16.1 (1.53)	6.8/9.5/10.4	30.5 (9.35)	40	0
3,092 (188)	3,702 (290)	4,700/4,700/5,100*	—	ND	—
3,855 (235)	4,519 (359)	1,500*	—	2,300	83.9 (9.28)
736 (71.9)	946 (121)	500/550/900	58.0 (7.34)	—	—
600 (64.5)	798 (112)	—	—	3,000	0
8.0 (0.66)	9.9 (1.24)	12/12/16	98.3 (3.71)	1,000	0
142 (17.9)	190 (31.7)	60/70/100	32.0 (10.22)	2,000	0
1.9 (0.12)	2.2 (0.18)	0.9/1.2/1.2	15.9 (11.06)	ND	—
2.5 (0.17)	2.9 (0.26)	0.9/1.2/1.2	7.1 (8.18)	ND	—
29.2 (2.10)	35.8 (3.83)	11/14/13	6.0 (6.10)	35	12.7 (8.18)
2.4 (0.18)	2.9 (0.33)	1.1/1.6/1.7	34.3 (8.20)	100	0
608 (40.2)	705 (61.4)	320/520/450	41.7 (7.85)	1,000	0
6.8 (0.64)	8.2 (1.10)	2.0/2.2/2.4	1.1 (3.67)	ND	—
388 (27.4)	474 (45.0)	425/450/550	—	3,500	0

TABLE P-4 Usual Intake Distributions of Selected Micronutrients for Infants 0 to Less Than 6 Months: All Low-Income, NHANES 2011–2012

	Intake Distribution (percentiles and mean) (SE)								
Nutrient	10th	25th	Median	Mean	75th	90th	AI	UL	% > UL (SE)
Calcium (mg/d)	443 (27.06)	520 (24.30)	636 (25.86)	693 (27.01)	803 (49.36)	1013 (98.37)	200	1,000	10.6 (4.9)
Copper (mg/d)	0.5 (0.03)	0.5 (0.02)	0.6 (0.02)	0.6 (0.02)	0.7 (0.03)	0.9 (0.05)	0.2	—	—
Iron (mg/d)	9.2 (0.58)	10.8 (0.52)	13.2 (0.54)	14.3 (0.54)	16.6 (1.00)	20.8 (1.96)	0.27	—	—
Magnesium (mg/d)	49 (3.42)	58 (2.91)	72 (3.15)	78 (3.07)	92 (5.99)	116 (11.02)	30	—	—
Phosphorus (mg/d)	232 (17.51)	279 (14.40)	345 (15.15)	394 (20.59)	449 (32.35)	605 (79.00)	100	—	—
Selenium (μg/d)	12 (0.76)	14 (0.63)	16 (0.59)	17 (0.54)	20 (0.98)	24 (1.73)	15	—	—
Zinc (mg/d)	4.1 (0.28)	4.8 (0.22)	5.8 (0.20)	6.0 (0.18)	7.0 (0.32)	8.3 (0.54)	2	4	91.0 (4.5)
Potassium (mg/d)	561 (37.16)	661 (30.79)	797 (29.03)	835 (26.40)	968 (48.16)	1,157 (85.66)	400	—	—
Sodium (mg/d)	163 (12.80)	193 (9.24)	228 (8.15)	240 (7.99)	273 (14.30)	331 (29.90)	120	—	—
Vitamin A (μg RAE/d)	451 (29.52)	529 (23.73)	632 (21.46)	654 (18.81)	754 (33.85)	884 (57.48)	400	—	—
Retinol (μg/d)	420 (28.6)	496 (22.4)	593 (19.6)	610 (17.1)	705 (29.8)	819 (49.1)	—	600	49.1 (5.5)
Vitamin E (mg αTOC/d)	5.5 (0.37)	6.4 (0.26)	7.7 (0.28)	8.1 (0.25)	9.5 (0.52)	11.4 (0.79)	4	—	—
Vitamin C (mg/d)	50 (3.12)	59 (2.80)	72 (2.98)	78 (3.09)	91 (5.69)	115 (11.33)	40	—	—
Thiamin (mg/d)	0.4 (0.04)	0.5 (0.03)	0.7 (0.03)	0.7 (0.03)	0.9 (0.06)	1.1 (0.11)	0.2	—	—
Riboflavin (mg/d)	0.7 (0.05)	0.9 (0.04)	1.0 (0.04)	1.1 (0.04)	1.2 (0.06)	1.5 (0.13)	0.3	—	—
Niacin (mg/d)	5.4 (0.36)	6.4 (0.33)	8.0 (0.35)	8.8 (0.37)	10.2 (0.68)	13.1 (1.36)	2	—	—
Vitamin B6 (mg/d)	0.3 (0.02)	0.4 (0.02)	0.5 (0.02)	0.5 (0.02)	0.6 (0.03)	0.7 (0.05)	0.1	—	—
Folate (μg DFE/d)	128 (7.99)	149 (6.29)	176 (5.55)	181 (4.82)	208 (8.56)	240 (14.2)	65	—	—
Vitamin B12 (mg/d)	1.3 (0.10)	1.5 (0.07)	1.8 (0.06)	1.9 (0.06)	2.2 (0.10)	2.6 (0.22)	0.4	—	—
Choline (mg/d)	71 (5.46)	86 (4.67)	106 (4.56)	113 (4.12)	133 (7.72)	163 (14.01)	125	—	—

NOTES: N = 86. See additional notes following Table P-15.

TABLE P-5 Usual Intake Distributions of Selected Micronutrients for Infants 0 to Less Than 6 Months: WIC, NHANES 2005–2008

Nutrient	Intake Distribution (percentiles and mean) (SE)						AI	UL	% > UL (SE)
	10th	25th	Median	Mean	75th	90th			
Calcium (mg/d)	433 (23.90)	515 (17.19)	610 (14.55)	625 (11.36)	718 (21.90)	834 (37.75)	200	1,000	2.2 (1.8)
Copper (mg/d)	0.5 (0.02)	0.6 (0.02)	0.7 (0.01)	0.7 (0.01)	0.8 (0.02)	0.9 (0.04)	0.2	—	—
Iron (mg/d)	9.5 (0.58)	11.4 (0.38)	13.9 (0.44)	15.5 (0.45)	18.2 (0.94)	23.8 (1.83)	0.27	—	—
Magnesium (mg/d)	44 (2.73)	55 (2.11)	70 (2.33)	77 (2.24)	93 (4.54)	121 (8.15)	30	—	—
Phosphorus (mg/d)	241 (15.45)	297 (10.82)	367 (10.55)	388 (9.32)	461 (18.31)	567 (31.05)	100	—	—
Selenium (μg/d)	12 (0.56)	14 (0.46)	17 (0.52)	18 (0.40)	21 (0.72)	25 (1.18)	15	—	—
Zinc (mg/d)	4.2 (0.26)	5.1 (0.17)	6.0 (0.14)	6.2 (0.12)	7.1 (0.22)	8.3 (0.39)	2	4	92.2 (3.5)
Potassium (mg/d)	540 (30.28)	649 (20.52)	787 (20.17)	821 (17.36)	967 (34.09)	1,160 (53.59)	400	—	—
Sodium (mg/d)	155 (8.12)	184 (5.90)	221 (5.73)	236 (5.66)	270 (10.55)	333 (21.58)	120	—	—
Vitamin A (μg RAE/d)	461 (24.43)	532 (16.80)	614 (14.25)	625 (9.68)	705 (21.50)	802 (36.77)	400	—	—
Retinol (μg/d)	426 (19.4)	483 (13.0)	558 (12.5)	573 (9.2)	650 (20.2)	748 (32.6)	—	600	39.2 (2.9)
Vitamin E (mg αTOC/d)	5.7 (0.29)	6.7 (0.18)	7.8 (0.19)	8.2 (0.16)	9.4 (0.34)	11.3 (0.56)	4	—	—
Vitamin C (mg/d)	52 (3.33)	64 (2.33)	79 (2.20)	83 (1.99)	98 (3.83)	120 (6.94)	40	—	—
Thiamin (mg/d)	0.5 (0.03)	0.6 (0.02)	0.7 (0.03)	0.8 (0.03)	1.0 (0.05)	1.3 (0.10)	0.2	—	—
Riboflavin (mg/d)	0.7 (0.05)	0.9 (0.03)	1.1 (0.03)	1.1 (0.03)	1.3 (0.05)	1.6 (0.09)	0.3	—	—
Niacin (mg/d)	5.7 (0.37)	7.0 (0.25)	8.7 (0.28)	9.8 (0.30)	11.5 (0.61)	15.3 (1.19)	2	—	—
Vitamin B6 (mg/d)	0.3 (0.02)	0.4 (0.01)	0.5 (0.01)	0.5 (0.01)	0.6 (0.02)	0.7 (0.04)	0.1	—	—
Folate (μg DFE/d)	129.9 (6.34)	150.2 (4.12)	174.5 (3.92)	179.9 (3.10)	205.6 (6.48)	239.0 (10.4)	65	—	—
Vitamin B12 (mg/d)	1.3 (0.08)	1.5 (0.05)	1.8 (0.04)	1.9 (0.03)	2.1 (0.06)	2.5 (0.11)	0.4	—	—
Choline (mg/d)	65 (3.45)	76 (2.23)	90 (2.53)	97 (2.23)	113 (5.03)	140 (8.91)	125	—	—

NOTES: N = 204. See additional notes following Table P-15.

TABLE P-6 Usual Intake Distributions of Selected Micronutrients for Infants 0 to Less Than 6 Months: Eligible Non-WIC, NHANES 2005–2008

	Intake Distribution (percentiles and mean) (SE)								
Nutrient	10th	25th	Median	Mean	75th	90th	AI	UL	% > UL (SE)
Calcium (mg/d)	382 (50.91)	449 (42.82)	546 (41.41)	582 (41.15)	675 (75.97)	829 (145.98)	200	1,000	3.4 (5.8)
Copper (mg/d)	0.5 (0.04)	0.5 (0.04)	0.6 (0.04)	0.6 (0.03)	0.7 (0.07)	0.8 (0.12)	0.2	—	—
Iron (mg/d)	9.3 (1.28)	10.9 (1.12)	13.2 (1.16)	14.1 (1.02)	16.4 (2.11)	20.2 (4.06)	0.27	—	—
Magnesium (mg/d)	38 (5.65)	46 (5.21)	59 (5.71)	68 (7.02)	80 (12.31)	107 (27.17)	30	—	—
Phosphorus (mg/d)	217 (29.06)	257 (26.84)	323 (29.47)	365 (34.91)	426 (62.59)	565 (135.93)	100	—	—
Selenium (μg/d)	12 (1.32)	14 (0.97)	16 (0.78)	16 (0.63)	18 (1.12)	19 (1.74)	15	—	—
Zinc (mg/d)	4.1 (0.44)	4.7 (0.35)	5.4 (0.32)	5.5 (0.26)	6.2 (0.51)	7.1 (0.88)	2	4	92.8 (10.0)
Potassium (mg/d)	510 (64.69)	593 (54.24)	713 (52.32)	754 (46.40)	874 (95.03)	1,062 (180.89)	400	—	—
Sodium (mg/d)	156 (12.61)	171 (9.71)	196 (14.62)	215 (13.12)	251 (33.16)	309 (50.66)	120	—	—
Vitamin A (μg RAE/d)	415 (39.98)	466 (36.38)	545 (39.24)	584 (36.87)	660 (75.34)	804 (148.69)	400	—	—
Retinol (μg/d)	387 (69.3)	461 (42.5)	536 (32.4)	552 (32.1)	623 (55.8)	735 (116.0)	—	600	30.4 (9.8)
Vitamin E (mg αTOC/d)	4.8 (0.83)	5.9 (0.71)	7.6 (0.69)	8.2 (0.72)	9.8 (1.30)	12.5 (2.57)	4	—	—
Vitamin C (mg/d)	58 (9.66)	67 (8.14)	79 (7.90)	82 (4.79)	94 (12.59)	111 (21.67)	40	—	—
Thiamin (mg/d)	0.4 (0.07)	0.5 (0.06)	0.7 (0.07)	0.7 (0.07)	0.9 (0.13)	1.1 (0.26)	0.2	—	—
Riboflavin (mg/d)	0.7 (0.07)	0.8 (0.06)	0.9 (0.05)	1.0 (0.04)	1.1 (0.08)	1.2 (0.14)	0.3	—	—
Niacin (mg/d)	4.8 (0.78)	5.9 (0.74)	7.7 (0.84)	9.0 (1.03)	10.6 (1.83)	14.7 (4.11)	2	—	—
Vitamin B6 (mg/d)	0.3 (0.04)	0.4 (0.03)	0.4 (0.03)	0.5 (0.03)	0.5 (0.06)	0.6 (0.12)	0.1	—	—
Folate (μg DFE/d)	112.6 (21.2)	135.9 (13.2)	159.8 (10.2)	165.5 (10.42)	188.3 (17.8)	225.0 (37.3)	65	—	—
Vitamin B12 (mg/d)	1.1 (0.18)	1.3 (0.15)	1.7 (0.15)	1.8 (0.14)	2.1 (0.27)	2.6 (0.51)	0.4	—	—
Choline (mg/d)	68 (6.46)	74 (5.54)	83 (5.58)	86 (3.42)	94 (9.17)	106 (15.91)	125	—	—

NOTES: N = 21. See additional notes following Table P-15.

TABLE P-7 starts on the next page.

TABLE P-7 Usual Intake Distributions of Selected Micronutrients for Infants 6 to Less Than 12 Months: All Low-Income, NHANES 2011–2012

	Intake Distribution (percentiles and mean) (SE)			
Nutrient	10th	25th	Median	Mean
Calcium (mg/d)	551 (53.87)	666 (43.10)	812 (38.59)	832 (25.68)
Copper (mg/d)	0.5 (0.04)	0.6 (0.03)	0.7 (0.03)	0.7 (0.02)
Iron (mg/d)	7.9 (1.20)	11 (1.06)	15.6 (1.04)	16.9 (0.89)
Magnesium (mg/d)	85 (7.89)	101 (6.34)	121 (5.70)	124 (3.56)
Phosphorus (mg/d)	338 (37.96)	434 (33.20)	568 (32.76)	607 (26.76)
Selenium (µg/d)	17 (1.95)	22 (1.84)	29 (2.03)	33 (1.85)
Zinc (mg/d)	4.8 (0.42)	5.6 (0.33)	6.7 (0.28)	6.8 (0.18)
Potassium (mg/d)	848 (69.30)	1,008 (59.23)	1,226 (57.98)	1,286 (43.11)
Sodium (mg/d)	256 (38.76)	373 (44.28)	586 (55.81)	698 (48.93)
Vitamin A (µg RAE/d)	441 (44.52)	542 (34.89)	674 (32.95)	725 (30.68)
Retinol (µg/d)	380 (33.14)	452 (25.23)	538 (21.50)	545 (14.65)
Vitamin E (mg αTOC/d)	4.9 (0.65)	6.4 (0.51)	8.3 (0.45)	8.6 (0.33)
Vitamin C (mg/d)	61 (6.48)	75 (5.25)	94 (4.77)	97 (3.33)
Thiamin (mg/d)	0.6 (0.07)	0.8 (0.06)	1.0 (0.06)	1.0 (0.04)
Riboflavin (mg/d)	1.0 (0.10)	1.2 (0.07)	1.4 (0.06)	1.5 (0.05)
Niacin (mg/d)	6.8 (0.91)	9.0 (0.77)	11.9 (0.72)	12.5 (0.54)
Vitamin B6 (mg/d)	0.5 (0.05)	0.6 (0.04)	0.8 (0.05)	0.8 (0.03)
Folate (µg DFE/d)	144 (13.8)	174 (11.8)	214 (11.4)	224 (7.70)
Vitamin B12 (mg/d)	1.4 (0.16)	1.8 (0.14)	2.4 (0.14)	2.5 (0.11)
Choline (mg/d)	80 (8.12)	101 (7.11)	129 (7.06)	138 (5.80)

NOTES: N = 82. Asterisk (*) indicates AI (used when EAR could not be determined). See additional notes following Table P-15.

75th	90th	EAR or AI*	% Inadeq (SE)	UL	% > UL (SE)
976 (55.03)	1,140 (85.55)	260*	—	1,500	0.7 (1.50)
0.8 (0.04)	0.9 (0.05)	0.22*	—	ND	—
21.3 (1.70)	27.6 (2.95)	6.9	9.0 (8.0)	40	1.3 (1.62)
144 (8.10)	167 (12.58)	75*	—	ND	—
737 (53.26)	927 (93.16)	275*	—	ND	—
40 (3.75)	54 (7.38)	20*	—	60	6.9 (5.18)
7.8 (0.39)	8.9 (0.58)	2.5	0.1 (0.24)	5	86.7 (8.54)
1,497 (92.27)	1,799 (159.19)	700*	—	ND	—
905 (105.82)	1,290 (187.03)	370*	—	ND	—
846 (57.83)	1,064 (119.40)	500*	—	—	—
630 (29.48)	719 (44.18)	—	—	600	32.3 (7.42)
10.5 (0.64)	12.6 (0.98)	5*	—	ND	—
115 (7.01)	137 (11.16)	50*	—	ND	—
1.2 (0.09)	1.5 (0.15)	0.3*	—	ND	—
1.7 (0.10)	2.1 (0.18)	0.4*	—	ND	—
15.3 (1.10)	19.0 (1.80)	4*	—	ND	—
1.0 (0.07)	1.2 (0.13)	0.3*	—	ND	—
262 (17.7)	316 (29.9)	80	0.08 (0.27)	ND	—
3.1 (0.24)	3.8 (0.41)	0.5*	—	ND	—
165 (11.63)	207 (20.71)	150*	—	ND	—

TABLE P-8 Usual Intake Distributions of Selected Micronutrients for Infants 6 to Less Than 12 Months: WIC, NHANES 2005–2008

	Intake Distribution (percentiles and mean) (SE)			
Nutrient	10th	25th	Median	Mean
Calcium (mg/d)	496 (25.30)	593 (18.96)	719 (18.87)	752 (14.15)
Copper (mg/d)	0.5 (0.02)	0.6 (0.02)	0.7 (0.01)	0.8 (0.01)
Iron (mg/d)	9.2 (0.69)	12 (0.54)	15.7 (0.49)	16.5 (0.40)
Magnesium (mg/d)	75 (3.88)	92 (3.25)	116 (3.06)	122 (2.58)
Phosphorus (mg/d)	354 (20.01)	442 (16.80)	573 (18.32)	618 (14.87)
Selenium (μg/d)	19 (1.21)	24 (1.05)	32 (1.17)	35 (0.95)
Zinc (mg/d)	4.7 (0.27)	5.7 (0.20)	7.0 (0.18)	7.3 (0.15)
Potassium (mg/d)	862 (41.71)	1,041 (33.50)	1,278 (31.55)	1,353 (28.72)
Sodium (mg/d)	259 (20.56)	378 (25.30)	611 (34.6)	780 (36.41)
Vitamin A (μg RAE/d)	438 (25.58)	538 (20.14)	661 (17.69)	676 (12.27)
Retinol (μg/d)	340 (20.47)	420 (15.61)	516 (13.25)	524 (9.35)
Vitamin E (mg αTOC/d)	4.4 (0.39)	6.1 (0.31)	8.0 (0.23)	8.0 (0.18)
Vitamin C (mg/d)	72 (5.10)	90 (3.88)	112 (3.59)	119 (2.74)
Thiamin (mg/d)	0.6 (0.04)	0.8 (0.03)	1.0 (0.03)	1.0 (0.02)
Riboflavin (mg/d)	1.0 (0.05)	1.2 (0.04)	1.4 (0.04)	1.5 (0.03)
Niacin (mg/d)	7.1 (0.47)	9.1 (0.39)	11.8 (0.36)	12.3 (0.28)
Vitamin B6 (mg/d)	0.5 (0.03)	0.6 (0.02)	0.8 (0.02)	0.8 (0.02)
Folate (μg DFE/d)	149 (7.84)	180 (6.08)	223 (6.26)	239 (5.29)
Vitamin B12 (mg/d)	1.4 (0.09)	1.8 (0.07)	2.4 (0.08)	2.6 (0.07)
Choline (mg/d)	89 (5.07)	110 (4.20)	140 (4.31)	149 (3.31)

NOTES: N = 252. Asterisk (*) indicates AI (used when EAR could not be determined). See additional notes following Table P-15.

75th	90th	EAR or AI*	% Inadeq (SE)	UL	% > UL (SE)
883 (30.94)	1,058 (48.96)	260*	—	1,500	0.4 (0.44)
0.9 (0.02)	1.0 (0.04)	0.22*	—	ND	—
20 (0.77)	24.8 (1.35)	6.9	5.0 (2.0)	40	0.4 (0.40)
145 (4.84)	176 (8.24)	75*	—	ND	—
755 (32.45)	955 (50.45)	275*	—	ND	—
44 (2.11)	57 (3.39)	20*	—	60	7.6 (2.86)
8.5 (0.28)	10.3 (0.52)	2.5	0.3 (0.40)	5	86.1 (3.86)
1,577 (53.08)	1,930 (101.39)	700*	—	ND	—
1,000 (72.95)	1,520 (143.05)	370*	—	ND	—
798 (25.07)	934 (38.70)	500*	—	—	—
620 (18.21)	720 (27.37)	—	—	600	29.2 (4.15)
9.8 (0.29)	11.6 (0.50)	5*	—	ND	—
140 (6.02)	174 (11.71)	50*	—	ND	—
1.2 (0.04)	1.5 (0.08)	0.3*	—	ND	—
1.7 (0.06)	2.1 (0.10)	0.4*	—	ND	—
14.9 (0.54)	18.1 (0.89)	4*	—	ND	—
1.0 (0.04)	1.2 (0.08)	0.3*	—	ND	—
281 (11.1)	349 (20.1)	80	0.25 (0.31)	ND	—
3.2 (0.15)	4.1 (0.25)	0.5*	—	ND	—
179 (7.19)	221 (11.57)	150*	—	ND	—

TABLE P-9 Usual Intake Distributions of Selected Micronutrients for Infants 6 to Less Than 12 Months: Eligible Non-WIC, NHANES 2005–2008

	Intake Distribution (percentiles and mean) (SE)			
Nutrient	10th	25th	Median	Mean
Calcium (mg/d)	400 (68.78)	528 (64.17)	734 (69.74)	858 (83.28)
Copper (mg/d)	0.5 (0.05)	0.5 (0.04)	0.6 (0.03)	0.6 (0.02)
Iron (mg/d)	7.2 (1.54)	9.8 (1.28)	13.4 (1.17)	14.1 (1.00)
Magnesium (mg/d)	74 (9.73)	91 (8.35)	115 (8.18)	124 (7.91)
Phosphorus (mg/d)	334 (51.19)	429 (48.72)	586 (55.33)	690 (67.20)
Selenium (μg/d)	18 (2.59)	22 (2.44)	29 (2.73)	34 (2.94)
Zinc (mg/d)	4.9 (0.47)	5.6 (0.37)	6.4 (0.32)	6.5 (0.22)
Potassium (mg/d)	796 (121.05)	1,007 (102.13)	1,301 (96.43)	1,389 (90.43)
Sodium (mg/d)	236 (56.19)	345 (56.67)	531 (66.32)	667 (84.51)
Vitamin A (μg RAE/d)	515 (69.98)	620 (54.27)	749 (46.60)	764 (34.34)
Retinol (μg/d)	329 (61.16)	426 (44.82)	539 (35.52)	544 (28.60)
Vitamin E (mg αTOC/d)	2.9 (0.61)	4.0 (0.53)	5.5 (0.51)	5.9 (0.44)
Vitamin C (mg/d)	35 (12.51)	56 (10.93)	85 (10.35)	92 (8.12)
Thiamin (mg/d)	0.6 (0.08)	0.7 (0.07)	0.9 (0.06)	0.9 (0.05)
Riboflavin (mg/d)	0.9 (0.14)	1.1 (0.13)	1.5 (0.13)	1.7 (0.13)
Niacin (mg/d)	6.9 (0.82)	8.0 (0.69)	9.5 (0.67)	9.9 (0.44)
Vitamin B6 (mg/d)	0.5 (0.06)	0.6 (0.04)	0.7 (0.04)	0.7 (0.03)
Folate (μg DFE/d)	136 (19.0)	158 (15.4)	184 (14.0)	189 (7.44)
Vitamin B12 (mg/d)	1.2 (0.24)	1.7 (0.24)	2.4 (0.28)	3.1 (0.38)
Choline (mg/d)	86 (11.42)	106 (10.35)	136 (11.06)	151 (10.98)

NOTES: N = 35. Asterisk (*) indicates AI (used when EAR could not be determined). See additional notes following Table P-15.

