Proposed Criteria for Selecting the WIC Food Packages

A Preliminary Report of the Committee to Review the WIC Food Packages
Food and Nutrition Board

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This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the NRC's Report Review Committee. 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:

Steven A. Abrams, Baylor College of Medicine and Texas Children's Hospital; Lindsay H. Allen, University of California—Davis; Susan S. Baker, Children's Hospital of Buffalo; George H. Beaton, Professor Emeritus, University of Toronto; Mary Kay Fox, Independent Nutrition Consultant, Reading, MA; Philip M. Gleason, Mathematica Policy Research, Inc., Geneva, NY; Geraldine Henchy, Food Research and Action Center, Washington, DC; Anne Looker, National Center for Health Statistics, Centers for Disease Control and Prevention; Edward R. B. McCabe, Mattel Children's Hospital and David Geffen School of Medicine, University of California—Los Angeles; Roy M. Pitkin, Professor Emeritus, University of California—Los Angeles; Kathleen M. Rasmussen, Cornell University.

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 Johanna T. Dwyer, Tufts-New England Medical Center and Office of Dietary Supplements at the National Institutes of Health. Appointed by the National Research Council and the Institute of Medicine, she was 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.

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Executive Summary

INTRODUCTION AND BACKGROUND

Started in 1974, the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) was designed to meet the special nutritional needs of low-income pregnant, breastfeeding, or postpartum women; infants; and children up to 5 years of age who have at least one nutritional risk factor. The WIC Program provides three main benefits: supplemental foods, nutrition education, and referrals to health and social services. WIC food packages provide supplemental foods but the proportion of the total diet that is supplied through the package varies by participant category (see Chapter 1). The food is generally provided through food vouchers or checks that can be exchanged for specific foods at participating grocery outlets.

Since the inception of the WIC program around 1974, substantial changes have occurred that make it important to review the WIC food packages.

- *Changes have occurred in the WIC population*. The size and scope of the WIC Program have changed. The WIC program has grown substantially and the WIC participants are a very culturally diverse population.
- *Changes have occurred in the food supply and in dietary patterns*. Since 1990 the number of food products in U.S. retail grocery stores has increased by approximately 60 percent. Women's intake of carbonated soft drinks has more than doubled since 1977-1978.
- *Changes have occurred in health concerns.* Obesity has emerged as a major public health concern in both the general population and the population subgroups that participate in the WIC program. At the same time, a need still exists to ensure adequate nutrition during critical periods of growth and development. It is important to keep in mind that overweight or obesity can co-exist with inadequate intakes and even deficiencies of micronutrients. Addressing both the risk of overweight and obesity and prevention/remediation of undernutrition among vulnerable groups poses a challenge in terms of optimizing the potential contribution of the WIC food package.
- *Changes have occurred in nutrition knowledge and its application through dietary guidance and recommendations.* Knowledge about the effects of diet on health has increased substantially in the past few decades. New dietary reference standards called