75th	90th	EAR or AI*	% Inadeq (SE)	UL	% > UL (SE)
1,046 (144.07)	1,461 (311.03)	260*	—	1,500	9.2 (6.93)
0.7 (0.04)	0.8 (0.06)	0.22*	—	ND	—
17.6 (1.86)	22.1 (3.15)	6.9	7.0 (6.0)	40	0.1 (0.31)
147 (14.57)	184 (27.57)	75*	—	ND	—
831 (117.06)	1,168 (258.53)	275*	—	ND	—
41 (5.47)	55 (11.53)	20*	—	60	7.5 (7.25)
7.3 (0.46)	8.2 (0.72)	2.5	0	5	88.5 (11.45)
1,674 (164.44)	2,094 (298.05)	700*	—	ND	—
830 (143.66)	1,249 (325.14)	370*	—	ND	—
892 (66.71)	1,032 (104.10)	500*	—	—	—
656 (48.69)	765 (73.05)	—	—	600	36.1 (8.90)
7.3 (0.84)	9.4 (1.48)	5*	—	ND	—
120 (16.29)	156 (27.15)	50*	—	ND	—
1.1 (0.10)	1.3 (0.18)	0.3*	—	ND	—
2.0 (0.25)	2.7 (0.49)	0.4*	—	ND	—
11.3 (1.06)	13.4 (1.81)	4*	—	ND	—
0.9 (0.06)	1.0 (0.09)	0.3*	—	ND	—
215 (20.4)	247 (32.5)	80	0.01 (0.13)	ND	—
3.7 (0.63)	5.6 (1.47)	0.5*	—	ND	—
179 (20.89)	233 (41.70)	150*	—	ND	—

TABLE P-10 Usual Intake Distributions of Selected Micronutrients for Children 1 to Less Than 2 Years: All Low-Income, NHANES 2011–2012

	Intake Distribution (percentiles and mean) (SE)			
Nutrient	10th	25th	Median	Mean
Calcium (mg/d)	629 (61.29)	762 (48.68)	929 (43.03)	950 (24.86)
Copper (mg/d)	0.4 (0.04)	0.5 (0.03)	0.6 (0.03)	0.7 (0.02)
Iron (mg/d)	5.3 (0.56)	6.9 (0.48)	9 (0.47)	9.6 (0.35)
Magnesium (mg/d)	122 (10.03)	146 (7.86)	177 (6.84)	180 (4.52)
Phosphorus (mg/d)	692 (52.73)	813 (40.58)	959 (34.82)	972 (21.37)
Selenium (µg/d)	45 (3.67)	53 (2.87)	63 (2.51)	64 (1.44)
Zinc (mg/d)	4.9 (0.36)	5.7 (0.29)	6.7 (0.26)	6.8 (0.15)
Potassium (mg/d)	1,310 (100.76)	1,549 (77.84)	1,840 (67.11)	1,869 (42.84)
Sodium (mg/d)	1,090 (92.88)	1,336 (74.68)	1,650 (67.29)	1,701 (48.21)
Vitamin A (µg RAE/d)	337 (35.37)	412 (28.27)	504 (24.31)	518 (14.31)
Retinol (µg/d)	272 (31.04)	345 24.81)	436 (22.06)	448 (13.65)
Vitamin E (mg αTOC/d)	2.5 (0.26)	3.2 (0.21)	4.0 (0.19)	4.3 (0.15)
Vitamin C (mg/d)	38 (5.93)	52 (5.23)	73 (5.19)	78 (3.37)
Thiamin (mg/d)	0.6 (0.05)	0.8 (0.04)	1.0 (0.04)	1.0 (0.03)
Riboflavin (mg/d)	1.1 (0.10)	1.4 (0.08)	1.7 (0.07)	1.7 (0.04)
Niacin (mg/d)	7.6 (0.75)	9.3 (0.62)	11.5 (0.56)	11.8 (0.33)
Vitamin B6 (mg/d)	0.7 (0.06)	0.9 (0.05)	1.1 (0.05)	1.2 (0.03)
Folate (µg DFE/d)	188 (18.1)	231 (14.9)	286 (13.7)	296 (8.58)
Vitamin B12 (mg/d)	2.5 (0.26)	3.1 (0.21)	3.9 (0.18)	4.0 (0.12)
Choline (mg/d)	143 (12.73)	174 (10.25)	212 (9.23)	218 (5.84)

NOTES: N = 112. Asterisk (*) indicates AI (used when EAR could not be determined). See additional notes following Table P-15.

75th	90th	EAR or AI*	% Inadeq (SE)	UL	% > UL (SE)
1,114 (60.52)	1,298 (93.12)	500	2.6 (4.02)	2,500	0
0.8 (0.05)	1.0 (0.09)	0.26	0	1	0
11.7 (0.75)	14.6 (1.28)	3.0	0	40	0
211 (9.62)	244 (14.79)	65	0.1 (0.33)	—	—
1,117 (47.89)	1,270 (72.23)	380	0.1 (0.26)	3,000	0
73 (3.51)	84 (5.36)	17	0	90	5.3 (6.08)
7.8 (0.37)	8.9 (0.57)	2.5	0	7	41.6 (7.15)
2,158 (93.18)	2,467 (141.58)	3,000*	—	ND	—
2,011 (98.99)	2,378 (157.69)	1,000*	—	1,500	62.1 (5.79)
606 (34.35)	711 (58.60)	210	0.5 (1.38)	—	—
538 (31.44)	640 (48.73)	—	—	600	14.7 (7.87)
5.1 (0.32)	6.4 (0.59)	5.0	72.9 (6.51)	200	0
98 (8.19)	126 (13.75)	13	0.2 (0.55)	400	0
1.2 (0.06)	1.4 (0.10)	0.4	0.3 (0.70)	ND	—
2.0 (0.09)	2.3 (0.14)	0.4	0	ND	—
14.0 (0.82)	16.5 (1.31)	5.0	0.7 (1.60)	10	67.3 (7.92)
1.4 (0.08)	1.6 (0.13)	0.4	0.1 (0.34)	30	0
350 (20.3)	416 (32.5)	120	0.6 (1.31)	300	0
4.8 (0.26)	5.7 (0.41)	0.7	0	ND	—
255 (13.35)	300 (21.03)	200*	—	1,000	0

TABLE P-11 Usual Intake Distributions of Selected Micronutrients for Children 1 to Less Than 2 Years: WIC, NHANES 2005–2008

	Intake Distribution (percentiles and mean) (SE)			
Nutrient	10th	25th	Median	Mean
Calcium (mg/d)	655 (34.49)	808 (29.24)	1,018 (28.45)	1,053 (18.93)
Copper (mg/d)	0.5 (0.02)	0.6 (0.02)	0.7 (0.01)	0.7 (0.01)
Iron (mg/d)	5.8 (0.36)	7.3 (0.31)	9.4 (0.30)	9.9 (0.20)
Magnesium (mg/d)	129 (5.06)	149 (3.79)	173 (3.31)	177 (2.33)
Phosphorus (mg/d)	698 (28.75)	826 (23.83)	1,000 (23.56)	1,029 (15.88)
Selenium (μg/d)	45 (2.03)	53 (1.60)	62 (1.43)	63 (0.86)
Zinc (mg/d)	5.0 (0.23)	5.9 (0.19)	7.2 (0.18)	7.4 (0.12)
Potassium (mg/d)	1,471 (57.50)	1,699 (45.50)	1,983 (40.40)	2,021 (25.67)
Sodium (mg/d)	1,131 (59.93)	1,373 (48.01)	1,685 (44.42)	1,756 (31.02)
Vitamin A (μg RAE/d)	339 (20.79)	413 (17.18)	510 (16.04)	534 (9.85)
Retinol (μg/d)	265 (16.46)	332 (14.25)	425 (14.79)	450 (9.60)
Vitamin E (mg αTOC/d)	2.1 (0.12)	2.6 (0.10)	3.2 (0.10)	3.4 (0.07)
Vitamin C (mg/d)	36 (3.87)	55 (3.82)	84 (4.24)	97 (3.35)
Thiamin (mg/d)	0.8 (0.03)	0.9 (0.03)	1.1 (0.03)	1.1 (0.01)
Riboflavin (mg/d)	1.4 (0.06)	1.6 (0.05)	1.9 (0.05)	2.0 (0.03)
Niacin (mg/d)	8.1 (0.44)	9.9 (0.37)	12.1 (0.34)	12.5 (0.21)
Vitamin B6 (mg/d)	0.8 (0.04)	1.0 (0.03)	1.2 (0.03)	1.2 (0.02)
Folate (μg DFE/d)	197 (12.0)	243 (10.5)	306 (10.4)	324 (6.45)
Vitamin B12 (mg/d)	2.8 (0.15)	3.4 (0.13)	4.3 (0.13)	4.5 (0.08)
Choline (mg/d)	143 (6.82)	171 (5.66)	208 (5.31)	215 (3.49)

NOTES: N = 311. Asterisk (*) indicates AI (used when EAR could not be determined). See additional notes following Table P-15.

75th	90th	EAR or AI*	% Inadeq (SE)	UL	% > UL (SE)
1,261 (39.70)	1,498 (60.36)	500	2.2 (1.58)	2,500	0.1 (0.11)
0.8 (0.02)	1.0 (0.05)	0.26	0	1	0
11.8 (0.47)	14.6 (0.80)	3.0	0	40	0
200 (4.99)	230 (8.64)	65	0	—	—
1,202 (32.59)	1,399 (50.04)	380	0.2 (0.22)	3,000	0
73 (2.01)	83 (3.08)	17	0	90	5.0 (3.25)
8.6 (0.27)	10.1 (0.44)	2.5	0	7	53.3 (3.66)
2,301 (57.13)	2,618 (88.45)	3,000*	—	ND	—
2,058 (68.57)	2,468 (118.91)	1,000*	—	1,500	65.0 (4.01)
626 (24.62)	755 (43.93)	210	0.5 (0.74)	—	—
540 (21.74)	664 (37.78)	—	—	600	16.3 (4.89)
4.0 (0.16)	4.9 (0.29)	5.0	91.2 (4.36)	200	0.1
125 (7.42)	174 (13.64)	13	0.6 (0.60)	400	0
1.3 (0.04)	1.5 (0.06)	0.4	0	ND	—
2.3 (0.07)	2.7 (0.10)	0.4	0	ND	—
14.6 (0.49)	17.3 (0.79)	5.0	0.3 (0.52)	10	73.5 (4.90)
1.4 (0.04)	1.6 (0.07)	0.4	0	30	0
386 (16.3)	474 (27.9)	120	0.4 (0.57)	300	0.5
5.3 (0.19)	6.4 (0.32)	0.7	0	ND	—
251 (7.95)	296 (12.94)	200*	—	1,000	0

TABLE P-12 Usual Intake Distributions of Selected Micronutrients for Children 1 to Less Than 2 Years: Eligible Non-WIC, NHANES 2005–2008

	Intake Distribution (percentiles and mean) (SE)			
Nutrient	10th	25th	Median	Mean
Calcium (mg/d)	680 (66.92)	815 (49.53)	980 (42.82)	1,010 (27.57)
Copper (mg/d)	0.5 (0.04)	0.6 (0.03)	0.7 (0.03)	0.7 (0.02)
Iron (mg/d)	6.8 (0.63)	8 (0.44)	9.4 (0.37)	9.6 (0.24)
Magnesium (mg/d)	136 (10.32)	155 (7.59)	178 (6.52)	182 (3.80)
Phosphorus (mg/d)	723 (61.48)	858 (45.93)	1,020 (39.17)	1,042 (25.74)
Selenium (μg/d)	41 (3.94)	51 (3.05)	64 (2.59)	66 (1.94)
Zinc (mg/d)	5.7 (0.43)	6.4 (0.30)	7.2 (0.24)	7.3 (0.13)
Potassium (mg/d)	1,492 (106.04)	1,715 (83.42)	1,993 (73.41)	2,032 (43.45)
Sodium (mg/d)	1,021 (122.83)	1,352 (97.08)	1,768 (83.79)	1,820 (63.30)
Vitamin A (μg RAE/d)	332 (37.44)	414 (28.18)	515 (25.13)	539 (17.79)
Retinol (μg/d)	267 (31.23)	335 (23.37)	418 (20.50)	435 (14.18)
Vitamin E (mg αTOC/d)	2.5 (0.25)	3.0 (0.20)	3.7 (0.18)	3.8 (0.11)
Vitamin C (mg/d)	48 (7.84)	65 (7.01)	90 (7.02)	97 (4.31)
Thiamin (mg/d)	0.8 (0.06)	0.9 (0.04)	1.1 (0.04)	1.1 (0.02)
Riboflavin (mg/d)	1.3 (0.12)	1.6 (0.08)	1.8 (0.07)	1.9 (0.04)
Niacin (mg/d)	8.1 (0.76)	9.8 (0.56)	12.0 (0.48)	12.4 (0.36)
Vitamin B6 (mg/d)	0.8 (0.07)	1.0 (0.06)	1.2 (0.05)	1.2 (0.03)
Folate (μg DFE/d)	217 (21.3)	260 (16.9)	314 (15.0)	322 (8.41)
Vitamin B12 (mg/d)	2.6 (0.30)	3.2 (0.20)	3.9 (0.17)	4.1 (0.13)
Choline (mg/d)	142 (10.78)	168 (8.80)	201 (8.09)	208 (5.43)

NOTES: N = 106. Asterisk (*) indicates AI (used when EAR could not be determined). See additional notes following Table P-15.

75th	90th	EAR or AI*	% Inadeq (SE)	UL	% > UL (SE)
1,170 (65.77)	1,376 (115.61)	500	1.6 (2.94)	2,500	0.03 (0.12)
0.8 (0.04)	1.0 (0.09)	0.26	0	1	0
11 (0.58)	12.8 (1.04)	3.0	1.0 (1.0)	40	0
204 (9.80)	232 (16.76)	65	0	—	—
1,201 (57.35)	1,388 (94.28)	380	0.1 (0.31)	3,000	0
78 (3.68)	92 (5.69)	17	0.1 (0.23)	90	11.6 (5.59)
8.1 (0.35)	9.0 (0.59)	2.5	0	7.0	56.5 (8.37)
2,307 (106.09)	2,623 (167.57)	3,000*	—	ND	—
2,230 (120.60)	2,685 (188.36)	1,000*	—	1,500	66.4 (5.71)
636 (40.46)	774 (74.29)	210	1.1 (1.99)	—	—
515 (32.11)	623 (57.56)	—	—	600	12.2 (7.79)
4.5 (0.27)	5.3 (0.42)	5.0	85.1 (8.88)	200	0
121 (11.40)	156 (19.79)	13	0.02 (0.08)	400	0
1.2 (0.05)	1.4 (0.09)	0.4	0	ND	—
2.1 (0.10)	2.4 (0.17)	0.4	0	ND	—
14.5 (0.74)	17.2 (1.30)	5.0	0.8 (1.32)	10	73.4 (6.92)
1.4 (0.08)	1.6 (0.12)	0.4	0	30	0
375 (21.6)	436 (34.1)	120	0.1 (0.45)	300	0
4.8 (0.27)	5.7 (0.50)	0.7	0.04 (0.15)	ND	—
240 (12.32)	282 (20.34)	200*	—	1,000	0

TABLE P-13 Usual Intake Distributions of Selected Micronutrients for Children 2 to Less Than 5 Years: All Low-Income, NHANES 2011–2012

	Intake Distribution (percentiles and mean) (SE)			
Nutrient	10th	25th	Median	Mean
Calcium (mg/d)	579 (33.27)	741 (26.77)	949 (24.39)	988 (17.25)
Copper (mg/d)	0.5 (0.02)	0.6 (0.02)	0.8 (0.02)	0.8 (0.01)
Iron (mg/d)	7.9 (0.34)	9.3 (0.28)	11 (0.26)	11.3 (0.14)
Magnesium (mg/d)	149 (4.95)	171 (3.90)	199 (3.45)	203 (2.22)
Phosphorus (mg/d)	767 (28.57)	902 (22.79)	1,072 (20.43)	1,097 (13.57)
Selenium (μg/d)	54 (1.99)	61 (1.52)	70 (1.32)	71 (0.72)
Zinc (mg/d)	5.9 (0.24)	6.8 (0.19)	7.9 (0.17)	8.1 (0.09)
Potassium (mg/d)	1,510 (54.89)	1,743 (41.61)	2,022 (35.62)	2,050 (21.81)
Sodium (mg/d)	1,591 (60.83)	1,856 (47.24)	2,182 (41.74)	2,229 (26.40)
Vitamin A (μg RAE/d)	337 (21.78)	428 (17.72)	543 (15.77)	565 (9.81)
Retinol (μg/d)	291 (18.95)	366 (14.81)	460 (13.27)	477 (7.88)
Vitamin E (mg αTOC/d)	3.6 (0.17)	4.3 (0.14)	5.2 (0.13)	5.4 (0.08)
Vitamin C (mg/d)	46 (3.77)	62 (3.40)	85 (3.45)	92 (2.02)
Thiamin (mg/d)	0.9 (0.03)	1.0 (0.03)	1.2 (0.02)	1.2 (0.01)
Riboflavin (mg/d)	1.2 (0.05)	1.4 (0.04)	1.7 (0.04)	1.8 (0.02)
Niacin (mg/d)	11.8 (0.46)	13.5 (0.36)	15.7 (0.32)	16.0 (0.18)
Vitamin B6 (mg/d)	1.0 (0.04)	1.2 (0.03)	1.4 (0.03)	1.4 (0.02)
Folate (μg DFE/d)	270 (12.8)	323 (10.7)	393 (10.1)	408 (5.89)
Vitamin B12 (mg/d)	3.0 (0.15)	3.6 (0.13)	4.3 (0.12)	4.5 (0.06)
Choline (mg/d)	150 (6.47)	178 (5.29)	215 (4.90)	221 (3.00)

NOTES: N = 406. Asterisk (*) indicates AI (used when EAR could not be determined). For % inadequate calculations, the approach of the Institute of Medicine (2000) was applied in which, when combining groups with different EARs, intakes in one of the groups are rescaled so they can be compared to the EAR of the other group. One value indicates that the EAR is the same across groups. See additional notes following Table P-15.

75th	90th	EAR or AI* (Ages 1–3/ Age 4)	% Inadeq (SE)	UL (Ages 1–3/ Age 4)	% > UL (SE)
1,191 (36.45)	1,445 (60.27)	500/800	13.8 (3.05)	2,500	0.1 (0.09)
0.9 (0.02)	1.1 (0.04)	0.26/0.34	0	1/3	9.8 (3.32)
13 (0.39)	15.1 (0.62)	3.0/4.1	0	40	0
231 (4.87)	262 (7.53)	65/110	0.1 (0.16)	—	—
1,265 (29.31)	1,459 (45.86)	380/405	0	3,000	0
80 (1.86)	90 (2.94)	17/23	0	90/150	4.7 (3.28)
9.3 (0.24)	10.6 (0.38)	2.5/4.0	0.1 (0.11)	7/12	47.0 (3.29)
2,325 (49.31)	2,624 (76.09)	3,000/3,800*	—	ND	—
2,550 (60.12)	2,926 (96.58)	1,000/1,200*	—	1,500/1,900	90.9 (3.77)
674 (23.21)	816 (41.11)	210/275	2.1 (1.70)	—	—
568 (19.80)	683 (33.46)	—	—	600/900	19.7 (5.03)
6.3 (0.20)	7.5 (0.34)	5.0/6.0	52.1 (3.60)	200/300	0
114 (5.46)	146 (9.28)	13/22	0.1 (0.24)	400/650	0
1.4 (0.03)	1.6 (0.06)	0.4/0.5	0	ND	—
2.1 (0.05)	2.4 (0.08)	0.4/0.5	0	ND	—
18.1 (0.46)	20.6 (0.75)	5.0/6.0	0	10/15	96.5 (3.10)
1.6 (0.04)	1.9 (0.07)	0.4/0.5	0	30/40	0
477 (15.3)	565 (24.9)	120/160	0	300/400	2.3
5.2 (0.17)	6.1 (0.28)	0.7/1.0	0	ND	—
257 (7.22)	301 (11.51)	200/250*	—	1,000	0

TABLE P-14 Usual Intake Distributions of Selected Micronutrients for Children 2 to Less Than 5 Years: WIC, NHANES 2005–2008

	Intake Distribution (percentiles and mean) (SE)			
Nutrient	10th	25th	Median	Mean
Calcium (mg/d)	549 (25.88)	686 (21.82)	869 (20.70)	908 (14.16)
Copper (mg/d)	0.6 (0.02)	0.7 (0.02)	0.8 (0.01)	0.8 (0.01)
Iron (mg/d)	7.3 (0.32)	8.9 (0.27)	11.1 (0.26)	11.6 (0.17)
Magnesium (mg/d)	133 (4.61)	157 (3.78)	190 (3.50)	196 (2.44)
Phosphorus (mg/d)	701 (26.43)	834 (20.53)	1,000 (18.47)	1,032 (13.09)
Selenium (µg/d)	48 (1.73)	56 (1.40)	67 (1.28)	69 (0.78)
Zinc (mg/d)	5.9 (0.23)	7.0 (0.18)	8.3 (0.17)	8.6 (0.11)
Potassium (mg/d)	1,417 (54.12)	1,693 (41.98)	2,040 (37.94)	2,114 (27.91)
Sodium (mg/d)	1,430 (57.97)	1,721 (46.05)	2,091 (42.13)	2,168 (29.32)
Vitamin A (µg RAE/d)	328 (17.04)	403 (13.56)	499 (12.71)	525 (8.12)
Retinol (µg/d)	283 (14.60)	345 (11.64)	425 (10.75)	442 (6.35)
Vitamin E (mg αTOC/d)	2.6 (0.11)	3.2 (0.10)	4.0 (0.10)	4.3 (0.08)
Vitamin C (mg/d)	45 (3.69)	66 (3.48)	98 (3.78)	113 (3.11)
Thiamin (mg/d)	0.9 (0.03)	1.0 (0.03)	1.2 (0.02)	1.3 (0.02)
Riboflavin (mg/d)	1.3 (0.05)	1.6 (0.04)	1.9 (0.04)	1.9 (0.02)
Niacin (mg/d)	10.6 (0.43)	12.6 (0.35)	15.1 (0.32)	15.5 (0.19)
Vitamin B6 (mg/d)	1.0 (0.04)	1.2 (0.03)	1.5 (0.03)	1.5 (0.02)
Folate (µg DFE/d)	261 (13.3)	327 (11.4)	417 (11.2)	439 (7.14)
Vitamin B12 (mg/d)	2.9 (0.14)	3.5 (0.11)	4.3 (0.10)	4.5 (0.07)
Choline (mg/d)	145 (5.94)	175 (4.87)	214 (4.59)	223 (3.15)

NOTES: N = 474. Asterisk (*) indicates AI (used when EAR could not be determined). For % inadequate calculations, the approach of the Institute of Medicine (2000) was applied in which, when combining groups with different EARs, intakes in one of the groups are rescaled so they can be compared to the EAR of the other group. One value indicates that the EAR is the same across groups. See additional notes following Table P-15.

		EAR or AI*		UL	
75th	90th	(Ages 1–3/ Age 4)	% Inadeq (SE)	(Ages 1–3/ Age 4)	% > UL (SE)
1,087 (31.22)	1,317 (51.01)	500/800	16.7 (2.99)	2,500	0.1 (0.07)
1.0 (0.02)	1.2 (0.05)	0.26/0.34	0.1 (0.07)	1/3	15.5 (3.13)
13.7 (0.39)	16.4 (0.63)	3.0/4.1	0	40	0
227 (5.19)	266 (8.38)	65/110	0.6 (0.45)	—	—
1,195 (27.91)	1,403 (47.56)	380/405	0.1 (0.18)	3,000	0
79 (1.85)	91 (2.92)	17/23	0	90/150	6.6 (2.77)
9.9 (0.26)	11.8 (0.46)	2.5/4.0	0.1 (0.10)	7/12	54.3 (2.96)
2,451 (58.46)	2,900 (102.27)	3,000/3,800*	—	ND	—
2,529 (63.97)	3,000 (108.98)	1,000/1,200*	—	1,500/1,900	82.4 (3.59)
617 (20.26)	751 (36.81)	210/275	1.5 (1.37)	—	—
519 (16.31)	621 (27.99)	—	—	600/900	12.1 (4.51)
5.0 (0.17)	6.4 (0.33)	5.0/6.0	79.2 (3.62)	200/300	0
143 (6.76)	198 (13.22)	13/22	0.6 (0.46)	400/650	0.4 (0.37)
1.5 (0.03)	1.7 (0.06)	0.4/0.5	0	ND	—
2.2 (0.05)	2.6 (0.08)	0.4/0.5	0	ND	—
18.0 (0.45)	21.0 (0.71)	5.0/6.0	0	10/15	90.5 (3.72)
1.8 (0.05)	2.1 (0.07)	0.4/0.5	0	30/40	0
526 (17.1)	645 (28.6)	120/160	0	300/400	8.0
5.2 (0.16)	6.3 (0.30)	0.7/1.0	0	ND	—
261 (7.08)	313 (12.13)	200/250*	—	1,000	0

TABLE P-15 Usual Intake Distributions of Selected Micronutrients for Children 2 to Less Than 5 Years: Eligible Non-WIC, 2005–2008

	Intake Distribution (percentiles and mean) (SE)			
Nutrient	10th	25th	Median	Mean
Calcium (mg/d)	522 (27.29)	661 (22.13)	838 (19.93)	866 (14.34)
Copper (mg/d)	0.6 (0.02)	0.7 (0.02)	0.8 (0.02)	0.8 (0.01)
Iron (mg/d)	7.3 (0.31)	8.7 (0.25)	10.4 (0.24)	10.8 (0.15)
Magnesium (mg/d)	123 (5.07)	147 (3.70)	176 (3.15)	180 (2.37)
Phosphorus (mg/d)	682 (27.67)	813 (20.70)	971 (17.91)	996 (13.28)
Selenium (μg/d)	49 (2.20)	58 (1.64)	69 (1.41)	70 (0.90)
Zinc (mg/d)	5.6 (0.24)	6.6 (0.20)	8.0 (0.19)	8.3 (0.12)
Potassium (mg/d)	1,214 (54.16)	1,472 (41.66)	1,792 (36.80)	1,847 (26.89)
Sodium (mg/d)	1,448 (67.55)	1,765 (52.55)	2,152 (45.33)	2,191 (30.19)
Vitamin A (μg RAE/d)	322 (19.84)	406 (16.09)	514 (14.89)	536 (9.22)
Retinol (μg/d)	265 (15.97)	329 (12.53)	409 (11.23)	422 (6.62)
Vitamin E (mg αTOC/d)	2.8 (0.14)	3.3 (0.11)	4.0 (0.10)	4.1 (0.06)
Vitamin C (mg/d)	39 (3.68)	54 (3.36)	77 (3.44)	83 (2.01)
Thiamin (mg/d)	0.8 (0.04)	1.0 (0.03)	1.2 (0.02)	1.2 (0.02)
Riboflavin (mg/d)	1.2 (0.05)	1.5 (0.04)	1.8 (0.04)	1.8 (0.03)
Niacin (mg/d)	10.4 (0.48)	12.3 (0.36)	14.7 (0.31)	15.1 (0.20)
Vitamin B6 (mg/d)	0.9 (0.04)	1.0 (0.03)	1.3 (0.03)	1.3 (0.02)
Folate (μg DFE/d)	253 (14.4)	315 (11.7)	397 (11.0)	417 (7.27)
Vitamin B12 (mg/d)	2.7 (0.16)	3.4 (0.13)	4.3 (0.12)	4.4 (0.07)
Choline (mg/d)	142 (6.42)	168 (5.17)	203 (5.02)	210 (2.94)

NOTES: N = 397. For % inadequate calculations, the approach of the Institute of Medicine (2000) was applied in which, when combining groups with different EARs, intakes in one of the groups are rescaled so they can be compared to the EAR of the other group. One value indicates that the EAR is the same across groups. See additional notes following this table.

75th	90th	EAR or AI* (Ages 1–3/ Age 4)	% Inadeq (SE)	UL Ages 1–3/ Age 4)	% > UL (SE)
1,040 (28.98)	1,245 (45.76)	500/800	21.9 (3.04)	2,500	0
0.9 (0.02)	1.1 (0.04)	0.26/0.34	0.3 (0.31)	1/3	11.5 (3.21)
12.5 (0.35)	14.7 (0.56)	3.0/4.1	0	40	0
207 (4.65)	241 (7.83)	65/110	2.5 (1.20)	—	—
1,151 (26.59)	1,339 (44.72)	380/405	0.3 (0.27)	3,000	0
81 (2.03)	94 (3.29)	17/23	0	90/150	5.9 (2.94)
9.6 (0.27)	11.3 (0.44)	2.5/4.0	0.7 (0.60)	7/12	45.4 (2.98)
2,160 (54.88)	2,546 (91.79)	3,000/3,800*	—	ND	—
2,575 (62.64)	2,985 (94.86)	1,000/1,200*	—	1,500/1,900	83.7 (3.75)
641 (22.44)	777 (37.43)	210/275	2.5 (1.93)	—	—
500 (16.44)	595 (26.81)	—	—	600/900	9.4 (4.30)
4.8 (0.15)	5.6 (0.23)	5.0/6.0	87.6 (5.42)	200/300	0
105 (5.50)	137 (9.40)	13/22	1.0 (1.00)	400/650	0
1.4 (0.03)	1.6 (0.06)	0.4/0.5	0.2 (0.27)	ND	—
2.1 (0.05)	2.5 (0.09)	0.4/0.5	0	ND	—
17.4 (0.45)	20.2 (0.73)	5.0/6.0	0.1 (0.20)	10/15	87.8 (4.22)
1.6 (0.05)	1.9 (0.08)	0.4/0.5	0.2 (0.25)	30/40	0
495 (17.0)	604 (30.0)	120/160	0	300/400	5.2
5.2 (0.17)	6.3 (0.29)	0.7/1.0	0	ND	—
245 (7.68)	289 (11.96)	200/250*	—	1,000	0

NOTES FOR TABLES P1–P15: αTOC = α-tocopherol; AI = Adequate Intake; DFE = dietary folate equivalents; EAR = Estimated Average Requirement; ND = not determined; RAE = retinol activity equivalents; SE = standard error; UL = Tolerable Upper Intake Level; % Inadeq = percentage of individuals with usual intake below the EAR. Asterisk (*) indicates AI (used when EAR could not be determined). The ULs for folate, vitamin E, and magnesium represent intake from pharmacological agents only and do not include food intake. Vitamin D is not included because intake is a poor reflection of status (IOM, 1997, 2000, 2011).

Subgroup definitions are as follows:

WIC = All individuals reporting participation in WIC regardless of income level. Some women reporting WIC participation did not report being pregnant, breastfeeding, or postpartum.

Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.

SOURCES FOR TABLES P1–P15: Intake data are from NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012). Intake recommendations from Dietary Reference Intake reports (IOM, 1997, 1998, 2000, 2001, 2002/2005, 2005, 2011).

TABLE P-16 Usual Intake Distributions of Macronutrients for Women Ages 19 to 50 Years: All Low-Income, NHANES 2011–2012

	Means and Percentiles (SE)					
Nutrient and Reported Units	10th	25th	Median	Mean	75th	90th
Carbohydrates (% of kcal)	46.3 (3.08)	49.2 (2.06)	52.2 (1.47)	51.9 (0.73)	54.9 (1.68)	57.2 (2.20)
Fiber (g/d)	8.2 (2.01)	10.8 (1.49)	13.8 (1.32)	14.6 (1.00)	17.5 (2.15)	21.9 (4.19)
Total fat (% of kcal)	29.6 (2.67)	32.1 (1.88)	34.9 (1.47)	34.9 (0.70)	37.7 (1.86)	40.1 (2.61)
Saturated fatty acids (% of kcal)	8.9 (1.06)	10.0 (0.79)	11.2 (0.67)	11.3 (0.33)	12.5 (0.87)	13.8 (1.26)
Protein (g/kg/d)	0.7 (0.13)	0.9 (0.11)	1.1 (0.11)	1.2 (0.09)	1.5 (0.19)	1.9 (0.34)

NOTES: N = 34. kcal = kilocalories; SE = standard error. All women were pregnant, breastfeeding, or postpartum.
SOURCES: Intake data were obtained from NHANES 2011–2012. Intake references are from Dietary Reference Intake report (IOM, 2002/2005).

TABLE P-17 Usual Intake Distributions of Macronutrients for Women Ages 19 to 50 Years: WIC, NHANES 2005–2008

	Means and Percentiles (SE)					
Nutrient and Reported Units	10th	25th	Median	Mean	75th	90th
Carbohydrates (% of kcal)	44.6 (1.23)	48.1 (0.82)	52.0 (0.63)	51.9 (0.36)	55.7 (0.80)	59.2 (1.17)
Fiber (g/d)	7.5 (0.61)	10.0 (0.49)	13.4 (0.47)	14.5 (0.40)	17.6 (0.80)	22.6 (1.52)
Total fat (% of kcal)	27.5 (0.93)	30.4 (0.64)	33.6 (0.51)	33.7 (0.31)	36.9 (0.68)	40.1 (1.04)
Saturated fatty acids (% of kcal)	8.9 (0.35)	9.9 (0.25)	11.1 (0.20)	11.1 (0.10)	12.2 (0.25)	13.2 (0.35)
Protein (g/kg/d)	0.6 (0.04)	0.8 (0.03)	1.0 (0.03)	1.0 (0.02)	1.2 (0.04)	1.5 (0.08)

NOTES: N = 260. kcal = kilocalories; SE = standard error. All women were pregnant, breastfeeding, or postpartum.
SOURCES: Intake data were obtained from NHANES 2005–2008. Intake references are from Dietary Reference Intake report (IOM, 2002/2005).

TABLE P-18 Usual Intake Distributions of Macronutrients for Women Ages 19 to 50 Years: Eligible Non-WIC, NHANES 2005–2008

	Means and Percentiles (SE)					
Nutrient and Reported Units	10th	25th	Median	Mean	75th	90th
Carbohydrates (% of kcal)	48.1 (2.01)	51.1 (1.41)	54.3 (1.10)	54.3 (0.50)	57.5 (1.36)	60.4 (1.88)
Fiber (g/d)	8.1 (1.07)	10.8 (0.92)	14.5 (0.87)	15.4 (0.67)	19.1 (1.36)	23.9 (2.27)
Total fat (% of kcal)	26.7 (1.34)	28.9 (0.99)	31.4 (0.81)	31.5 (0.40)	34.0 (1.07)	36.5 (1.54)
Saturated fatty acids (% of kcal)	8.6 (0.51)	9.6 (0.40)	10.7 (0.34)	10.8 (0.19)	12.0 (0.47)	13.2 (0.72)
Protein (g/kg/d)	0.7 (0.08)	0.9 (0.06)	1.2 (0.06)	1.2 (0.04)	1.5 (0.09)	1.8 (0.14)

NOTES: N = 90. kcal = kilocalories; SE = standard error. All women were pregnant, breastfeeding, or postpartum.
SOURCES: Intake data were obtained from NHANES 2005–2008. Intake references are from Dietary Reference Intake report (IOM, 2002/2005).

TABLE P-19 Usual Intake Distributions of Macronutrients for Infants 0 to Less Than 6 Months: All Low-Income, NHANES 2011–2012

	Percentiles and Mean (SE)					
Nutrient and Reported Units	10th	25th	Median	Mean	75th	90th
Carbohydrates (% of kcal)	42.5 (0.37)	43.4 (0.30)	44.7 (0.33)	45.5 (0.34)	46.7 (0.68)	49.4 (1.43)
Total fat (% of kcal)	41.6 (1.54)	44.4 (0.73)	46.5 (0.34)	45.7 (0.34)	47.7 (0.30)	48.6 (0.38)
Saturated fatty acids (% of kcal)	15.9 (0.55)	17.3 (0.45)	19.0 (0.31)	19.3 (0.35)	20.6 (0.53)	23.5 (1.62)
Protein (g/kg/d)	1.6 (0.12)	1.9 (0.10)	2.3 (0.10)	2.5 (0.09)	2.9 (0.16)	3.6 (0.30)

NOTES: N = 86. kcal = kilocalories; SE = standard error.
SOURCES: Intake data were obtained from NHANES 2011–2012. Intake references are from Dietary Reference Intake report (IOM, 2002/2005).

TABLE P-20 Usual Intake Distributions of Macronutrients for Infants 0 to Less Than 6 Months: WIC, NHANES 2005–2008

	Percentiles and Mean (SE)					
Nutrient and Reported Units	10th	25th	Median	Mean	75th	90th
Carbohydrates (% of kcal)	42.0 (0.25)	43.2 (0.26)	45.4 (0.34)	46.8 (0.35)	49.0 (0.70)	53.6 (1.33)
Total fat (% of kcal)	38.3 (1.24)	42.4 (0.64)	45.6 (0.33)	44.5 (0.32)	47.8 (0.29)	49.1 (0.29)
Saturated fatty acids (% of kcal)	14.5 (0.50)	16.1 (0.23)	17.5 (0.21)	17.6 (0.19)	19.3 (0.30)	20.7 (0.25)
Protein (g/kg/d)	1.6 (0.10)	2.0 (0.07)	2.4 (0.06)	2.4 (0.05)	2.8 (0.09)	3.3 (0.15)

NOTES: N = 204. kcal = kilocalories; SE = standard error.
SOURCES: Intake data were obtained from NHANES 2005–2008. Intake references are from Dietary Reference Intake report (IOM, 2002/2005).

TABLE P-21 Usual Intake Distributions of Macronutrients for Infants 0 to Less Than 6 Months: Eligible Non-WIC, NHANES 2005–2008

	Percentiles and Mean (SE)					
Nutrient and Reported Units	10th	25th	Median	Mean	75th	90th
Carbohydrates (% of kcal)	42.2 (1.48)	43.5 (1.26)	45.4 (1.25)	45.8 (0.69)	47.6 (2.03)	50.1 (3.40)
Total fat (% of kcal)	40.0 (3.70)	43.1 (2.01)	45.7 (1.19)	45.1 (0.85)	47.8 (1.27)	49.5 (1.73)
Saturated fatty acids (% of kcal)	15.3 (1.36)	16.6 (0.90)	17.8 (0.65)	17.7 (0.40)	19.0 (0.77)	20.0 (1.03)
Protein (g/kg/d)	1.8 (0.25)	2.0 (0.16)	2.3 (0.14)	2.5 (0.19)	2.8 (0.31)	3.5 (0.79)

NOTES: N = 21. kcal = kilocalories; SE = standard error.
SOURCES: Intake data were obtained from NHANES 2005–2008. Intake references are from Dietary Reference Intake report (IOM, 2002/2005).

TABLE P-22 Usual Intake Distributions of Macronutrients for Infants 6 to Less Than 12 Months: All Low-Income, NHANES 2011–2012

	Percentiles and Mean (SE)					
Nutrient and Reported Units	10th	25th	Median	Mean	75th	90th
Carbohydrates (% of kcal)	46.3 (1.17)	49.0 (0.88)	52.3 (0.73)	52.6 (0.56)	55.8 (1.02)	59.2 (1.56)
Fiber (g/d)	1.8 (0.44)	2.9 (0.41)	4.5 (0.41)	5.0 (0.31)	6.5 (0.66)	8.7 (1.11)
Total fat (% of kcal)	30.8 (1.54)	34.1 (1.01)	37.6 (0.71)	37.2 (0.54)	40.7 (0.82)	43.2 (1.08)
Saturated fatty acids (% of kcal)	11.3 (1.3)	13.2 (0.8)	15.2 (0.6)	14.9 (0.26)	17.1 (0.7)	18.6 (1.0)
Protein (g/kg/d)	1.7 (0.15)	2.1 (0.14)	2.6 (0.15)	2.9 (0.13)	3.5 (0.26)	4.4 (0.50)

NOTES: N = 82. kcal = kilocalories; SE = standard error.
SOURCES: Intake data were obtained from NHANES 2011–2012. Intake references are from Dietary Reference Intake report (IOM, 2002/2005).

TABLE P-23 Usual Intake Distributions of Macronutrients for Infants 6 to Less Than 12 Months: WIC, NHANES 2005–2008

	Means and Percentiles (SE)					
Nutrient and Reported Units	10th	25th	Median	Mean	75th	90th
Carbohydrates (% of kcal)	45.3 (0.94)	48.9 (0.63)	52.8 (0.48)	52.8 (0.38)	56.7 (0.64)	60.4 (1.00)
Fiber (g/d)	1.9 (0.24)	3.0 (0.21)	4.6 (0.22)	5.1 (0.19)	6.6 (0.37)	9.0 (0.68)
Total fat (% of kcal)	30.4 (0.88)	33.8 (0.58)	37.3 (0.42)	37.0 (0.32)	40.6 (0.50)	43.3 (0.67)
Saturated fatty acids (% of kcal)	11.4 (0.4)	13.1 (0.3)	14.9 (0.2)	14.7 (0.2)	16.8 (0.3)	18.4 (0.4)
Protein (g/kg/d)	1.6 (0.09)	2.1 (0.08)	2.7 (0.09)	2.9 (0.08)	3.6 (0.17)	4.7 (0.28)

NOTES: N = 252. kcal = kilocalories; SE = standard error.
SOURCES: Intake data were obtained from NHANES 2005–2008. Intake references are from Dietary Reference Intake report (IOM, 2002/2005).

TABLE P-24 Usual Intake Distributions of Macronutrients for Infants 6 to Less Than 12 Months: Eligible Non-WIC, NHANES 2005–2008

	Means and Percentiles (SE)					
Nutrient and Reported Units	10th	25th	Median	Mean	75th	90th
Carbohydrates (% of kcal)	45.2 (2.08)	48.3 (1.55)	52.2 (1.30)	52.6 (1.02)	56.3 (1.87)	60.5 (2.92)
Fiber (g/d)	1.8 (0.51)	2.7 (0.47)	4.0 (0.49)	4.5 (0.43)	5.8 (0.85)	7.9 (1.55)
Total fat (% of kcal)	30.3 (2.13)	33.2 (1.37)	36.2 (0.93)	35.9 (0.71)	38.9 (1.07)	41.0 (1.40)
Saturated fatty acids (% of kcal)	11.9 (0.7)	13.3 (0.5)	14.9 (0.4)	15.1 (0.48)	16.5 (0.5)	18.0 (0.8)
Protein (g/kg/d)	1.6 (0.26)	2.1 (0.24)	2.8 (0.25)	3.2 (0.28)	3.9 (0.49)	5.3 (1.01)

NOTES: N = 35. kcal = kilocalories; SE = standard error.
SOURCES: Intake data were obtained from NHANES 2005–2008. Intake references are from Dietary Reference Intake report (IOM, 2002/2005).

TABLE P-25 Usual Intake Distributions of Macronutrients for Children 1 to Less Than 2 Years: All Low-Income, NHANES 2011–2012

	Means and Percentiles (SE)					
Nutrient and Reported Units	10th	25th	Median	Mean	75th	90th
Carbohydrates (% of kcal)	45.9 (1.44)	48.8 (1.05)	52.0 (0.85)	52.1 (0.46)	55.3 (1.10)	58.4 (1.58)
Fiber (g/d)	4.8 (0.59)	6.4 (0.47)	8.4 (0.41)	8.6 (0.29)	10.5 (0.58)	12.7 (0.90)
Total fat (% of kcal)	28.6 (1.21)	31.0 (0.85)	33.6 (0.67)	33.6 (0.36)	36.2 (0.84)	38.5 (1.17)
Saturated fatty acids (% of kcal)	10.1 (0.60)	11.5 (0.44)	13.1 (0.36)	13.1 (0.22)	14.7 (0.48)	16.2 (0.69)
Protein (g/kg/d)	2.9 (0.22)	3.4 (0.17)	4.0 (0.15)	4.1 (0.09)	4.7 (0.22)	5.4 (0.34)

NOTES: N = 112. kcal = kilocalories; SE = standard error.
SOURCES: Intake data were obtained from NHANES 2011–2012. Intake references are from Dietary Reference Intake report (IOM, 2002/2005).

TABLE P-26 Usual Intake Distributions of Macronutrients for Children 1 to Less Than 2 Years: NHANES WIC, 2005–2008

	Means and Percentiles (SE)					
Nutrient and Reported Units	10th	25th	Median	Mean	75th	90th
Carbohydrates (% of kcal)	45.8 (0.93)	49.1 (0.68)	52.8 (0.55)	52.9 (0.32)	56.6 (0.71)	60.1 (1.01)
Fiber (g/d)	4.8 (0.30)	6.0 (0.23)	7.5 (0.21)	7.8 (0.14)	9.2 (0.31)	11.0 (0.51)
Total fat (% of kcal)	26.7 (0.85)	29.7 (0.59)	33.0 (0.45)	32.9 (0.27)	36.1 (0.54)	38.8 (0.73)
Saturated fatty acids (% of kcal)	11.4 (0.4)	13.1 (0.3)	14.9 (0.2)	13.6 (0.16)	16.8 (0.3)	18.4 (0.4)
Protein (g/kg/d)	3.1 (0.14)	3.6 (0.11)	4.4 (0.10)	4.5 (0.07)	5.2 (0.14)	6.0 (0.22)

NOTES: N = 311. kcal = kilocalories; SE = standard error.
SOURCES: Intake data were obtained from NHANES 2005–2008. Intake references are from Dietary Reference Intake report (IOM, 2002/2005).

TABLE P-27 Usual Intake Distributions of Macronutrients for Children 1 to Less Than 2 Years: Eligible Non-WIC, NHANES 2005–2008

	Means and Percentiles (SE)					
Nutrient and Reported Units	10th	25th	Median	Mean	75th	90th
Carbohydrates (% of kcal)	48.0 (1.35)	50.5 (0.97)	53.4 (0.78)	53.5 (0.42)	56.4 (1.02)	59.1 (1.48)
Fiber (g/d)	5.3 (0.73)	6.9 (0.55)	8.9 (0.49)	9.2 (0.33)	11.2 (0.74)	13.6 (1.27)
Total fat (% of kcal)	26.5 (1.32)	29.5 (0.93)	32.9 (0.73)	33.0 (0.49)	36.4 (0.95)	39.5 (1.37)
Saturated fatty acids (% of kcal)	11.9 (0.7)	13.3 (0.5)	14.9 (0.4)	13.2 (0.28)	16.5 (0.5)	18.0 (0.8)
Protein (g/kg/d)	3.0 (0.25)	3.6 (0.20)	4.3 (0.17)	4.4 (0.11)	5.1 (0.25)	5.9 (0.38)

NOTES: N = 106. kcal = kilocalories; SE = standard error.
SOURCES: Intake data were obtained from NHANES 2005–2008. Intake references are from Dietary Reference Intake report (IOM, 2002/2005).

TABLE P-28 Usual Intake Distributions of Macronutrients for Children 2 to Less Than 5 Years: All Low-Income, NHANES 2011–2012

	Means and Percentiles (SE)					
Nutrient and Reported Units	10th	25th	Median	Mean	75th	90th
Carbohydrates (% of kcal)	50.3 (0.74)	52.9 (0.51)	55.6 (0.40)	55.6 (0.20)	58.3 (0.50)	60.7 (0.73)
Fiber (g/d)	7.7 (0.35)	9.3 (0.27)	11.2 (0.24)	11.6 (0.17)	13.5 (0.37)	15.9 (0.62)
Total fat (% of kcal)	27.2 (0.61)	29.4 (0.42)	31.8 (0.33)	31.8 (0.18)	34.3 (0.42)	36.5 (0.62)
Saturated fatty acids (% of kcal)	10.0 (0.3)	10.9 (0.2)	12.1 (0.2)	11.2 (0.09)	13.2 (0.2)	14.3 (0.3)
Protein (g/kg/d)	2.3 (0.09)	2.8 (0.07)	3.3 (0.06)	3.4 (0.04)	3.9 (0.09)	4.5 (0.14)

NOTES: N = 406. kcal = kilocalories; SE = standard error.
SOURCES: Intake data were obtained from NHANES 2011–2012. Intake references are from Dietary Reference Intake report (IOM, 2002/2005).

TABLE P-29 Usual Intake Distributions of Macronutrients for Children 2 to Less Than 5 Years: WIC, NHANES 2005–2008

	Means and Percentiles (SE)					
Nutrient and Reported Units	10th	25th	Median	Mean	75th	90th
Carbohydrates (% of kcal)	49.0 (0.70)	51.9 (0.51)	55.3 (0.41)	55.3 (0.23)	58.6 (0.52)	61.7 (0.73)
Fiber (g/d)	6.2 (0.31)	7.8 (0.25)	10.0 (0.24)	10.5 (0.18)	12.6 (0.37)	15.5 (0.65)
Total fat (% of kcal)	26.4 (0.58)	29.0 (0.41)	31.8 (0.33)	31.8 (0.19)	34.6 (0.41)	37.1 (0.57)
Saturated fatty acids (% of kcal)	9.7 (0.2)	10.7 (0.2)	12.0 (0.1)	11.7 (0.09)	13.2 (0.2)	14.4 (0.2)
Protein (g/kg/d)	2.3 (0.09)	2.8 (0.07)	3.4 (0.07)	3.5 (0.04)	4.1 (0.09)	4.8 (0.15)

NOTES: N = 474. kcal = kilocalories; SE = standard error.
SOURCES: Intake data were obtained from NHANES 2005–2008. Intake references are from Dietary Reference Intake report (IOM, 2002/2005).

TABLE P-30 Usual Intake Distributions of Macronutrients for Children 2 to Less Than 5 Years: Eligible Non-WIC, NHANES 2005–2008

	Means and Percentiles (SE)					
Nutrient and Reported Units	10th	25th	Median	Mean	75th	90th
Carbohydrates (% of kcal)	48.6 (0.76)	51.3 (0.54)	54.3 (0.43)	54.3 (0.23)	57.3 (0.57)	60.2 (0.83)
Fiber (g/d)	5.9 (0.32)	7.5 (0.25)	9.5 (0.23)	9.8 (0.17)	11.8 (0.34)	14.2 (0.57)
Total fat (% of kcal)	27.8 (0.65)	30.1 (0.46)	32.6 (0.36)	32.6 (0.18)	35.1 (0.45)	37.3 (0.62)
Saturated fatty acids (% of kcal)	9.0 (0.3)	10.0 (0.2)	11.1 (0.2)	12.1 (0.08)	12.3 (0.2)	13.4 (0.3)
Protein (g/kg/d)	2.3 (0.10)	2.7 (0.07)	3.3 (0.06)	3.4 (0.05)	3.9 (0.10)	4.6 (0.17)

NOTES: N = 397. kcal = kilocalories; SE = standard error.
SOURCES: Intake data were obtained from NHANES 2005–2008. Intake references are from Dietary Reference Intake report (IOM, 2002/2005).

TABLE P-31 Usual Intake Distributions of Energy for Women Ages 19 to 50 Years

Participant Category	10th	25th	Median	Mean	75th	90th
Women 19 to 50 Years: All Low-Income, 2011–2012	1,628 (256)	1,961 (188)	2,346 (152)	2,361 (98.8)	2,743 (200)	3,109 (291)
Women 19 to 50 Years: WIC, 2005–2008	1,404 (69.7)	1,668 (53.6)	1,992 (47.3)	2,044 (33.38)	2,362 (69.2)	2,746 (114)
Women 19 to 50 Years: Eligible Non-WIC, 2005–2008	1,386 (147)	1,736 (114)	2,170 (97.6)	2,220 (71.48)	2,648 (139)	3,116 (215)

NOTES: Intakes reported in kilocalories. Standard errors in parentheses. All women were pregnant, breastfeeding, or postpartum.
SOURCE: Intake data were obtained from NHANES 2005–2008 and 2011–2012.

TABLE P-32 Usual Intake Distributions of Energy for Infants

Participant Category	10th	25th	Median	Mean	75th	90th
0 to Less Than 6 Months: All Low-Income, 2011–2012	519 (32.43)	600 (25.11)	702 (21.72)	716 (17.57)	816 (31.99)	931 (51.13)
0 to Less Than 6 Months: WIC, 2005–2008	501 (27.00)	592 (18.43)	693 (14.98)	705 (11.91)	804 (22.21)	922 (38.09)
0 to Less Than 6 Months: Eligible Non-WIC, 2005–2008	492 (44.42)	548 (37.60)	629 (37.05)	659 (34.04)	738 (66.36)	865 (123.72)
6 to Less Than 12 Months: All Low-Income, 2011–2012	650 (51.44)	764 (41.56)	911 (37.86)	936 (26.55)	1,080 (55.65)	1,255 (88.96)
6 to Less Than 12 Months: WIC, 2005–2008	672 (29.96)	792 (21.19)	941 (19.93)	978 (17.10)	1,128 (33.20)	1,337 (56.39)
6 to Less Than 12 Months: Eligible Non-WIC, 2005–2008	689 (64.52)	786 (52.24)	914 (48.02)	941 (36.74)	1,066 (74.51)	1,228 (125.24)

NOTES: Intakes reported in kilocalories. Standard errors in parentheses.
SOURCE: Intake data were obtained from NHANES 2005–2008 and 2011–2012.

TABLE P-33 Usual Intake Distributions of Energy for Children Ages 1 to Less Than 2 Years

Participant Category	10th	25th	Median	Mean	75th	90th
Children 1 to Less Than 2 Years: All Low-Income, 2011–2012	893 (61.28)	1,040 (47.97)	1,220 (41.96)	1,242 (27.00)	1,421 (59.21)	1,619 (91.45)
Children 1 to Less Than 2 Years: WIC, 2005–2008	951 (35.33)	1,098 (28.41)	1,284 (25.71)	1,314 (17.24)	1,498 (37.30)	1,716 (59.16)
Children 1 to Less Than 2 Years: Eligible Non-WIC, 2005–2008	978 (71.49)	1,152 (55.83)	1,367 (48.59)	1,395 (33.27)	1,608 (69.85)	1,848 (109.50)

NOTES: Intakes reported in kilocalories. Standard errors in parentheses.
SOURCE: Intake data were obtained from NHANES 2005–2008 and 2011–2012.

TABLE P-34 Usual Intake Distributions of Energy for Children Ages 2 to Less Than 5 Years

Participant Category	10th	25th	Median	Mean	75th	90th
Children 2 to Less Than 5 Years: All Low-Income, 2011–2012	1,164 (36.98)	1,335 (28.80)	1,546 (25.10)	1,569 (16.42)	1,777 (35.02)	2,005 (53.59)
Children 2 to Less Than 5 Years: WIC, 2005–2008	1,108 (34.63)	1,281 (26.55)	1,495 (23.60)	1,534 (16.75)	1,743 (35.40)	2,007 (60.15)
Children 2 to Less Than 5 Years: Eligible Non-WIC, 2005–2008	1,093 (38.34)	1,267 (27.79)	1,471 (23.36)	1,493 (16.59)	1,695 (33.49)	1,921 (54.22)

NOTES: Intakes reported in kilocalories. Standard errors in parentheses.
SOURCE: Intake data were obtained from NHANES 2005–2008 and 2011–2012.

TABLE P-35 Distributions of Estimated Energy Requirements for Women Ages 19 to 50 Years

Participant Category	10th	25th	Median	Mean	75th	90th
Women 19 to 50 Years: All Low-Income, 2011–2012	1,775	1,940	2,165 (91.6)	2,206 (73.1)	2,369	2,599
Women 19 to 50 Years: WIC, 2005–2008	1,917	2,050	2,211 (27.9)	2,262 (22.3)	2,410	2,592
Women 19 to 50 Years: Eligible Non-WIC, 2005–2008	1,751	1,896	2,062 (40.0)	2,080 (31.9)	2,273	2,432

NOTES: Estimated Energy Requirements (EERs) reported in kilocalories. Standard errors in parentheses. All women were pregnant, breastfeeding, or postpartum.
SOURCES: Intake data were obtained from NHANES 2005–2008 and 2011–2012. EERs were calculated according to Dietary Reference Intake report (IOM, 2002/2005).

TABLE P-36 Distributions of Estimated Energy Requirements for Infants

Participant Category	10th	25th	Median	Mean	75th	90th
0 to Less Than 6 Months: All Low-Income, 2011–2012	470	488	630 (16.0)	618 (12.8)	710	781
0 to Less Than 6 Months: WIC, 2005–2008	425	497	603 (10.7)	594 (8.6)	675	764
0 to Less Than 6 Months: Eligible Non-WIC, 2005–2008	390	425	497 (NA)	547 (32.7)	728	755
6 to Less Than 12 Months: All Low-Income, 2011–2012	572	634	705 (16.8)	717 (13.4)	794	857
6 to Less Than 12 Months: WIC, 2005–2008	607	661	750 (9.0)	744 (7.2)	821	901
6 to Less Than 12 Months: Eligible Non-WIC, 2005–2008	590	661	687 (19.3)	713 (15.4)	785	821

NOTES: Estimated energy requirements (EERs) reported in kilocalories. Standard errors in parentheses.
SOURCES: Intake data were obtained from NHANES 2005–2008 and 2011–2012. EERs were calculated according to Dietary Reference Intake report (IOM, 2002/2005).

TABLE P-37 Distributions of Estimated Energy Requirements for Children Ages 1 to Less Than 2 Years

Participant Category	10th	25th	Median	Mean	75th	90th
Children 1 to Less Than 2 Years: All Low-Income, 2011–2012	810	899	961 (16.0)	967 (12.8)	1,006	1,130
Children 1 to Less Than 2 Years: WIC, 2005–2008	739	819	917 (11.0)	925 (8.8)	1,006	1,104
Children 1 to Less Than 2 Years: Eligible Non-WIC, 2005–2008	739	837	944 (17.9)	945 (14.3)	1,041	1,130

NOTES: Estimated energy requirements (EERs) reported in kilocalories. Standard errors in parentheses.
SOURCES: Intake data were obtained from NHANES 2005–2008 and 2011–2012. EERs were calculated according to Dietary Reference Intake report (IOM, 2002/2005).

TABLE P-38 Distributions of Estimated Energy Requirements for Children Ages 2 to Less Than 5 Years

Participant Category	10th	25th	Median	Mean	75th	90th
Children 2 to Less Than 5 Years: All Low-Income, 2011–2012	1,050	1,253	1,371 (11.8)	1,341 (9.4)	1,454	1,545
Children 2 to Less Than 5 Years: WIC, 2005–2008	1,059	1,184	1,314 (10.0)	1,295 (8.0)	1,410	1,486
Children 2 to Less Than 5 Years: Eligible Non-WIC, 2005–2008	1,041	1,202	1,350 (12.3)	1,326 (9.8)	1,435	1,540

NOTES: Estimated energy requirements (EERs) reported in kilocalories. Standard errors in parentheses.
SOURCES: Intake data were obtained from NHANES 2005–2008 and 2011–2012. EERs were calculated according to Dietary Reference Intake report (IOM, 2002/2005).

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Appendix Q

Food Intake of WIC and WIC-Eligible Populations

DEFINITIONS FOR TABLE SUBGROUPS

Subgroup definitions are as follows:

1. WIC = All individuals reporting participation in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) regardless of income level.
2. Eligible Non-WIC = Low-income individuals who did not report participation in WIC.
3. All Low-Income = All individuals at less than or equal to 185 percent of poverty. At the time of analysis, the WIC indicator was not available for the National Health and Nutrition Examination Survey (NHANES) 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.

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TABLE Q-1 Food Group Intake Distributions of Pregnant Women Ages 19 to 50 Years, All Low-Income, NHANES 2011–2012

		Percentiles and Mean (SE)		
Food Group	N	10th	25th	Median
Total Fruit (c-eq/d)	21	0.36	0.73	1.49 (NA)
Total Vegetables (c-eq/d)	26	0.67	0.96	1.37 (NA)
Dark Green Vegetables (c-eq/wk)	3	0.05	0.24	0.89 (NA)
Red and Orange Vegetables (c-eq/wk)	23	1.54	2.11	2.95 (NA)
Beans and Peas Computed as Vegetables (c-eq/wk)	0	NA	NA	NA (NA)
Starchy Vegetables (c-eq/wk)	7	0.84	1.33	1.97 (NA)
Other Vegetables (c-eq/wk)	17	0.74	1.40	2.65 (NA)
Total Grains (oz-eq/d)	29	4.12	5.36	7.01 (NA)
Whole Grains (oz-eq/d)	12	0.33	0.51	0.85 (NA)
Refined Grains (oz-eq/d)	29	3.56	4.70	6.22 (NA)
Total Protein Foods (oz-eq/d)	28	4.50	5.06	5.72 (NA)
Meat, Poultry, and Eggs (not Seafood) (oz-eq/wk)	27	28.32	30.86	33.85 (NA)
Seafood (oz-eq/wk)	0	NA	NA	NA (NA)
Nuts Seeds and Soy (oz-eq/wk)	5	0.47	1.54	3.90 (NA)
Total Dairy (c-eq/d)	25	1.20	1.57	2.06 (NA)
Oils (g-eq/d)	28	10.59	15.52	22.74 (NA)
Solid Fats (g-eq/d)	27	31.50	36.65	42.83 (NA)
Added Sugars (tsp-eq/d)	27	6.63	11.14	17.91 (NA)

NOTES: N = 29. The reference food intake pattern used was 2,200 kcals, which was the calculated EER for WIC women in NHANES 2005–2008. All women were pregnant, breastfeeding, or postpartum. See additional notes following Table Q-15.

Mean	75th	90th	Recommended Intake	% Below Recommended Intake (SE)
2.19 (0.45)	2.85	4.84	2	62 (18.21)
1.48 (0.17)	1.88	2.42	3	97 (12.56)
1.29 (NA)	2.03	3.22	2	74 (NA)
3.24 (0.53)	4.05	5.31	6	94 (5.15)
NA	NA	NA	NA	NA
1.99 (0.74)	2.63	3.17	6	100 (12.56)
3.55 (0.69)	4.68	7.44	5	78 (9.15)
7.38 (0.59)	9.00	11.10	7	50 (12.46)
1.13 (0.30)	1.41	2.22	3.5	97 (20.80)
6.53 (0.58)	8.02	9.88	3.5	9 (8.57)
5.76 (0.39)	6.41	7.07	6	61 (15.02)
34.02 (2.74)	36.99	39.95	28	9 (19.54)
NA	NA	NA	NA	NA
4.62 (1.30)	7.13	10.04	5	60 (17.12)
2.15 (0.21)	2.63	3.21	3	86 (21.48)
25.06 (2.75)	32.07	42.52	29	68 (15.60)
				% Above Recommended Intake (SE)
43.36 (3.85)	49.49	55.89	< 18	100 (22.19)
20.07 (8.78)	26.63	36.22	< 8	87 (24.40)

TABLE Q-2 Food Group Intake Distributions of Women Ages 19 to 50 Years, WIC, NHANES 2005–2008

		Percentiles and Mean (SE)		
Food Group	N	10th	25th	Median
Total Fruit (c-eq/d)	137	0.14	0.35	0.85 (0.15)
Total Vegetables (c-eq/d)	198	0.69	0.93	1.26 (0.08)
Dark Green Vegetables (c-eq/wk)	5	NA	NA	NA
Red and Orange Vegetables (c-eq/wk)	148	0.88	1.40	2.23 (0.23)
Beans and Peas Computed as Vegetables (c-eq/wk)	21	0.00	0.05	0.37 (0.16)
Starchy Vegetables (c-eq/wk)	80	1.54	2.03	2.71 (1.23)
Other Vegetables (c-eq/wk)	148	0.73	1.35	2.51 (0.40)
Total Grains (oz-eq/d)	225	4.07	5.20	6.68 (0.36)
Whole Grains (oz-eq/d)	68	0.04	0.16	0.47 (0.08)
Refined Grains (oz-eq/d)	224	3.85	4.85	6.15 (0.33)
Total Protein Foods (oz-eq/d)	219	2.74	3.66	4.88 (0.29)
Meat, Poultry, and Eggs (not Seafood) (oz-eq/wk)	215	16.85	22.27	29.35 (1.99)
Seafood (oz-eq/wk)	6	0.11	0.54	1.98 (0.73)
Nuts, Seeds, and Soy (oz-eq/wk)	26	0.02	0.18	0.92 (0.49)
Total Dairy (c-eq/d)	208	0.75	1.14	1.70 (0.10)
Oils (g-eq/d)	203	8.46	12.69	18.89 (1.43)
Solid Fats (g-eq/d)	225	18.88	25.91	35.21 (1.68)
Added Sugars (tsp-eq/d)	222	8.90	13.72	20.78 (5.83)

NOTES: N = 226. The reference food intake pattern used was 2,200 kcals, which was the calculated EER for WIC women in NHANES 2005–2008. All women were pregnant, breastfeeding, or postpartum. See additional notes following Table Q-15.

Mean	75th	90th	Recommended Intake	% Below Recommended Intake (SE)
1.47 (0.12)	1.85	3.47	2	77 (3.19)
1.33 (0.06)	1.64	2.05	3	99 (4.41)
NA	NA	NA	NA	NA
2.63 (0.18)	3.42	4.87	6	95 (3.73)
0.94 (0.13)	1.28	2.69	2	84 (6.95)
2.91 (0.98)	3.58	4.54	6	98 (4.96)
3.31 (0.32)	4.37	6.86	5	80 (5.09)
6.96 (0.29)	8.42	10.21	7	55 (2.76)
0.56 (0.06)	0.85	1.21	3.5	100 (1.00)
6.38 (0.26)	7.65	9.20	3.5	6 (0.38)
5.10 (0.23)	6.30	7.75	6	71 (3.34)
30.58 (1.59)	37.54	45.88	28	45 (2.49)
3.32 (0.58)	4.86	8.57	9	91 (6.93)
1.93 (0.39)	2.62	5.14	5	89 (5.90)
1.88 (0.08)	2.43	3.23	3	87 (3.05)
20.87 (1.14)	26.87	35.75	29	80 (4.50)
				% Above Recommended Intake (SE)
36.98 (1.34)	46.12	57.34	< 18	91 (0.13)
23.00 (4.65)	29.86	39.91	< 8	93 (0.17)

TABLE Q-3 Food Group Intake Distributions of Women Ages 19 to 50 Years, Eligible Non-WIC, NHANES 2005–2008

		Percentiles and Mean (SE)		
Food Group	N	10th	25th	Median
Total Fruit (c-eq/d)	54	0.22	0.47	0.96 (0.19)
Total Vegetables (c-eq/d)	69	0.62	0.91	1.33 (0.15)
Dark Green Vegetables (c-eq/wk)	3	0.22	0.38	0.64 (NA)
Red and Orange Vegetables (c-eq/wk)	48	1.10	1.55	2.23 (0.30)
Beans and Peas Computed as Vegetables (c-eq/wk)	9	0.02	0.11	0.47 (NA)
Starchy Vegetables (c-eq/wk)	30	0.56	1.27	2.58 (0.59)
Other Vegetables (c-eq/wk)	55	0.75	1.45	2.81 (0.64)
Total Grains (oz-eq/d)	76	5.34	6.28	7.46 (0.48)
Whole Grains (oz-eq/d)	23	0.05	0.18	0.47 (NA)
Refined Grains (oz-eq/d)	76	5.22	5.98	6.90 (0.43)
Total Protein Foods (oz-eq/d)	74	3.44	4.35	5.50 (0.46)
Meat, Poultry, and Eggs (not Seafood) (oz-eq/wk)	73	14.82	21.01	29.41 (2.33)
Seafood (oz-eq/wk)	3	0.91	1.97	4.32 (NA)
Nuts, Seeds, and Soy (oz-eq/wk)	12	0.12	0.42	1.32 (NA)
Total Dairy (c-eq/d)	70	1.03	1.37	1.81 (0.23)
Oils (g-eq/d)	68	11.93	15.49	20.27 (2.21)
Solid Fats (g-eq/d)	76	22.86	29.73	38.90 (2.08)
Added Sugars (tsp-eq/d)	75	11.65	16.87	24.02 (8.85)

NOTES: N = 76. The reference food intake pattern used was 2,200 kcals, which was the calculated EER for WIC women in NHANES 2005–2008. All women were pregnant, breastfeeding, or postpartum. See additional notes following Table Q-15.

Mean	75th	90th	Recommended Intake	% Below Recommended Intake (SE)
1.36 (0.15)	1.81	2.99	2	79 (11.17)
1.46 (0.12)	1.87	2.46	3	96 (8.24)
0.71 (NA)	0.96	1.32	2	99 (NA)
2.47 (0.24)	3.12	4.15	6	98 (5.84)
0.85 (0.16)	1.25	2.25	2	87 (15.99)
3.40 (0.47)	4.62	7.25	6	84 (7.21)
3.84 (0.51)	5.06	8.18	5	75 (12.85)
7.60 (0.38)	8.76	10.05	7	40 (1.36)
0.64 (0.13)	0.92	1.44	3.5	100 (2.32)
6.99 (0.34)	7.89	8.86	3.5	0.2 (8.57)
5.67 (0.37)	6.80	8.11	6	61 (12.00)
31.22 (1.86)	39.45	49.91	28	46 (3.90)
7.16 (NA)	8.90	16.39	9	75 (NA)
2.87 (1.19)	3.42	7.09	5	84 (13.54)
1.91 (0.18)	2.34	2.90	3	92 (6.07)
21.32 (1.76)	25.99	32.01	29	84 (10.40)
				% Above Recommended Intake (SE)
40.84 (1.66)	49.82	61.30	< 18	96 (0.01)
25.66 (7.06)	32.66	41.73	< 8	97 (4.99)

TABLE Q-4 Food Group Intake Distributions of Infants 0 to Less Than 6 Months, All Low-Income, NHANES 2011–2012

		Percentiles and Mean (SE)					
Food Group	N	10th	25th	Median	Mean	75th	90th
Total Fruit (c-eq/d)	12	0	0	0.01 (0.05)	0.10 (0.04)	0.11	0.31
Total Vegetables (c-eq/d)	5	0	0	0.02 (0.01)	0.06 (0.01)	0.08	0.18
Dark Green Vegetables (c-eq/wk)	0	NA	NA	NA	NA	NA	NA
Red and Orange Vegetables (c-eq/wk)	4	0	0	0.04 (NA)	0.31 (NA)	0.32	1.00
Beans and Peas Computed as Vegetables (c-eq/wk)	0	NA	NA	NA	NA	NA	NA
Starchy Vegetables (c-eq/wk)	1	NA	NA	NA	NA	NA	NA
Other Vegetables (c-eq/wk)	0	NA	NA	NA	NA	NA	NA
Total Grains (oz-eq/d)	16	0	0	0.01 (0.04)	0.10 (0.03)	0.13	0.33
Whole Grains (oz-eq/d)	4	0	0	0	0.04 (NA)	0.01	0.10
Refined Grains (oz-eq/d)	10	0	0	0.02 (0.03)	0.09 (0.02)	0.10	0.26
Total Protein Foods (oz-eq/d)	0	NA	NA	NA	NA	NA	NA
Meat, Poultry, and Eggs (not Seafood) (oz-eq/wk)	0	NA	NA	NA	NA	NA	NA
Seafood (oz-eq/wk)	0	NA	NA	NA	NA	NA	NA
Nuts, Seeds, and Soy (oz-eq/wk)	0	NA	NA	NA	NA	NA	NA
Total Dairy (c-eq/d)	0	NA	NA	NA	NA	NA	NA
Oils (g-eq/d)	1	NA	NA	NA	NA	NA	NA
Solid Fats (g-eq/d)	0	NA	NA	NA	NA	NA	NA
Added Sugars (tsp-eq/d)	1	NA	NA	NA	NA	NA	NA

NOTES: N = 71. See additional notes following Table Q-15.

TABLE Q-5 Food Group Intake Distributions of Infants 0 to Less Than 6 Months, WIC, NHANES 2005–2008

		Percentiles and Mean (SE)					
Food Group	N	10th	25th	Median	Mean	75th	90th
Total Fruit (c-eq/d)	59	0	0	0.07 (0.03)	0.19 (0.02)	0.31	0.57
Total Vegetables (c-eq/d)	33	0	0	0.01 (0.01)	0.09 (0.01)	0.12	0.31
Dark Green Vegetables (c-eq/wk)	0	NA	NA	NA	NA	NA	NA
Red and Orange Vegetables (c-eq/wk)	23	0	0	0.04 (0.09)	0.40 (0.07)	0.41	1.24
Beans and Peas Computed as Vegetables (c-eq/wk)	0	NA	NA	NA	NA	NA	NA
Starchy Vegetables (c-eq/wk)	8	0	0	0.01 (0.05)	0.18 (0.04)	0.15	0.57
Other Vegetables (c-eq/wk)	1	NA	NA	NA	NA	NA	NA
Total Grains (oz-eq/d)	69	0	0	0.16 (0.08)	0.35 (0.06)	0.56	0.99
Whole Grains (oz-eq/d)	27	0	0	0.03 (0.03)	0.11 (0.02)	0.14	0.34
Refined Grains (oz-eq/d)	52	0	0	0.06 (0.06)	0.24 (0.05)	0.36	0.73
Total Protein Foods (oz-eq/d)	6	0	0	0	0.03 (0.01)	0.02	0.10
Meat, Poultry, and Eggs (not Seafood) (oz-eq/wk)	6	0	0	0	0.20 (0.05)	0.14	0.73
Seafood (oz-eq/wk)	0	NA	NA	NA	NA	NA	NA
Nuts, Seeds, and Soy (oz-eq/wk)	0	NA	NA	NA	NA	NA	NA
Total Dairy (c-eq/d)	6	0	0	0	0.01 (NA)	0.00	0.03
Oils (g-eq/d)	8	0	0	0	0.06 (0.01)	0.01	0.17
Solid Fats (g-eq/d)	13	0	0	0	0.21 (0.05)	0.17	0.79
Added Sugars (tsp-eq/d)	12	0	0	0	0.15 (0.30)	0.06	0.36

NOTES: N = 171. See additional notes following Table Q-15.

TABLE Q-6 Food Group Intake Distributions of Infants 0 to Less Than 6 Months, Eligible Non-WIC, NHANES 2005–2008

		Percentiles and Mean (SE)					
Food Group	N	10th	25th	Median	Mean	75th	90th
Total Fruit (c-eq/d)	2	0	0	0.00 (NA)	0.20 (NA)	0.05	0.74
Total Vegetables (c-eq/d)	2	0	0	0.00 (NA)	0.09 (NA)	0.03	0.44
Dark Green Vegetables (c-eq/wk)	0	NA	NA	NA	NA	NA	NA
Red and Orange Vegetables (c-eq/wk)	2	NA	NA	NA	NA	NA	NA
Beans and Peas Computed as Vegetables (c-eq/wk)	0	NA	NA	NA	NA	NA	NA
Starchy Vegetables (c-eq/wk)	1	NA	NA	NA	NA	NA	NA
Other Vegetables (c-eq/wk)	0	NA	NA	NA	NA	NA	NA
Total Grains (oz-eq/d)	4	0	0	0.00 (NA)	0.26 (NA)	0.41	0.95
Whole Grains (oz-eq/d)	0	NA	NA	NA	NA	NA	NA
Refined Grains (oz-eq/d)	4	0	0	0.00 (NA)	0.16 (NA)	0.45	0.49
Total Protein Foods (oz-eq/d)	1	NA	NA	NA	NA	NA	NA
Meat, Poultry, and Eggs (not Seafood) (oz-eq/wk)	1	NA	NA	NA	NA	NA	NA
Seafood (oz-eq/wk)	0	NA	NA	NA	NA	NA	NA
Nuts, Seeds, and Soy (oz-eq/wk)	0	NA	NA	NA	NA	NA	NA
Total Dairy (c-eq/d)	0	NA	NA	NA	NA	NA	NA
Oils (g-eq/d)	0	NA	NA	NA	NA	NA	NA
Solid Fats (g-eq/d)	1	NA	NA	NA	NA	NA	NA
Added Sugars (tsp-eq/d)	0	NA	NA	NA	NA	NA	NA

NOTES: N = 19. See additional notes following Table Q-15.

TABLE Q-7 Food Group Intake Distributions of Infants 6 to Less Than 12 Months, All Low-Income, NHANES 2011–2012

		Percentiles and Mean (SE)					
Food Group	N	10th	25th	Median	Mean	75th	90th
Total Fruit (c-eq/d)	58	0.23	0.38	0.63 (0.08)	0.73 (0.06)	0.96	1.36
Total Vegetables (c-eq/d)	48	0.16	0.25	0.39 (0.05)	0.45 (0.04)	0.58	0.82
Dark Green Vegetables (c-eq/wk)	0	NA	NA	NA	NA	NA	NA
Red and Orange Vegetables (c-eq/wk)	32	0.89	1.48	2.56 (0.79)	3.40 (0.63)	4.33	6.86
Beans and Peas Computed as Vegetables (c-eq/wk)	1	NA	NA	NA	NA	NA	NA
Starchy Vegetables (c-eq/wk)	17	0.13	0.31	0.63 (NA)	0.79 (0.14)	1.10	1.67
Other Vegetables (c-eq/wk)	14	0.05	0.13	0.32 (NA)	0.60 (0.13)	0.72	1.42
Total Grains (oz-eq/d)	63	0.44	0.78	1.34 (0.15)	1.61 (0.12)	2.14	3.10
Whole Grains (oz-eq/d)	29	0.07	0.14	0.26 (NA)	0.32 (0.05)	0.44	0.66
Refined Grains (oz-eq/d)	57	0.24	0.49	0.97 (0.16)	1.30 (0.13)	1.75	2.78
Total Protein Foods (oz-eq/d)	29	0.12	0.30	0.60 (NA)	0.73 (0.13)	1.01	1.50
Meat, Poultry, and Eggs (not Seafood) (oz-eq/wk)	27	0.46	1.39	3.27 (NA)	4.57 (0.94)	6.33	10.33
Seafood (oz-eq/wk)	0	NA	NA	NA	NA	NA	NA
Nuts, Seeds, and Soy (oz-eq/wk)	1	NA	NA	NA	NA	NA	NA
Total Dairy (c-eq/d)	32	0.00	0.03	0.13 (0.20)	0.56 (0.16)	0.48	1.35
Oils (g-eq/d)	40	0.25	0.70	2.02 (1.57)	5.20 (1.23)	5.44	12.54
Solid Fats (g-eq/d)	43	0.14	0.87	2.98 (1.57)	5.48 (1.25)	7.17	13.73
Added Sugars (tsp-eq/d)	46	0.19	0.51	1.41 (3.43)	3.13 (2.74)	3.56	7.65

NOTES: N = 73. See additional notes following Table Q-15.

TABLE Q-8 Food Group Intake Distributions of Infants 6 to Less Than 12 Months, WIC, NHANES 2005–2008

		Percentiles and Mean (SE)					
Food Group	N	10th	25th	Median	Mean	75th	90th
Total Fruit (c-eq/d)	171	0.20	0.38	0.70 (0.05)	0.86 (0.04)	1.16	1.73
Total Vegetables (c-eq/d)	150	0.09	0.17	0.31 (0.03)	0.40 (0.02)	0.53	0.81
Dark Green Vegetables (c-eq/wk)	2	0.00	0.00	0.00 (NA)	0.05 (NA)	0.03	0.13
Red and Orange Vegetables (c-eq/wk)	104	0.22	0.50	1.19 (0.34)	2.13 (0.27)	2.60	5.01
Beans and Peas Computed as Vegetables (c-eq/wk)	7	0.00	0.00	0.03 (NA)	0.16 (0.05)	0.18	0.51
Starchy Vegetables (c-eq/wk)	69	0.16	0.36	0.76 (0.15)	1.02 (0.12)	1.38	2.18
Other Vegetables (c-eq/wk)	42	0.06	0.13	0.28 (0.08)	0.40 (0.06)	0.53	0.90
Total Grains (oz-eq/d)	188	0.37	0.70	1.25 (0.09)	1.49 (0.07)	2.02	2.91
Whole Grains (oz-eq/d)	83	0.04	0.10	0.21 (0.04)	0.26 (0.03)	0.36	0.54
Refined Grains (oz-eq/d)	181	0.24	0.50	0.96 (0.09)	1.22 (0.07)	1.66	2.53
Total Protein Foods (oz-eq/d)	123	0.04	0.21	0.58 (0.19)	0.80 (0.15)	1.13	1.83
Meat, Poultry, and Eggs (not Seafood) (oz-eq/wk)	119	0.32	1.46	3.86 (1.04)	5.22 (0.83)	7.44	11.79
Seafood (oz-eq/wk)	1	NA	NA	NA	NA	NA	NA
Nuts, Seeds, and Soy (oz-eq/wk)	2	0.00	0.01	0.03 (NA)	0.12 (NA)	0.10	0.30
Total Dairy (c-eq/d)	112	0.03	0.08	0.25 (0.71)	0.58 (0.57)	0.65	1.43
Oils (g-eq/d)	133	0.21	0.56	1.47 (0.34)	2.80 (0.27)	3.43	6.79
Solid Fats (g-eq/d)	158	0.41	1.39	4.28 (1.05)	9.11 (0.84)	11.02	22.98
Added Sugars (tsp-eq/d)	136	0.13	0.39	1.16 (1.75)	2.72 (1.40)	3.07	6.75

NOTES: N = 212. See additional notes following Table Q-15.

TABLE Q-9 Food Group Intake Distributions of Infants 6 to Less Than 12 Months, Eligible Non-WIC, NHANES 2005–2008

		Percentiles and Mean (SE)					
Food Group	N	10th	25th	Median	Mean	75th	90th
Total Fruit (c-eq/d)	26	0.38	0.56	0.82 (NA)	0.90 (0.09)	1.16	1.53
Total Vegetables (c-eq/d)	21	0.13	0.22	0.38 (NA)	0.45 (0.06)	0.61	0.87
Dark Green Vegetables (c-eq/wk)	0	NA	NA	NA	NA	NA	NA
Red and Orange Vegetables (c-eq/wk)	17	0.26	0.58	1.26 (NA)	1.91 (0.29)	2.50	4.34
Beans and Peas Computed as Vegetables (c-eq/wk)	0	NA	NA	NA	NA	NA	NA
Starchy Vegetables (c-eq/wk)	9	0.26	0.44	0.74 (NA)	0.90 (0.24)	1.19	1.72
Other Vegetables (c-eq/wk)	3	NA	NA	NA	NA	NA	NA
Total Grains (oz-eq/d)	28	0.64	1.04	1.63 (NA)	1.85 (0.19)	2.42	3.31
Whole Grains (oz-eq/d)	14	0.14	0.27	0.55 (NA)	0.87 (0.29)	1.07	1.93
Refined Grains (oz-eq/d)	26	0.33	0.65	1.21 (NA)	1.51 (0.20)	2.04	3.07
Total Protein Foods (oz-eq/d)	18	0.07	0.19	0.47 (NA)	0.86 (0.14)	1.06	2.07
Meat, Poultry, and Eggs (not Seafood) (oz-eq/wk)	18	0.59	1.35	3.08 (NA)	5.05 (0.75)	6.43	11.71
Seafood (oz-eq/wk)	1	NA	NA	NA	NA	NA	NA
Nuts, Seeds, and Soy (oz-eq/wk)	1	NA	NA	NA	NA	NA	NA
Total Dairy (c-eq/d)	19	0.01	0.07	0.40 (NA)	1.76 (0.77)	1.57	4.47
Oils (g-eq/d)	18	0.41	0.87	1.87 (NA)	3.01 (0.64)	3.79	6.84
Solid Fats (g-eq/d)	25	0.50	1.83	6.06 (NA)	14.26 (2.99)	16.56	36.23
Added Sugars (tsp-eq/d)	22	0.73	1.35	2.48 (NA)	3.28 (2.19)	4.32	6.80

NOTES: N = 31. See additional notes following Table Q-15.

TABLE Q-10 Food Group Intake Distributions of Children 1 to Less Than 2 Years, All Low-Income, NHANES 2011–2012

		Percentiles and Mean (SE)					
Food Group	N	10th	25th	Median	Mean	75th	90th
Total Fruit (c-eq/d)	79	0.48	0.75	1.15 (0.13)	1.29 (0.10)	1.68	2.27
Total Vegetables (c-eq/d)	65	0.22	0.32	0.47 (0.05)	0.52 (0.04)	0.67	0.90
Dark Green Vegetables (c-eq/wk)	4	0.01	0.03	0.10 (NA)	0.23 (NA)	0.25	0.56
Red and Orange Vegetables (c-eq/wk)	42	0.33	0.58	1.07 (0.33)	1.56 (0.26)	1.94	3.28
Beans and Peas Computed as Vegetables (c-eq/wk)	7	0.00	0.03	0.18 (NA)	0.38 (0.07)	0.58	1.08
Starchy Vegetables (c-eq/wk)	23	0.39	0.66	1.10 (NA)	1.32 (0.16)	1.74	2.53
Other Vegetables (c-eq/wk)	28	0.32	0.48	0.71 (NA)	0.80 (0.14)	1.02	1.37
Total Grains (oz-eq/d)	91	1.89	2.46	3.19 (0.20)	3.31 (0.16)	4.03	4.87
Whole Grains (oz-eq/d)	45	0.10	0.19	0.40 (0.14)	0.69 (0.11)	0.83	1.55
Refined Grains (oz-eq/d)	90	1.73	2.16	2.71 (0.20)	2.78 (0.16)	3.32	3.94
Total Protein Foods (oz-eq/d)	82	1.04	1.44	1.99 (0.20)	2.12 (0.16)	2.66	3.36
Meat, Poultry, and Eggs (not Seafood) (oz-eq/wk)	77	4.96	7.67	11.69 (1.28)	12.99 (1.02)	16.88	22.61
Seafood (oz-eq/wk)	2	0.07	0.19	0.46 (NA)	0.64 (NA)	0.91	1.45
Nuts, Seeds, and Soy (oz-eq/wk)	15	0.13	0.42	1.07 (NA)	1.24 (0.29)	1.91	2.64
Total Dairy (c-eq/d)	92	1.36	1.75	2.26 (0.14)	2.33 (0.11)	2.83	3.41
Oils (g-eq/d)	86	5.54	6.87	8.58 (0.60)	8.89 (0.48)	10.57	12.61
Solid Fats (g-eq/d)	92	14.41	18.59	24.14 (1.92)	25.30 (1.53)	30.75	37.68
Added Sugars (tsp-eq/d)	92	4.22	5.89	8.26 (2.82)	8.98 (2.25)	11.29	14.65

NOTES: N = 93. See additional notes following Table Q-15.

TABLE Q-11 Food Group Intake Distributions of Children 1 to Less Than 2 Years, WIC, NHANES 2005–2008

		Percentiles and Mean (SE)					
Food Group	N	10th	25th	Median	Mean	75th	90th
Total Fruit (c-eq/d)	231	0.55	0.84	1.26 (0.08)	1.39 (0.06)	1.79	2.37
Total Vegetables (c-eq/d)	229	0.27	0.36	0.49 (0.03)	0.52 (0.02)	0.64	0.80
Dark Green Vegetables (c-eq/wk)	7	0.00	0.00	0.03 (NA)	0.13 (0.02)	0.13	0.35
Red and Orange Vegetables (c-eq/wk)	142	0.38	0.63	1.06 (0.14)	1.33 (0.11)	1.73	2.61
Beans and Peas Computed as Vegetables (c-eq/wk)	21	0.00	0.03	0.18 (NA)	0.35 (0.04)	0.53	0.97
Starchy Vegetables (c-eq/wk)	118	0.62	0.93	1.39 (0.25)	1.53 (0.20)	1.97	2.63
Other Vegetables (c-eq/wk)	108	0.26	0.48	0.92 (0.31)	1.37 (0.25)	1.72	2.97
Total Grains (oz-eq/d)	259	1.68	2.21	2.89 (0.13)	3.02 (0.10)	3.69	4.51
Whole Grains (oz-eq/d)	122	0.13	0.21	0.34 (0.04)	0.39 (0.03)	0.51	0.72
Refined Grains (oz-eq/d)	257	1.41	1.88	2.50 (0.11)	2.62 (0.09)	3.23	4.00
Total Protein Foods (oz-eq/d)	240	0.83	1.27	1.93 (0.10)	2.13 (0.08)	2.77	3.70
Meat, Poultry, and Eggs (not Seafood) (oz-eq/wk)	236	5.31	8.18	12.40 (0.66)	13.72 (0.53)	17.80	23.75
Seafood (oz-eq/wk)	1	NA	NA	NA	NA	NA	NA
Nuts, Seeds, and Soy (oz-eq/wk)	31	0.03	0.15	0.49 (0.19)	0.84 (0.15)	1.15	2.06
Total Dairy (c-eq/d)	259	1.32	1.85	2.55 (0.10)	2.67 (0.08)	3.35	4.16
Oils (g-eq/d)	236	3.03	4.73	7.32 (0.51)	8.27 (0.41)	10.78	14.74
Solid Fats (g-eq/d)	262	15.62	20.29	26.29 (0.96)	27.25 (0.77)	33.17	40.11
Added Sugars (tsp-eq/d)	254	2.92	4.66	7.33 (1.85)	8.30 (1.48)	10.87	14.91

NOTES: N = 263. See additional notes following Table Q-15.

TABLE Q-12 Food Group Intake Distributions of Children 1 to Less Than 2 Years, Eligible Non-WIC, NHANES 2005–2008

		Percentiles and Mean (SE)					
Food Group	N	10th	25th	Median	Mean	75th	90th
Total Fruit (c-eq/d)	73	0.40	0.71	1.22 (0.13)	1.43 (0.10)	1.91	2.72
Total Vegetables (c-eq/d)	73	0.21	0.35	0.54 (0.06)	0.61 (0.05)	0.80	1.10
Dark Green Vegetables (c-eq/wk)	4	0	0	0.03 (NA)	0.27 (NA)	0.23	0.77
Red and Orange Vegetables (c-eq/wk)	55	0.29	0.55	1.03 (0.18)	1.38 (0.14)	1.82	2.88
Beans and Peas Computed as Vegetables (c-eq/wk)	2	0.14	0.22	0.34 (NA)	0.37 (NA)	0.49	0.66
Starchy Vegetables (c-eq/wk)	38	1.04	1.49	2.20 (0.49)	2.57 (0.39)	3.24	4.54
Other Vegetables (c-eq/wk)	34	0.25	0.39	0.60 (0.74)	0.71 (0.59)	0.91	1.30
Total Grains (oz-eq/d)	79	1.39	2.12	3.14 (0.26)	3.38 (0.21)	4.38	5.69
Whole Grains (oz-eq/d)	34	0.10	0.18	0.33 (0.09)	0.41 (0.07)	0.55	0.83
Refined Grains (oz-eq/d)	78	1.05	1.71	2.66 (0.23)	2.95 (0.18)	3.88	5.21
Total Protein Foods (oz-eq/d)	76	0.84	1.30	1.96 (0.18)	2.15 (0.14)	2.80	3.71
Meat, Poultry, and Eggs (not Seafood) (oz-eq/wk)	72	5.44	8.17	12.14 (0.96)	13.31 (0.77)	17.15	22.62
Seafood (oz-eq/wk)	1	NA	NA	NA	NA	NA	NA
Nuts, Seeds, and Soy (oz-eq/wk)	8	0.27	0.52	0.98 (NA)	1.29 (0.30)	1.72	2.69
Total Dairy (c-eq/d)	79	1.08	1.64	2.38 (0.18)	2.53 (0.14)	3.26	4.16
Oils (g-eq/d)	72	4.22	5.97	8.47 (1.03)	9.20 (0.82)	11.63	15.09
Solid Fats (g-eq/d)	80	14.08	19.59	26.64 (1.60)	27.63 (1.28)	34.58	42.44
Added Sugars (tsp-eq/d)	80	2.89	5.05	8.60 (3.98)	10.25 (3.18)	13.65	19.71

NOTES: N = 82. See additional notes following Table Q-15.

TABLE Q-13 starts on the next page.

TABLE Q-13 Food Group Intake Distributions of Children 2 to Less Than 5 Years, All Low-Income, NHANES 2011–2012

		Percentiles and Mean (SE)		
Food Group	N	10th	25th	Median
Total Fruit (c-eq/d)	299	0.53	0.83	1.27 (0.06)
Total Vegetables (c-eq/d)	287	0.32	0.45	0.62 (0.04)
Dark Green Vegetables (c-eq/wk)	10	0.00	0.01	0.07 (NA)
Red and Orange Vegetables (c-eq/wk)	189	0.36	0.61	1.07 (0.11)
Beans and Peas Computed as Vegetables (c-eq/wk)	34	0.01	0.06	0.27 (0.08)
Starchy Vegetables (c-eq/wk)	123	0.72	1.22	2.18 (0.46)
Other Vegetables (c-eq/wk)	146	0.80	1.26	2.07 (0.54)
Total Grains (oz-eq/d)	338	3.29	3.94	4.74 (0.18)
Whole Grains (oz-eq/d)	170	0.14	0.27	0.53 (0.08)
Refined Grains (oz-eq/d)	337	2.66	3.27	4.03 (0.15)
Total Protein Foods (oz-eq/d)	328	1.69	2.26	3.01 (0.11)
Meat, Poultry, and Eggs (not Seafood) (oz-eq/wk)	318	8.31	12.24	17.73 (0.81)
Seafood (oz-eq/wk)	10	0	0.03	0.27 (0.19)
Nuts, Seeds, and Soy (oz-eq/wk)	55	0.47	0.92	1.71 (0.34)
Total Dairy (c-eq/d)	333	1.01	1.41	1.95 (0.08)
Oils (g-eq/d)	332	8.30	10.88	14.30 (0.66)
Solid Fats (g-eq/d)	338	16.50	20.77	26.32 (0.95)
Added Sugars (tsp-eq/d)	337	6.92	9.50	13.05 (2.47)

NOTES: N = 340. For all children 1 to less than 5 years of age, recommended intakes were generated by weighting the 1,000 and 1,300 (averaged from 1,200 and 1,400 kcal patterns) kcal food patterns in a 1:3 ratio following the methodology applied by the Institute of Medicine (2011). See additional notes following Table Q-15.

Mean	75th	90th	Recommended Intake	% Below Recommended Intake (SE)
1.41 (0.05)	1.84	2.46	1.19	45 (5.20)
0.67 (0.03)	0.83	1.06	1.38	98 (1.10)
0.26 (0.08)	0.27	0.71	0.88	92 (4.00)
1.38 (0.09)	1.78	2.76	2.88	91 (1.90)
0.47 (0.06)	0.71	1.25	0.50	65 (4.23)
3.04 (0.37)	3.83	6.30	3.13	67 (5.04)
2.62 (0.43)	3.35	5.08	2.25	55 (7.12)
4.84 (0.14)	5.63	6.51	4.13	31 (4.25)
0.81 (0.06)	1.03	1.79	2.06	93 (1.42)
4.14 (0.12)	4.89	5.76	2.06	2 (0.81)
3.14 (0.09)	3.87	4.74	3.13	54 (3.80)
19.05 (0.65)	24.41	31.46	14.88	37 (3.76)
0.90 (0.15)	1.12	2.68	4.50	96 (1.66)
2.13 (0.27)	2.86	4.30	2.38	66 (6.38)
2.04 (0.06)	2.57	3.21	2.38	68 (3.82)
14.99 (0.53)	18.34	22.54	16.50	65 (3.77)
				% Above Recommended Intake (SE)
27.30 (0.76)	32.75	39.35	< 7.75	100 (0.09)
13.91 (1.97)	17.38	21.99	< 3.24	99 (0.002)

TABLE Q-14 Food Group Intake Distributions of Children 2 to Less Than 5 Years, WIC, NHANES 2005–2008

		Percentiles and Mean (SE)		
Food Group	N	10th	25th	Median
Total Fruit (c-eq/d)	335	0.48	0.81	1.35 (0.06)
Total Vegetables (c-eq/d)	347	0.28	0.43	0.64 (0.04)
Dark Green Vegetables (c-eq/wk)	12	0.02	0.05	0.12 (NA)
Red and Orange Vegetables (c-eq/wk)	218	0.40	0.69	1.24 (0.11)
Beans and Peas Computed as Vegetables (c-eq/wk)	26	0.05	0.13	0.33 (NA)
Starchy Vegetables (c-eq/wk)	149	0.93	1.38	2.02 (0.50)
Other Vegetables (c-eq/wk)	191	0.30	0.59	1.21 (0.23)
Total Grains (oz-eq/d)	398	2.52	3.25	4.18 (0.11)
Whole Grains (oz-eq/d)	160	0.16	0.25	0.38 (0.04)
Refined Grains (oz-eq/d)	393	2.20	2.89	3.77 (0.11)
Total Protein Foods (oz-eq/d)	378	1.69	2.23	2.93 (0.10)
Meat, Poultry, and Eggs (not Seafood) (oz-eq/wk)	365	10.22	13.56	17.95 (0.66)
Seafood (oz-eq/wk)	6	0.14	0.32	0.68 (NA)
Nuts, Seeds, and Soy (oz-eq/wk)	59	0.18	0.44	1.06 (0.36)
Total Dairy (c-eq/d)	394	1.09	1.49	2.00 (0.06)
Oils (g-eq/d)	382	5.44	7.88	11.37 (0.65)
Solid Fats (g-eq/d)	401	18.38	22.61	27.90 (0.90)
Added Sugars (tsp-eq/d)	398	6.85	9.51	13.18 (2.48)

NOTES: N = 402. For all children 1 to less than 5 years of age, recommended intakes were generated by weighting the 1,000 and 1,300 (averaged from 1,200 and 1,400 kcal patterns) kcal food patterns in a 1:3 ratio following the methodology applied by the Institute of Medicine (2011). See additional notes following Table Q-15.

Mean	75th	90th	Recommended Intake	% Below Recommended Intake (SE)
1.57 (0.05)	2.09	2.94	1.19	43 (5.59)
0.71 (0.03)	0.91	1.22	1.38	94 (1.41)
0.19 (0.03)	0.25	0.45	0.88	98 (1.85)
1.63 (0.09)	2.12	3.33	2.88	86 (2.83)
0.50 (0.04)	0.68	1.18	0.50	65 (3.55)
2.23 (0.40)	2.85	3.78	3.13	81 (5.47)
1.90 (0.18)	2.37	4.21	2.25	73 (3.65)
4.32 (0.09)	5.24	6.30	4.13	48 (4.36)
0.43 (0.03)	0.55	0.75	2.06	100 (0.02)
3.91 (0.09)	4.78	5.80	2.06	8 (1.03)
3.05 (0.08)	3.75	4.57	3.13	57 (4.87)
18.76 (0.53)	23.08	28.33	14.88	32 (6.19)
0.90 (0.09)	1.24	1.96	4.50	100 (1.06)
1.83 (0.29)	2.30	4.31	2.38	76 (5.13)
2.10 (0.05)	2.61	3.24	2.38	66 (10.84)
12.41 (0.52)	15.80	20.67	16.50	78 (5.53)
				% Above Recommended Intake (SE)
28.61 (0.72)	33.84	39.75	< 7.75	100 (0.003)
14.07 (1.98)	17.65	22.42	< 3.24	99 (0.04)

TABLE Q-15 Food Group Intake Distributions of Children 2 to Less Than 5 Years, Eligible Non-WIC, NHANES 2005–2008

		Percentiles and Mean (SE)		
Food Group	N	10th	25th	Median
Total Fruit (c-eq/d)	250	0.39	0.67	1.12 (0.08)
Total Vegetables (c-eq/d)	291	0.32	0.45	0.64 (0.03)
Dark Green Vegetables (c-eq/wk)	6	0.01	0.04	0.11 (NA)
Red and Orange Vegetables (c-eq/wk)	202	0.58	0.91	1.44 (0.11)
Beans and Peas Computed as Vegetables (c-eq/wk)	13	0.04	0.10	0.24 (NA)
Starchy Vegetables (c-eq/wk)	122	0.84	1.28	1.89 (0.19)
Other Vegetables (c-eq/wk)	150	0.30	0.50	0.81 (0.38)
Total Grains (oz-eq/d)	324	2.74	3.53	4.53 (0.15)
Whole Grains (oz-eq/d)	133	0.13	0.22	0.38 (0.10)
Refined Grains (oz-eq/d)	322	2.47	3.18	4.08 (0.14)
Total Protein Foods (oz-eq/d)	315	1.84	2.32	2.92 (0.11)
Meat, Poultry, and Eggs (not Seafood) (oz-eq/wk)	306	10.36	13.43	17.41 (0.71)
Seafood (oz-eq/wk)	8	0	0.05	0.35 (NA)
Nuts, Seeds, and Soy (oz-eq/wk)	50	0.57	0.94	1.58 (0.39)
Total Dairy (c-eq/d)	323	1.01	1.41	1.95 (0.06)
Oils (g-eq/d)	312	7.29	9.28	11.88 (0.55)
Solid Fats (g-eq/d)	327	18.17	22.95	28.90 (1.01)
Added Sugars (tsp-eq/d)	328	8.20	11.03	14.86 (2.18)

NOTES: N = 329. For all children 1 to less than 5 years of age, recommended intakes were generated by weighting the 1,000 and 1,300 (averaged from 1,200 and 1,400 kcal patterns) kcal food patterns in a 1:3 ratio following the methodology applied by the Institute of Medicine (2011). See additional notes following this table.

Mean	75th	90th	Recommended Intake	% Below Recommended Intake (SE)
1.32 (0.06)	1.75	2.50	1.19	53 (3.59)
0.69 (0.02)	0.87	1.12	1.38	97 (0.45)
0.21 (NA)	0.27	0.52	0.88	96 (NA)
1.71 (0.09)	2.21	3.15	2.88	87 (2.33)
0.31 (0.04)	0.45	0.70	0.50	79 (6.30)
2.06 (0.15)	2.65	3.49	3.13	85 (4.50)
0.98 (0.30)	1.27	1.85	2.25	95 (4.78)
4.67 (0.12)	5.66	6.79	4.13	40 (5.04)
0.46 (0.08)	0.60	0.89	2.06	100 (1.60)
4.22 (0.11)	5.11	6.14	2.06	5 (0.64)
3.00 (0.09)	3.60	4.27	3.13	58 (6.49)
18.08 (0.57)	21.99	26.65	14.88	34 (5.26)
0.94 (0.21)	1.30	2.81	4.50	97 (3.08)
2.04 (0.31)	2.62	4.04	2.38	71 (6.93)
2.05 (0.05)	2.57	3.21	2.38	68 (3.46)
12.36 (0.44)	14.91	18.03	16.50	84 (9.53)
				% Above Recommended Intake (SE)
29.63 (0.81)	35.51	42.02	< 7.75	100 (0.01)
15.72 (1.74)	19.47	24.34	< 3.24	100 (0.002)

NOTES FOR TABLES Q-1 to Q-15: c-eq = cup-equivalents; d = day; EER = Estimated Energy Requirement; g-eq = gram-equivalents; N = sample size; NA = data not available; NHANES = National Health and Nutrition Examination Survey; oz-eq = ounce-equivalents; SE = standard error; wk = week. NA = estimate could not be obtained because the Statistical Program for Age-adjusted Dietary Assessment (SPADE) requires more than two observations per group with two non-zero intakes in order to estimate a within-person variance, or, for median standard errors, a sample size of 30 is required to estimate this value from mean standard error.

Population subgroup definitions are as follows:

All individuals reporting participation in WIC regardless of income level.

Eligible Non-WIC = Low-income individuals who did not report participation in WIC.

All Low-Income = All individuals at ≤ 185 percent of poverty. At the time of analysis, the WIC indicator was not available for NHANES 2011–2012. Thus, the "All Low-Income 2011–2012" group serves as a proxy for current intakes of this population.

Note on Red and Orange Vegetables: Although all data are compared to values presented in the 2015 DGAC report, the DGA in place at the time of the 2005–2008 NHANES survey (the 2005 DGA) did not include a red and orange vegetables subgroup.

SOURCES: Intake data are from NHANES 2005–2008 and 2011–2012 (USDA/ARS, 2005–2008, 2011–2012). Reference values are the USDA food patterns from the report of the 2015 Dietary Guidelines Advisory Committee (USDA/HHS, 2015).

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Appendix R

Summary of National Dataset Characteristics Applied in the Evaluation of Health Risks

TABLE R-1 Summary of National Dataset Characteristics Applied in the Evaluation of Health Risks

Database	Summary	Data Collection	Relevant Outcomes
NHANES: National Health and Nutrition Examination Survey (USDA/ARS, 2005–2008, 2011–2012)	Nationwide data collected annually from 1999–2014 20,000–50,000 individuals of all ages each cycle Sample sizes and design differ across cycles of NHANES NHANES 1999–2006 oversampled Hispanics, pregnant women, and adolescents	Household screener, an interview, and an examination Interview: person-level demographic, health, and nutrition information, information about the household Examination: physical measurements such as blood pressure, dental examination, plus blood and urine specimens for laboratory testing Dietary survey: 24-hour recalls with the USDA Automated Multiple-Pass Method	Women: Prevalence of diabetes, visual impairment, iron deficiency anemia, low serum, and RBC folate Children: Prevalence of child obesity and overweight, underweight, and iron deficiency anemia in children Dietary intake for women and children
WIC ITFPS-2 Infant Report: Intention to Breastfeed (May et al., 2015)	Longitudinal study from 1994–2013 measuring feeding practices employed by caregivers and the nutrition outcomes of children who participate in WIC Captures data on caregivers and children over the first 3 years of the child's life	Screening and enrollment interviews with WIC enrollees, telephone follow-up interviews, WIC administrative records, site visits and key informants interviews, and WIC site staff survey	Prenatal views on breastfeeding Pre-pregnancy weight status

TABLE R-1 Continued

Database	Summary	Data Collection	Relevant Outcomes
NIS: National Immunization Survey (CDC, 2015a)	Retrospective national breastfeeding data collected annually from 2001 to 2013 on children 19 to 35 months of age	List-assisted random-digit-dialing telephone survey followed by a mailed survey to children's immunization providers. Breastfeeding questions posed to mothers are retrospective	Breastfeeding initiation, duration, and exclusivity
PC 2008 and 2012: WIC Participant and Program Characteristics 2008 and 2012 (USDA/FNS, 2010, 2013)	National WIC participant data collected by FNS and published in reports every 2 years starting in 1984 Anthropometric data from NCHS Cutoff values are according to FNS-issued nutrition risk criteria	The Minimum Data Set provided by states to FNS consists of 20 items	Maternal weight status by pregnancy and breastfeeding status, prevalence of anemia, prevalence of overweight in children 2 years and older, growth outcomes, underweight in children, low birth weight, or premature birth
PNSS: Pregnancy Nutrition Surveillance System (CDC, 2011a)	WIC program data from 29 states, the District of Columbia, 3 ITOs, and 1 U.S. territory Discontinued after 2011 Data collected at the clinic level, aggregated at the state level, then submitted to CDC for analysis	Demographic data: maternal age, race and ethnicity, education level, household income, migrant status, and participation in food and medical assistance programs Women: height/weight before, during, and after pregnancy; hemoglobin and hematocrit levels; parity; medical care during pregnancy; and enrollment in WIC	Prevalence of prepregnancy overweight and obesity, maternal weight gain greater than ideal, gestational diabetes, 3rd trimester anemia, and postpartum anemia

continued

TABLE R-1 Continued

Database	Summary	Data Collection	Relevant Outcomes
PedNSS: Pediatric Nutrition Surveillance System (CDC, 2011b)	WIC program (87.5 percent) and other programs (12.5 percent) data from 46 states, the District of Columbia, Puerto Rico, the U.S. Virgin Islands, and 6 ITOs Discontinued after 2011 Data collected at the clinic level, aggregated at the state level, then submitted to CDC for analysis	Children: birthweight, anemia, breastfeeding, short stature, underweight, overweight, and obesity	Prevalence of obesity and overweight for children < 5 years and ≥ 2 years Prevalence of underweight and short stature for children < 5 years Prevalence of anemia for children 5 years Prevalence of very low birth weight, low birth weight, normal birth weight, high birth weight, preterm birth, full-term low birth weight, and multiple births
NATFAN: National Food and Nutrition Questionnaire—WIC Food Package Revisions (Texas A&M, 2013)	National multiyear, multilevel study to examine participant food and nutrition behavior before and after implementation of the revisions in the WIC food package (FY 2009, FY 2010, and early 2011)	Food choice questionnaires and frequency instruments developed specifically for WIC participants. Involved state, territorial, tribal, and local WIC programs	Data not used in this review due to convenience sampling

TABLE R-1 Continued

Database	Summary	Data Collection	Relevant Outcomes
PRAMS: Pregnancy Risk Assessment Monitoring System (CDC, 2015b)	Data from state birth certificates for 40 states, self-reported data from samples of 1,300–3,400 women per state per year, from 1988–2009	Mailed questionnaire with multiple follow-ups by mail and telephone Questions: Barriers to and content of prenatal care, obstetric history, maternal use of alcohol and cigarettes, physical abuse, contraception, economic status, maternal stress, and early infant development and health status	Prevalence of prepregnancy obesity in 2009 for women ages 20+, gestational diabetes in 2010
Ross Laboratories Mothers Survey (Ryan, 2005)	Large prospective national survey conducted by infant formula manufacturer Ross Laboratories. Nearly 1 million surveys sent annually Data collection from 1971–2003	Monthly questionnaires sent to mothers when infants reached 1 month, 2 months, and so on up to 12 months. Breastfeeding initiation measured by in-hospital rates	Breastfeeding initiation and exclusivity

NOTE: CDC = Centers for Disease Control and Prevention; FNS = Food and Nutrition Service; FY = fiscal year; ITFPS = Infant and Toddler Feeding Practices Study; ITO = Indian Tribal Organization; NCHS = National Center for Health Statistics; RBC = red blood cell.

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Appendix S

Breastfeeding Literature Findings

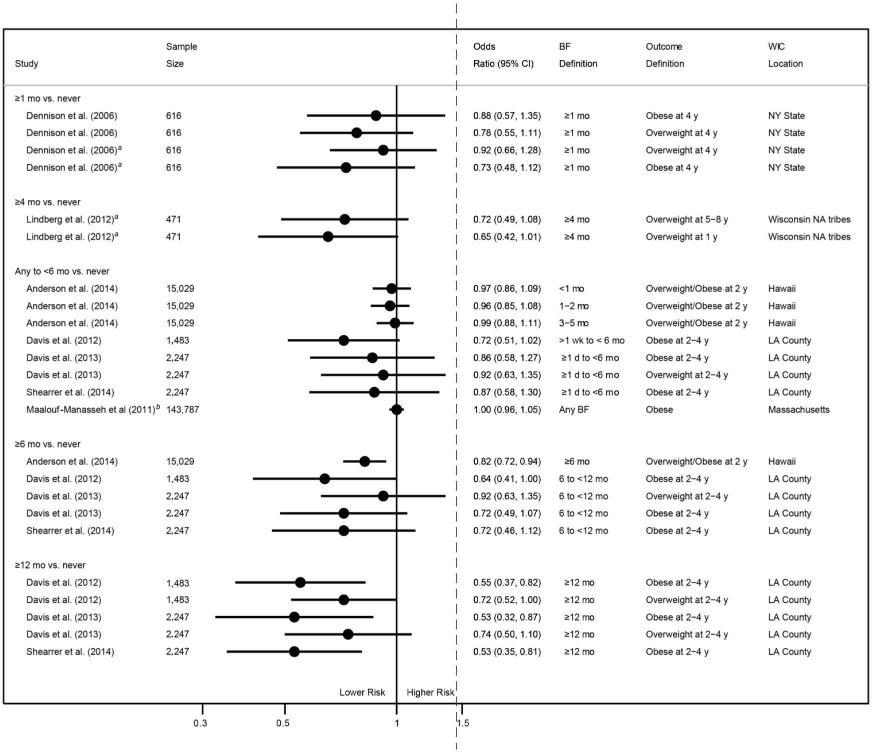

FIGURE S-1 Associations between breastfeeding duration and child overweight or obesity among WIC participants.

NOTES: BF = breastfeeding; d = days; LA = Los Angeles; mo = months; NA = Native American; NY = New York; y = years. Overweight = body mass index (BMI) for age ≥ 85 percentile based on Centers for Disease Control and Prevention (CDC) growth chart and obesity = BMI for age ≥ 95 percentile based on CDC growth chart, with one exception indicated below.

[a] Unadjusted analysis. All other analyses are adjusted.

[b] Criteria for obesity using the World Health Organization growth standards (BMI ≥ 30).

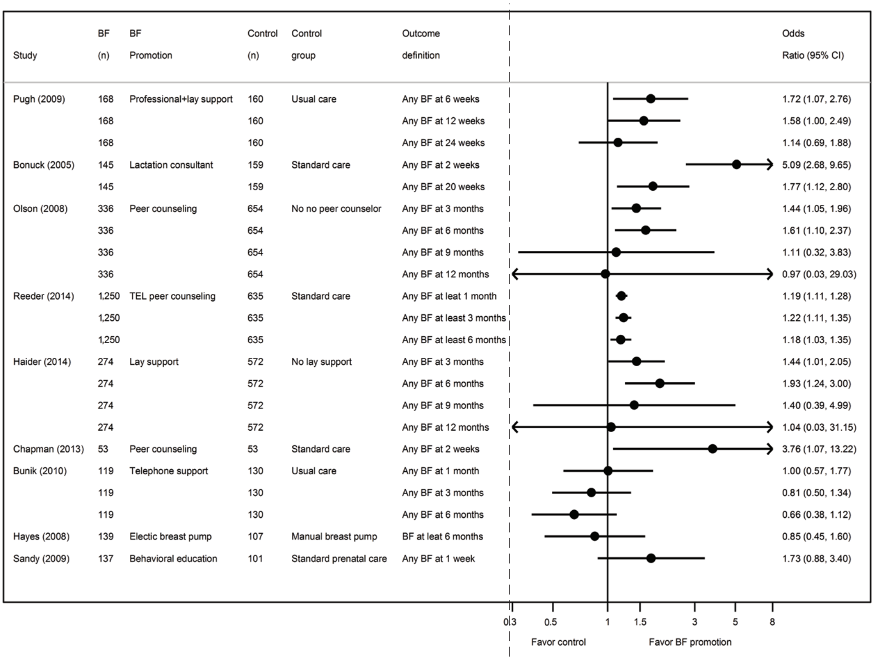

FIGURE S-2 Effects of breastfeeding promotion on breastfeeding rates.

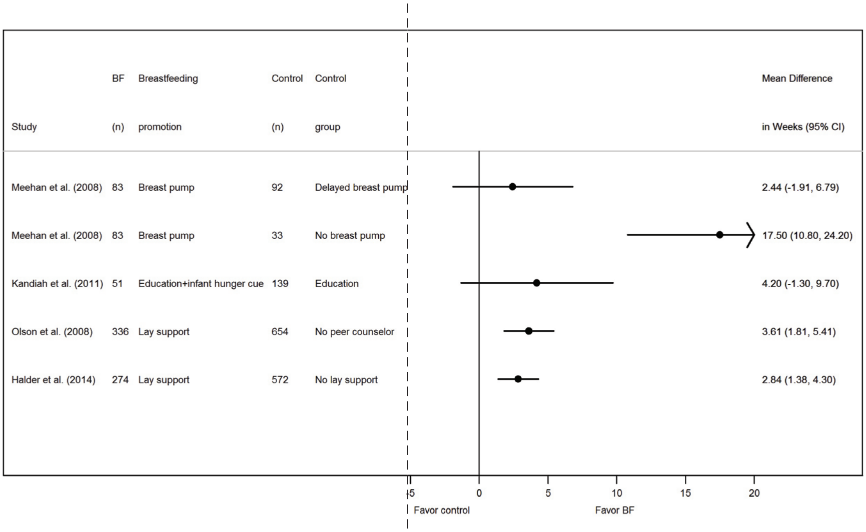

FIGURE S-3 Effects of breastfeeding promotion on breastfeeding duration.

TABLE S-1 Summary of Factors Associated with Breastfeeding Initiation, Duration, and Exclusivity Among WIC Participants

	BF Initiation	
Factor Associated with BF	Study	Association
BF beliefs/attitudes		
BF in first hour	Ma and Magnus, 2012	↑
BF in hospital	Ma and Magnus, 2012	↑
BF information in hospital	Ma et al., 2014	↔
	Ma and Magnus, 2012	↑
BF support groups	Gross et al., 2011	↑
Peer counseling	Gross et al., 2009	Reference: standard care Peer counselor: ↑↑ Lactation consultant: ↔
	Yun et al., 2010	PC has other positions in WIC: ↔ BF coordinator is BF PC task force member: ↔
Birth weight	Ma and Magnus, 2012	↔
	Gross et al., 2009	Reference: normal weight Very low: ↑↑ Low: ↓↓ Very preterm birth: ↔ Unknown birth weight: ↔
Child age		

BF Duration		BF Exclusivity	
Study	Association	Study	Association
		Wojcicki et al., 2010	Embarrassing or difficult in public ↔ Difficult if someone else feeds the child ↔ Physically painful and uncomfortable ↑↑ If friends and family do not approve of breastfeeding impacts attitudes ↔ If husband/partner does not approve of breastfeeding impacts attitudes ↔
Langellier et al., 2012	BF 6 months ↑↑ BF 12 months ↑↑ BF 24 months ↑↑	Langellier et al., 2012	Exclusive BF 6 months ↑↑ Exclusive BF 12 months ↑↑ Exclusive BF 24 months ↑↑
Haughton et al., 2010	↔		
Langellier et al., 2012	BF 6 months ↑↑ BF 12 months ↔ BF 24 months ↔	Langellier et al., 2012	Exclusive BF 6 months ↔

continued

TABLE S-1 Continued

	BF Initiation	
Factor Associated with BF	Study	Association
Child care arrangement		
Child gender	Ziol-Guest and Hernandez, 2010	Boy vs. girl ↔
Employed	Darfour-Oduro and Kim, 2014	↔
Foreign born	Ziol-Guest and Hernandez, 2010	↑↑
Formula at hospital		
Gestational diabetes mellitus	Ma et al., 2014	↔
	Jacobson et al., 2015	↔
Government assistance	Darfour-Oduro and Kim, 2014	↔
	Gross et al., 2009	Food stamps ↓
Hypertension	Jacobson et al., 2015	↔
Incentives	Murimi et al., 2010	Incentives to encourage breastfeeding ↔

BF Duration		BF Exclusivity	
Study	Association	Study	Association
Shim et al., 2012	Reference: parental care Center-based care: ⇔ Nonrelative care: ⇔ Relative care: ↑		
Ziol-Guest and Hernandez, 2010	BF 4 months boy vs. girl ⇔	Ziol-Guest and Hernandez, 2010	Boy vs. girl ⇔
Haughton et al., 2010	BF 6 months boy vs. girl ⇔ BF > 6 months boy vs. girl ⇔		
Langellier et al., 2012	BF 6 months boy vs. girl ⇔ BF 12 months boy vs. girl ⇔ BF 24 months boy vs. girl ⇔		
Darfour-Oduro and Kim, 2014	BF 3 months ⇔	Darfour-Oduro and Kim, 2014	⇔
Haughton et al., 2010	BF 6 months ⇔ BF > 6 months ⇔	Wojcicki et al., 2010	Early introduction to formula ⇔
Ziol-Guest and Hernandez, 2010	BF 4 months ↑↑	Ziol-Guest and Hernandez, 2010;	⇔
Langellier et al., 2012	BF 6 months ↑↑ BF 12 months ↑↑ BF 24 months ⇔	Langellier et al., 2012	Exclusive BF 6 months ⇔
Langellier et al., 2012	BF 6 months ⇔ BF 12 months ⇔ BF 24 months ⇔	Langellier et al., 2012	Exclusive BF 6 months ↓↓
Darfour-Oduro and Kim, 2014	BF 3 months ⇔	Darfour-Oduro and Kim, 2014	⇔

continued

TABLE S-1 Continued

	BF Initiation	
Factor Associated with BF	Study	Association
Income	Jacobson et al., 2015	Reference: annual income ≥ 25,000
		Annual income < 4,999 urban: ↑
		Annual income < 4,999 rural: ↔
		Annual income 5,000–9,999 urban: ↑
		Annual income 5,000–9,999 rural: ↔
		Annual income 10,000–14,999: ↔
		Annual income 15,000–19,999: ↔
		Annual income 20,000–24,999: ↔
Intention to BF		
Married	Ma et al., 2014	↔
	Ziol-Guest and Hernandez, 2010	↑↑
	Darfour-Oduro and Kim, 2014	↑↑
	Ma and Magnus, 2012	↑↑
Maternal age	Ma et al., 2014	↔
	Ziol-Guest and Hernandez, 2010	↔
	Jacobson et al., 2015	Reference: 30 and older
		17 and younger: ↔
		18–19: ↑↑
		20–29: ↔

BF Duration		BF Exclusivity	
Study	Association	Study	Association
		Wojcicki et al., 2010	↑
Haughton et al., 2010	BF 6 months ↔ BF > 6 months ↔	Tenfelde et al., 2011	Prenatal intention to exclusive BF ↑↑
Ziol-Guest and Hernandez, 2010	BF 4 months ↑↑	Ziol-Guest and Hernandez, 2010	↔
Darfour-Oduro and Kim, 2014	BF 3 months ↑↑	Darfour-Oduro and Kim, 2014	↔
Dodgson et al., 2007	Duration any BF ↑↑	Dodgson et al., 2007	↔
		Wojcicki et al., 2010	Early introduction to formula ↔
Ziol-Guest and Hernandez, 2010	BF 4 months ↔	Ziol-Guest and Hernandez, 2010	↑↑
		Dodgson et al., 2007	
Tenfelde et al., 2012	BF cessation: ↓↓		
Dodgson et al., 2007	Duration any BF Reference: 22–29 21 and younger: ↑↑ 30 and older: ↔	Dodgson et al., 2007	Duration of exclusive BF Reference: 22–29 21 and younger: ↔ 30 and older: ↔

continued

TABLE S-1 Continued

	BF Initiation	
Factor Associated with BF	Study	Association
	Gross et al., 2009	Reference: 35–43
		14–17: ↓↓
		18–19: ↓↓
		20–24: ↓↓
		44–53: ↑↑
Maternal weight/BMI	Gross et al., 2009	Reference: BMI 19–24.99
		BMI < 19: ↔
		BMI 25–29.99: ↓↓
		BMI 30–39.99: ↔
		BMI 40+: ↔
Mother return to work		

BF Duration		BF Exclusivity	
Study	Association	Study	Association
Haughton et al., 2010	↑↑		
Langellier et al., 2012	BF 6 months ↑↑	Langellier et al., 2012	Exclusive BF 6 months ↔
	BF 12 months ↔		
	BF 24 months ↔		
		Wojcicki et al., 2010	Early introduction to formula ↔
Haughton et al., 2010	Maternal weight ↔		
Langellier et al., 2012	BF 6 months, Reference: ≥ 7 months until work	Langellier et al., 2012	Exclusive BF 6 months, Reference: ≥ 7 months until work
	4–6 months: ↔		4–6 months: ↔
	0–3 months: ↓↓		0–3 months: ↓↓
	Not employed: ↔		Not employed: ↔
	BF 12 months:		
	4–6 months: ↔		
	0–3 months: ↓↓		
	Not employed: ↔		
	BF 24 months:		
	4–6 months: ↔		
	0–3 months: ↓↓		
	Not employed: ↔		

continued

TABLE S-1 Continued

	BF Initiation	
Factor Associated with BF	Study	Association
Number of children	Ziol-Guest and Hernandez, 2010	⇔
Postpartum health/ depression	Darfour-Oduro and Kim, 2014	⇔
Poverty	Ziol-Guest and Hernandez, 2010	Poverty ratio: ↑↑
	Gross et al., 2009	At or below poverty: ↓↓
Pregnancy intent		
Prenatal WIC enrollment duration	Yun et al., 2010	Non-PC agencies Reference: < 3 months
		3–6 months: ↑↑
		≥ 6 months: ↑↑
		PC agencies
		< 3 months: ⇔
		3–6 months: ↑↑
		≥ 6 months: ↑↑
Prenatal WIC participation		
Prepregnancy BMI		
Previous BF experience		
Race	Ma et al., 2014	Reference: Non-Hispanic black
		Non-Hispanic white: ↑↑
		Other: ↑↑
	Ziol-Guest and Hernandez, 2010	Reference: white
		Non-Hispanic black: ↓↓
		Hispanic: ⇔
		Non-Hispanic other: ↓↓

BF Duration		BF Exclusivity	
Study	Association	Study	Association
Ziol-Guest and Hernandez, 2010	BF 4 months ↔	Ziol-Guest and Hernandez, 2010	↔
Dodgson et al., 2007	Duration any BF: ↔	Dodgson et al., 2007	↔
		Wojcicki et al., 2010	↔
Darfour-Oduro and Kim, 2014	BF 3 months: ↔	Darfour-Oduro and Kim, 2014	↔
Ziol-Guest and Hernandez, 2010	PIR, BF 4 months: ↑↑	Ziol-Guest and Hernandez, 2010	PIR: ↑↑
Haughton et al., 2010	↔		
Dodgson et al., 2007	Duration any BF: ↔	Dodgson et al., 2007	↔
		Tenfelde et al., 2011	Prepregnancy overweight/obese ↓↓
Tenfelde et al., 2012	BF cessation: ↓↓		
Ziol-Guest and Hernandez, 2010	BF 4 months, Reference: white	Ziol-Guest and Hernandez, 2010	Reference: white
	Non-Hispanic black: ↓↓		Non-Hispanic black: ↓↓
	Hispanic: ↓↓		Hispanic: ↔
	Non-Hispanic other: ↓↓		Non-Hispanic other: ↓↓

continued

TABLE S-1 Continued

	BF Initiation	
Factor Associated with BF	Study	Association
	Jacobson et al., 2015	Reference: Non-Hispanic white
		Non-Hispanic black: ↓↓
		Hispanic: ↑↑
		American Indian: ↔
		Asian/Pacific Islander: ↔
	Ma and Magnus, 2012	Reference: white
		Black: ↓↓
	Gross et al., 2009	Reference: Non-Hispanic African American
		Non-Hispanic white: ↔
		Non-Hispanic other: ↑↑
		Hispanic: ↑↑
		Unknown: ↑↑
	Evans et al., 2011	African American: ↓
		White: ↑
		Hispanic: ↑

BF Duration		BF Exclusivity	
Study	Association	Study	Association
Tenfelde et al., 2012	BF cessation, Mexican: ↓↓		
Haughton et al., 2010	↔		
Langellier et al., 2012	BF 6 months ↔	Langellier et al., 2012	Exclusive BF 6 months, Reference: Hispanic
	BF 12 months ↔		Non-Hispanic white: ↑↑
	BF 24 months ↔		Non-Hisapnic black: ↔
			Other: ↔
		Wojcicki et al., 2010	Early introduction to formula
			Reference: white
			Asian/Pacific Islander: ↑↑
			Black/African American: ↔
			Latino: ↔

continued

TABLE S-1 Continued

	BF Initiation	
Factor Associated with BF	Study	Association
Region of the United States	Ziol-Guest and Hernandez, 2010	Reference: East Midwest: ↔ South: ↔ West: ↑↑
Stress factors at home	Ma and Magnus, 2012	Number of stress factors at 12 months before baby was born ↑↑
Time in the United States		
Trimester medical care began	Jacobson et al., 2015	Reference: 1st trimester 2nd trimester: ↔ 3rd trimester urban: ↓↓ 3rd trimester rural: ↔ No medical care: ↔
	Ma and Magnus, 2012	Prenatal care in 1st trimester: ↓
Trimester WIC entry	Ziol-Guest and Hernandez, 2010	Reference: No participation 1st trimester: ↓↓ 2nd trimester: ↔ 3rd trimester: ↔
	Jacobson et al., 2015	Reference: 1st trimester 2nd trimester urban: ↓↓ 2nd trimester rural: ↔ 3rd trimester urban: ↓↓ 3rd trimester rural: ↔ Postpartum urban: ↔

BF Duration		BF Exclusivity	
Study	Association	Study	Association
Ziol-Guest and Hernandez, 2010	BF 4 months, Reference: East Midwest: ↔ South: ↔ West: ↑↑	Ziol-Guest and Hernandez, 2010	Reference: East Midwest: ↔ South: ↔ West: ↑↑
Haughton et al., 2010	Years in the United States ↓↓		
Ziol-Guest and Hernandez, 2010	Reference: No participation 1st trimester: ↓↓ 2nd trimester: ↔ 3rd trimester: ↔	Ziol-Guest and Hernandez, 2010	Reference: No participation 1st trimester: ↔ 2nd trimester: ↔ 3rd trimester: ↔
		Tenfelde et al., 2011	1st trimester entry: ↑↑
Langellier et al., 2012	BF 6 months: ↔ BF 12 months: ↔ BF 24 months: ↔	Langellier et al., 2012	↔

continued

TABLE S-1 Continued

	BF Initiation	
Factor Associated with BF	Study	Association
	Metallinos-Katsaras et al., 2015	No previous live birth 1st vs. 3rd: ↑↑ 2nd vs. 3rd: ↑↑ 1st vs. 2nd: ↔ 1 or more previous live births 1st vs. 3rd: ↑↑ 2nd vs. 3rd: ↑↑ 1st vs. 2nd: ↑↑ No previous live birth Prenatal vs. postpartum: ↔ 1st trimester vs. postpartum: ↔ 1 or more previous live births Prenatal vs. postpartum: ↑↑ 1st trimester vs. postpartum: ↑↑

BF Duration		BF Exclusivity	
Study	Association	Study	Association
		Metallinos-Katsaras et al., 2015	First birth
			First vs. third:
			BF 3 months: ↔
			BF 6 months: ↔
			BF 12 months: ↔
			Second vs. third:
			BF 3 months: ↑↑
			BF 6 months: ↑↑
			BF 12 months: ↔
			First vs. second:
			BF 3 months: ↓↓
			BF 6 months: ↔
			BF 12 months: ↑↑
			Prenatal vs. postpartum
			BF 3 months: ↑↑
			BF 6 months: ↑↑
			BF 12 months: ↑↑
			Subsequent birth
			First vs. third:
			BF 3 months: ↑↑
			BF 6 months: ↑↑
			BF 12 months: ↑↑
			Second vs. third:
			BF 3 months: ↑↑
			BF 6 months: ↑↑
			BF 12 months: ↑↑
			First vs. second:
			BF 3 months: ↔
			BF 6 months: ↔
			BF 12 months: ↑↑

continued

TABLE S-1 Continued

	BF Initiation	
Factor Associated with BF	Study	Association
	Joyce et al., 2008	1st vs. 3rd: ↑↑ 1st vs. 2nd: ↑↑

NOTES: BF = breastfeeding; BMI = body mass index; PC = peer counselor; PIR = poverty-to-income ratio. ↑↑ Factor was significantly associated with higher BF initiation, longer duration (continuous or categorical outcomes), or exclusivity in adjusted analysis; ↑ Factor was significantly associated with higher BF initiation, longer duration (continuous or categorical outcomes), or exclusivity in unadjusted/crude analysis; ↔ no significant association; ↓ Factor was significantly associated with lower BF initiation, shorter duration (continuous or categorical outcomes), or shorter exclusivity in unadjusted/crude analysis; ↓↓ Factor was significantly associated with lower BF initiation, longer duration (continuous or categorical outcomes), or exclusivity in unadjusted/crude analysis; data excluded in summary if no significance tests were performed.

BF Duration		BF Exclusivity	
Study	Association	Study	Association
			Prenatal vs. post-partum
			BF 3 months: ↑↑
			BF 6 months: ↑↑
			BF 12 months: ↑↑

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Appendix T

Chronology of Statutes Pertaining to the Definition of WIC Supplemental Foods

September 26, 1972: Public Law No. 92-433. The term "supplemental foods" is defined in the original Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) statute, Child Nutrition Act, as amended.

> § 17(f)(3): "Supplemental foods" shall mean those foods containing nutrients known to be lacking in the diets of populations at nutritional risks and, in particular, those foods and food products, containing high-quality protein, iron, calcium, vitamin A, and vitamin C. Such term may also include (at the discretion of the Secretary) any food product commercially formulated preparation specifically designed for infants.

July 11, 1973: In what appears to be the first WIC rule (*Fed Reg* p. 18447):

> § 246.2(v): "Supplemental food" means any food authorized to be made available under the WIC program.

October 7, 1975: Public Law No. 94-105. Child Nutrition Act § 17(f)(3) is amended to include a new, final sentence:

> The contents of the food package shall be made available in such a manner as to provide flexibility, taking into account medical and nutritional objectives and cultural eating patterns.

January 12, 1976: Interim "Revision, Reorganization, and Republication" (*Fed Reg* p. 1743) reads:

> § 246.2(t): "Supplemental foods" means the foods authorized by FNS in this part to be made available under the WIC program.

January 9, 1979: Proposed Rule, to comply with section 3 of Public Law No. 95-627 § 3 (beginning *Fed Reg* p. 2114) deletes the definition of supplemental foods (no explanation is provided for this change):

> § 246.2 (no "letter" designation): "Supplemental foods" [Reserved].

July 27, 1979: Final Rule, to comply with Public Law No. 95-627 § 3 (beginning *Fed Reg* p. 44422):

> § 246.2 (no "letter" designation): "Supplemental foods" [Reserved].

July 8, 1983: Proposed Rule (beginning on *Fed Reg* p. 31502) issued to "reduce the regulatory burden on State and local agencies." It states:

> A definition of "supplemental foods" was reserved in the 1979 regulations because of the pending issuance of the proposed food package regulations. A definition consistent with the legislative definition and past regulatory definitions is proposed in this rulemaking.
>
> § 246.2 (no "letter" designation): "Supplemental foods" means those foods containing nutrients determined to be beneficial for pregnant, breastfeeding, and postpartum women, infants, and children, as prescribed by the Secretary in section 246.10.

November 10, 1989: Public Law No. 101-147. Child Nutrition and WIC Reauthorization Act of 1989 continues the statutory emphasis on providing nutrients for which WIC participants are most vulnerable to deficiencies and adds concern regarding nutrient density and how to effectively provide the priority nutrients.

June 30, 2004: Public Law No. 108-265. Child Nutrition and WIC Reauthorization Act of 2004 continues the statutory emphasis on nutrients that are lacking. It also adds language about foods to the definition, still at (b)(14), and adds material to (f)(11) without altering the sentences inserted in 1978. The new (b)(14) reads:

> (b)(14): "Supplemental foods" means those foods containing nutrients determined by nutritional research to be lacking in the diets of pregnant, breastfeeding, and postpartum women, infants, and children, and those foods that promote the health of the population served by the

program authorized by this section, as indicated by relevant nutrition science, public health concerns, and cultural eating patterns, as prescribed by the Secretary. State agencies may, with the approval of the Secretary, substitute different foods providing the nutritional equivalent of foods prescribed by the Secretary, to allow for different cultural eating patterns.

Child Nutrition Act § 17, includes the following relevant provisions in a paragraph primarily addressing state operations:

"(f)(11) SUPPLEMENTAL FOODS—

(A) IN GENERAL—The Secretary shall prescribe by regulation the supplemental foods to be made available in the program under this section.

(B) APPROPRIATE CONTENT—To the degree possible, the Secretary shall assure that the fat, sugar, and salt content of the prescribed foods is appropriate."

TABLE T-1 2015 DGAC Food Groups, Definitions, and Example Foods

Food Group	Definition and Unit	Examples of 1 Serving Equivalent*
Fruits	Total intact fruits (whole or cut) and fruit juices (c-eq)	1 c raw or cooked fruit; 1 c fruit juice
Vegetables	Total dark green, red and orange, starchy, and other vegetables; excludes legumes (c-eq)	1 c raw or cooked vegetables
Dark green vegetables	Dark green vegetables (c-eq)	1 c raw or cooked dark green vegetables
Red/Orange vegetables	Total red and orange vegetables (tomatoes and tomato products + other red and orange vegetables) (c-eq)	1 c raw or cooked red/orange vegetables
Dry beans and peas	Beans and peas (legumes) computed as vegetables (c-eq)	175 g cooked beans; 175 g cooked peas
Starchy vegetables	Total starchy vegetables (white potatoes + other starchy vegetables) (c-eq)	155 g boiled or canned potatoes; 245 g cooked, frozen, or canned pumpkin
Other vegetables	Other vegetables not in the vegetable components listed above (c-eq)	100 g raw cauliflower; 80 g raw eggplant
Grains	Total whole and refined grains (oz-eq)	1/2 c cooked rice, pasta; 1 slice bread
Whole grains	Grains defined as whole grains and contain the entire grain kernel—the bran, germ, and endosperm (oz-eq)	1/2 c cooked whole grain rice, pasta; 1 slice whole grain bread
Protein foods	Total meat, poultry, organ meat, cured meat, seafood, eggs, soy, and nuts and seeds; excludes legumes (oz-eq)	1 egg
Meat, poultry, eggs	Total meat, poultry, organ meat, and cured meat (oz-eq)	28.35 g cooked, lean meat or poultry
Seafood	Seafood (finfish, shellfish, and other seafood) (oz-eq)	28.35 g cooked fish or shellfish
Nuts, seeds, soy	Peanuts, tree nuts, and seeds; excludes coconut; soy products, excluding calcium-fortified soy milk (soy milk), and mature soybeans (oz-eq)	1/2 oz nuts; 1/2 oz seeds; 1 Tbsp peanut butter; 1/4 c roasted soybeans
Dairy	Total milk, yogurt, cheese, and whey. For some foods, the total dairy values could be higher than the sum of D_MILK, D_YOGURT, and D_CHEESE because the Miscellaneous Dairy component composed of whey is not included in FPED as a separate variable (c-eq)	1 c milk; 1–2 oz cheese

TABLE T-1 Continued

Food Group	Definition and Unit	Examples of 1 Serving Equivalent*
Oils	Fats naturally present in nuts, seeds, and seafood; unhydrogenated vegetable oils, except palm oil, palm kernel oil, and coconut oil; fat present in avocado and olives above the allowable amount; 50 percent of fat present in stick and tub margarines and margarine spreads (grams)	1.5 g per 100 g in olives and avocados; 100 g per 100 g in vegetable oil; 60 g per 100 g in tub margarine
Solid fats	Fats naturally present in meat, poultry, eggs, and dairy (lard, tallow, and butter); fully or partially hydrogenated oils; shortening; palm, palm kernel, and coconut oils; fats naturally present in coconut meat and cocoa butter; and 50 percent of fat present in stick and tub margarines and margarine spreads (grams)	100 g per 100 g in coconut or palm oil; 81.1 g of 100 g in butter
Added sugars	Foods defined as added sugars: honey, corn syrup, white sugar, brown sugar, fructose (tsp-eq)	1 tsp-eq of added sugars = 4 g of added sugars such as honey, corn syrup

NOTES: c-eq = cup equivalents; DGAC = Dietary Guidelines Advisory Committee; FPED = Food Patterns Equivalent Database; oz-eq = ounce equivalents; Tbsp = tablespoon; tsp-eq = tsp equivalents.
* As indicated in the Food Patterns Serving Equivalent Database documentation (USDA/ARS, 2014).
SOURCES: USDA/HHS, 2015; serving sizes from USDA/ARS, 2014.

TABLE T-2 Food Package Modifications Suggested by Public Comment: Selected Themes

Proposed Modification	Rationale Provided
CVV:	
Mandate that states offer both fresh and some form of processed fruit and vegetable in the CVV	There is no nutritional loss in other forms Would reduce confusion for participants with family members whose CVV does allow the purchase of other forms Longer shelf life
Milk:	
Allow purchase of 2% or whole milk	Literature shows no difference between 1% and 2% milk in childhood weight gain
Reduce the amount of milk alternatives and increase the CVV or cheese/yogurt	WIC gives too much milk; if more than one family member on WIC, gallons of milk would not fit standard refrigerator
Allow almond, rice, or coconut milk to accommodate allergies	Some participants have both milk and soy allergies
Whole grains:	
Offer more whole grain options (e.g., whole grain pasta, rolls)	Increase flexibility
Increase whole grain bread sizes to 24–26 ounces per month	Difficult to find certain sizes; would likely be cost neutral as stores charge the same for 16 ounce versus 26 ounce loaves
Include enriched pasta. Permit flexibility of whole grain pasta package sizes up to 16 ounces	Increase flexibility
Canned fish:	
Offer pregnant women canned seafood	DGA recommends more fish
Add canned wild Alaskan salmon	Comments regarding nutritional value and supporting local economy in Alaska
Offer tuna as an option for children	
Cereal:	
Increase options for hot cereals (e.g. single packages)	Participants would like more options
Decrease amount of cereal/number of sugary cereals	Highly processed increases blood sugar levels
Yogurt:	
Allow all fat levels of yogurt for all participants	Concerns that the restriction for only whole milk yogurt for 1-year-olds is challenging at the retail levels (limited yogurt availability in some stores; yogurt not labelled as whole milk)
Reduce the allowed sugar content of yogurt to align with DGA	Specification of < 40 grams of total sugar is too generous given that many popular yogurts contain lower levels. Manufacturers are working to lower sugar contents

TABLE T-2 Continued

Proposed Modification	Rationale Provided
Cheese:	
Allow cheese for pregnant and postpartum women	Cheese can be tolerated better than milk for lactose intolerant
Peanut Butter/Legumes:	
Make canned beans an option	"If participants can get peanut butter with added sugar and salt, canned beans should be an option."
Decrease amount of peanut butter, consider limiting additives allowed for peanut butters including hydrogenated oils and sweeteners added as "seasoning," allow natural nut butters	Packages have too much peanut butter (1 comment) Many participants with peanut allergy
Eggs:	
Increase egg allowance	Eggs are an important protein source for growing toddlers and pregnant moms Cholesterol is important for central nervous system development
Juice:	
Increase CVV and remove or reduce juice Allow partial or full replacement of the juice benefit with CVV	Participants ask for more fruits and vegetables in place of juice Minimal nutrition Dental dangers Mixed message of juice being a health food since provided by WIC Request by recipients Referred to as liquid candy
Infant foods:	
Offer additional forms of fruits/vegetables with infant CVV	Would reduce confusion among participants and allows more shelf-stable fruits/vegetables for families in rural areas
Add meat for formula-fed infants; do not add meat	Majority of families do not choose infant meats
Flexibility for infants 6–12 months to use fresh fruits and vegetables instead of jarred foods	Families can make their own baby foods
Reduce the amount of baby foods to exclusively breastfed infants	Excessive amounts of baby foods increase risk of abuse
Consider additional complementary foods for infants age 9–11 months as they are transitioning to soft table foods such as regular breakfast cereal	Infant cereal and infant fruits and vegetables provided by WIC are inappropriate texture for this age group

continued

TABLE T-2 Continued

Proposed Modification	Rationale Provided
Special diets and other:	
Expand substitutions for food allergies and vegetarians	Currently no vegan WIC substitutions for egg and fish categories. DGA recommends increased consumption of plant foods.
Offer vegan substitutions in the eggs/fish categories	Vegetarians might be at risk for protein, iron, vitamin B12, zinc, calcium, and vitamin D deficiencies
Continue to allow organic foods and Farmers' Market Nutrition Program benefits	Organic foods are perceived by some participants to be of improved safety or nutritional quality compared to conventionally produced foods
Expand organic food options at the state level	
Administration:	
Consider a flexible range of package sizes that allow practical and cost-effective implementation	16-ounce size of bread and 16-ounce whole wheat pasta are difficult to obtain, vegetable juices not available in 48 ounce sizes
Consider practical application of recommendations	Often difficult for staff to explain allowable items and difficult for participants to find items at store
Incentivize breastfeeding by increasing the dollar amount of CVV for fully breastfeeding women above postpartum, pregnant, and partially breastfeeding	
Support breastfeeding through prenatal education, not food package incentives	
Allow option for frozen foods	
Round to next dollar amount instead of rounding down; allow flexibility to go above the maximum benefit when state funds allow	
Provide CVVs instead of specific foods for all food groups	Simplify shopping experience, eliminate need for cost containment (participants will be elastic consumers), reduce vendor fraud
Revisit cost containment of formula	Rebate model is unsustainable and some argue it violates the World Health Organization code
Do not place the 67 kcal per 100 mL minimum energy requirement on standard infant formula but allow for the regulatory range of 63 to 71 kcal per 100 mL	Increasing range of childhood obesity. The best estimates for the energy content of breastmilk is in a somewhat lower range than earlier studies, between 62–63 and 65–71 kcal per mL. Current recommendation is at odds with AAP and European guidelines
Redefine "fully breastfeed"	Definition of "fully breastfed" is not helpful

TABLE T-2 Continued

NOTES: AAP = American Academy of Pediatrics; CVV = cash value voucher; DGA = *Dietary Guidelines for Americans*. This table summarizes only the public comments relevant to the task, or very commonly submitted. All public comments are accessible through the National Academies Public Access File. Email: paro@nas.edu.

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Appendix U

Committee Biosketches

Kathleen M. Rasmussen, Sc.D., R.D. (*Chair*), is the Nancy Schlegel Meinig Professor of Maternal and Child Nutrition, Division of Nutritional Sciences, at Cornell University. Dr. Rasmussen is internationally known for her research on maternal and child nutrition, particularly in the areas of pregnancy and lactation. She has served as program director for Cornell's National Institutes of Health (NIH)-sponsored training grant in maternal and child nutrition since 1986 and has also directed a training grant in international maternal and child nutrition. Dr. Rasmussen has taught a nationally recognized course in maternal and child nutrition for graduate students since 1980 and has taught a unique course on public health nutrition for undergraduate students since 1998. As part of her commitment to mentoring future leaders in nutrition, Dr. Rasmussen serves as the principal faculty member at the Dannon Nutrition Leadership Institute, which she helped to develop in 1998. She has received the Excellence in Nutrition Education Award and also the Mentorship Award from the American Society for Nutrition. The American Public Health Association honored her for her research accomplishments with its Agnes Higgins Award in 2012. Dr. Rasmussen has served as president of the American Society of Nutritional Sciences and also as president of the International Society for Research on Human Milk and Lactation. She has been associate dean and secretary of the university faculty and served a 4-year term on Cornell's Board of Trustees as one of its faculty-elected members. Dr. Rasmussen has been a member of several expert committees at the Institute of Medicine, including the Committee on Scientific Evaluation of WIC Nutrition Risk Criteria. Recently, she served as the chair of the Committee on Reexamination of Institute of Medicine Pregnancy Weight Guidelines and then as chair of a committee to disseminate these new guidelines. She received her A.B. degree from Brown University in molecular biology and both her Sc.M. and Sc.D. degrees from Harvard University in nutrition.

Shannon E. Whaley, Ph.D. (*Vice Chair*), is the director of Research and Evaluation for Public Health Foundation Enterprises WIC Program (PHFE WIC), the largest local agency WIC program in the nation. In her 16 years of experience on the front lines of WIC, Dr. Whaley has become an expert in understanding both how the program functions and how it can be maximally effective in achieving positive health outcomes for the families WIC serves. Dr. Whaley's expertise is in the planning, development, and evaluation of programs designed to optimize the healthy development of children and families served by WIC. Her work spans a broad range of topics including childhood nutrition and obesity, prevention of prenatal alcohol use, promotion of early literacy for low-income children, and examination of the impact of the recent WIC food package change on WIC participants. Dr. Whaley's work includes controlled research studies as well as implementation of community-based interventions using evidence-based practices. In her role at PHFE WIC, Dr. Whaley has been successful in supporting her work with public and private grants that support research endeavors as well as enhance core WIC services. She supervises graduate students from local universities and has mentored a postdoctoral researcher who recently moved on to a full-time academic position. Dr. Whaley also serves as chair of the Evaluation Committee of the National WIC Association and in this role works closely with other WIC programs to advance the national WIC research agenda. Dr. Whaley received her undergraduate degree in psychology from Pomona College, and her Ph.D. in developmental psychology from the University of California, Los Angeles.

Susan S. Baker, M.D., Ph.D., is professor, Department of Pediatrics, professor and co-chief, Digestive Diseases and Nutrition Center, University of Buffalo School of Medicine. She also serves as the laboratory director for the Gastroenterology Laboratory at Women and Children's Hospital of Buffalo. Dr. Baker is the program director for the Pediatric Gastrointestinal Fellowship program. Her research focus is on liver (hepatology), nutrition, pediatric gastroenterology, and pediatrics. Dr. Baker worked in Africa and established two new programs in gastroenterology and nutrition at the University of Massachusetts Medical Center and the Medical University of South Carolina before moving to Buffalo. She has published many peer-reviewed articles, chapters, and reviews, as well as having edited four medical textbooks and one nonmedical book. Dr. Baker is recognized as a leader in the field, having served as the chairperson of the American Academy of

Pediatrics Committee on Nutrition, the chairperson of the American Board of Pediatrics, subboard of Gastroenterology, and numerous other national and international advisory groups, including the National Academies of Sciences, Engineering, and Medicine, U.S. Department of Agriculture, and the U.S. Food and Drug Administration representative to the CODEX expert committee on infant formula. Dr. Baker received her M.D. from Temple University School of Medicine and her Ph.D. from Massachusetts Institute of Technology.

Marianne P. Bitler, Ph.D., is professor of economics in the Department of Economics at the University of California (UC), Davis, and a faculty research associate at the National Bureau of Economic Research, in the programs on children and health economics. Dr. Bitler is also a visiting scholar at the San Francisco Federal Reserve Bank and a research fellow at the Institute for the Study of Labor in Bonn, Germany. Previously, she was a professor of economics at UC Irvine, a postdoctoral fellow and then an economist at the RAND Corporation, a research fellow at the Public Policy Institute of California, and an economist on the Board of Governors of the Federal Reserve in the Division of Research and Statistics (where she worked on the Survey of Small Business Finances). Her research interests include labor economics, health economics, public economics, and applied microeconomics. Her publications include several on participation in and effects of the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) program, which appeared in the *Journal of Human Resources*, the *Review of Agricultural Economics*, and the *Journal of Policy Analysis and Management*. Dr. Bitler has a B.S. degree in mathematics from the Pennsylvania State University and a Ph.D. in economics from the Massachusetts Institute of Technology.

Patsy M. Brannon, Ph.D., R.D., is professor, Division of Nutritional Sciences, Cornell University, where she has also served as dean of the College of Human Ecology. Prior to moving to Cornell University, Dr. Brannon was chair, Department of Nutrition and Food Science, University of Maryland. She has also served as visiting professor, Office of Dietary Supplements, National Institutes of Health (NIH). Her research focus includes nutritional and metabolic regulation of gene expression, especially as relating to human development, the placenta, and exocrine pancreas. She was a member of the Committee to Review Dietary Reference Intakes for Vitamin D and Calcium, and she is currently a member of the Food and Nutrition Board. Dr. Brannon is a member of a number of professional and scientific associations and has served on the Executive Board of the American Society for Nutrition. She has received numerous awards, including the Pew Faculty Scholar in Nutrition award as well as the Centennial Laureate award from Florida State University. Dr. Brannon received her Ph.D. from Cornell University in nutritional biochemistry.

Alicia L. Carriquiry, Ph.D., M.Sc., is a distinguished professor of liberal arts and sciences and professor of statistics at Iowa State University. Dr. Carriquiry research interests include Bayesian statistics and general methods. Her recent work focuses on nutrition and dietary assessment, as well as on problems in genomics, forensic sciences, and traffic safety. Dr. Carriquiry is an elected member of the International Statistical Institute and a fellow of the American Statistical Association and of the Institute of Mathematical Statistics. She has served on the executive committees of the Institute of Mathematical Statistics, the American Statistical Association, and the International Society for Bayesian Analysis, and she has served on the Council of the International Statistical Institute. She has served on several committees of the National Academies of Sciences, Engineering, and Medicine. Dr. Carriquiry received an M.Sc. in animal science from the University of Illinois, and an M.Sc. in statistics and a Ph.D. in statistics and animal science from Iowa State University.

David E. Davis, Ph.D., is an associate professor in the Department of Economics at South Dakota State University. Dr. Davis studies industrial organization, currently focusing on the effects of food assistance programs on market interactions. Dr. Davis previously held a position with the Economic Research Service of the U.S. Department of Agriculture, where he studied food markets. He has researched WIC and infant formula markets, and analyzed the effects of WIC cost-containment practices for creating interstate variation in WIC food package costs. He has expertise in empirical microeconometrics: applications of panel data methods to empirical investigations of industrial organization and market power. Dr. Davis received his Ph.D. from the University of Oregon in economics.

Mary Kay Fox, M.Ed., is senior fellow and area leader for nutrition policy research at Mathematica Policy Research. Ms. Fox has more than 25 years of research experience with child nutrition and food assistance programs. She has conducted research on the adequacy and quality of diets consumed by children, from birth through adolescence, and has examined the contributions of school- and childcare-based meal programs to children's dietary intakes and obesity risk. She was a co-principal investigator on the 2002 and 2008 Feeding Infants and Toddler Studies, which examined feeding practices and food and nutrient intakes among infants, toddlers, and preschoolers from birth to 48 months of age. Ms. Fox conducted a comprehensive review of research literature on the impacts of the WIC program on health- and nutrition-related outcomes. She is currently directing the Food and Nutrition Service WIC-Medicaid II study, which is updating the landmark WIC-Medicaid study conducted in the early 1990s. Ms. Fox served on the IOM Committee to Review Child and Adult Care Food Program Meal Requirements, as well as the Committee on Nutrition Standards for the National School Lunch and Breakfast Programs, and the Committee on the Consequences of Sodium Reduction in Populations. Ms. Fox has a M.Ed. in nutrition from Tufts University.

Tamera J. Hatfield, M.D., Ph.D., is a board certified obstetrician-gynecologist specializing in maternal-fetal medicine at the University of California (UC), Irvine. She treats high-risk pregnancy patients and has a particular interest in managing maternal conditions that complicate pregnancy. Dr. Hatfield's research interests include using magnetic resonance imaging (MRI) to evaluate brain injury as it relates to perinatal risk factors, weight gain during pregnancy among obese patients, and preeclampsia. She is involved with teaching residents, fellows, and medical students and previously served on the Council on Resident Education in Obstetrics and Gynecology. Dr. Hatfield received her M.D. from UC Irvine, where she also completed a residency in obstetrics and gynecology and a fellowship in maternal-fetal medicine. In addition, she holds a Ph.D. in Behavioral Neuroscience from the University of North Carolina at Chapel Hill. She is a member of the Society for Maternal-Fetal Medicine and the American College of Obstetricians and Gynecologists.

Helen H. Jensen, Ph.D., is professor of economics and leads a research group focused on food and nutrition programs in the Center for Agricultural and Rural Development at Iowa State University, an internationally recognized research center that addresses issues of the food, agricultural, and natural resource sectors. Her research interests include the design of food and nutrition programs and policies, assessment of nutritional enhancement of foods, food demand and markets, linkages between agricultural policies and nutrition, and food-safety regulations. She has led projects that analyze food demand, and that involve dietary, nutritional, and health assessment as well as the design and implementation food consumption surveys in the United States as well as in several developing countries. Dr. Jensen was elected Fellow of the Agricultural and Applied Economics Association (AAEA) in 2012 and recently completed a term on the Executive Board of Directors of the Agricultural and Applied Economics Association. She has served on several committees of the National Academies of Sciences, Engineering, and Medicine, including the recent IOM Committee on Child and Adult Care Food Program Meal, and the National Research Council (NRC) and IOM Committee on Risk-Characterization for Decision-Making at the U.S. Food and Drug Administration. She chaired the IOM and NRC's True Cost of

Food Workshop planning committee and is a member of the Food Forum. Dr. Jensen holds a Ph.D. in agricultural economics from the University of Wisconsin.

Rachel K. Johnson, Ph.D., M.P.H., R.D., is the Robert L. Bickford, Jr., Professor of Nutrition and Professor of Medicine at the University of Vermont. Dr. Johnson served as dean of the College of Agriculture and Life Sciences at the University of Vermont from 2001 to 2008 and as associate provost for Faculty Affairs from 2009 to 2011. Dr. Johnson's research expertise covers pediatric nutrition and obesity, dietary intake methodology, diet and cardiovascular disease, and national nutrition policy. She was appointed to the Year 2000 Dietary Guidelines Advisory Committee. She served on the Panel on Dietary Reference Intakes (DRIs) for the macronutrients for the IOM. Dr. Johnson served on the President's Council on Fitness, Sports and Nutrition Science Board from 2011 to 2014 and was chair of the American Heart Association Nutrition Committee from 2012 to 2014. Dr. Johnson holds a Ph.D. in nutrition from the Pennsylvania State University, an M.P.H. from the University of Hawaii, and is a registered dietitian.

Angela Odoms-Young, Ph.D., is assistant professor in the Department of Kinesiology and Nutrition at the University of Illinois at Chicago (UIC) College of Applied Health Sciences and an Institute of Health Research and Policy Fellow. Dr. Odoms-Young's research is focused on understanding social, cultural, and environmental determinants of dietary behaviors and diet-related diseases in low-income and minority populations. Her current projects include studies to evaluate the impact of the new WIC food package on dietary intake, weight status, and chronic disease risk in 2- to 3-year-old low-income children and vendor participation; identify strategies to improve program participation and retention among WIC-eligible children; evaluate the efficacy of a community-based participatory weight loss intervention in African American women; and examine community engagement approaches to promote food justice. Prior to joining UIC, Dr. Odoms-Young served on the faculty of Northern Illinois University in Public Health and Health Education. She completed a Family Research Consortium Postdoctoral Fellowship examining family processes in diverse populations at the Pennsylvania State University and the University of Illinois at Urbana-Champaign and a Community Health Scholars Fellowship in community-based participatory research at the University of Michigan School of Public Health. She received her M.S. in human nutrition and her Ph.D. in community nutrition from Cornell University.

Rafael Pérez-Escamilla, Ph.D., is professor of Epidemiology and Public Health, and director of the Global Health Concentration and the Office of Public Health Practice at the Yale School of Public Health. His public health nutrition and food security research has led to improvements in breastfeeding protection, promotion and support programs and prevention of iron deficiency anemia among infants, as well as improvements in household food insecurity measurement and community nutrition programs worldwide. His health disparities research focuses on the impact of community health workers on improving behavioral and metabolic outcomes among Latinos with type 2 diabetes. He is a member of the National Academies of Sciences, Engineering, and Medicine Food and Nutrition Board, and he served on the 2010 and 2015 Dietary Guidelines Advisory Committees. He chaired the IOM Planning Workshop Committee Updating the USDA National Breastfeeding Campaign and served on the Committee to Reexamine the IOM Pregnancy Weight Guidelines. He is past chair of the American Society for Nutrition's Global Nutrition Council and president of the International Society for Research in Human Milk and Lactation (ISRHML). He has served on the editorial boards of the *Journal of Nutrition*, the *Journal of Human Lactation*, *Global Food Security*, and the *Journal of Hunger and Environmental Nutrition*. He received a B.S. in chemical engineering from the Universidad Iberoamericana in Mexico City, an M.S. in food science, and a Ph.D. in nutrition from the University of California, Davis.

A. Catharine Ross, Ph.D., is professor and occupant of the Dorothy Foehr Huck Chair of Nutrition in the Department of Nutritional Sciences at Pennsylvania State University. As a nutritional biochemist, Dr. Ross has studied cellular factors involved in the biosynthesis and transport of vitamin A molecules. Her focus has been on the cellular basis of vitamin A homeostasis. She also investigates the role of retinoids in immune function, principally antibody production, and in neonatal lung development. She served as editor-in-chief of the *Journal of Nutrition* from 2004 to 2013. Dr. Ross has received numerous awards, including the Mead-Johnson Award and the Osborne and Mendel Award from the American Society for Nutrition. She is active within a range of professional societies, including the American Association of Immunologists, Sigma Xi, and the American Physiological Society, and has served on a number of committees for the American Society for Nutrition and the Federation of the American Societies for Experimental Biology. Dr. Ross is a Fellow of the American Association for the Advancement of Science and a member of the National Academy of Sciences. She chaired the Committee to Review Dietary Reference Intakes for Vitamin D and Calcium and is a member of the Food and Nutrition Board. Dr. Ross received her Ph.D. from Cornell University in biochemistry and molecular and cell biology.

Charlene Russell-Tucker, M.S.M., R.D., is the chief operating officer (COO) for the Connecticut State Department of Education. As COO, Ms. Russell-Tucker leads priority project management functions to help improve the planning, efficiency, service, and delivery effectiveness of the department's programs and services. In addition to broad agency efforts, she directly provides leadership and oversight to the department's Office of Student Supports and Organizational Effectiveness. Her prior position was associate commissioner for the Connecticut State Department of Education. In this role, Ms. Russell-Tucker was responsible for the administration of the Division of Family and Student Support Services, which comprises three bureaus: the Bureau of Choice Programs; the Bureau of Health/Nutrition, Family Services, and Adult Education; and the Bureau of Special Education. She provides leadership and support in developing and implementing effective family and student support programs and services to assist schools and other educational partners in improving student performance. Prior to her appointment as associate commissioner, Ms. Russell-Tucker was chief of the Bureau of Health and Nutrition Services and Child/Family/School Partnerships at the Connecticut State Department of Education. The bureau was strategically positioned within the department to support the social, emotional, physical, and mental health of students and families in order to achieve success in school and in life. Its initiatives and services include school-family-community partnerships, child nutrition programs, school health promotion/mental health services/school nurses, nutrition education, safe and drug-free schools program, 21st century community learning centers/after-school programs, family resource centers, young parents program, and education of homeless children and youth. Ms. Russell-Tucker is past president of the Connecticut Dietetic Association and the Child and Adult Care Food Program National Professional Association. She is also an adjunct faculty member at a local college where she teaches business management courses in the program for nontraditional students. She received her M.S. in management from Albertus Magnus College in New Haven, Connecticut, and is a registered dietitian.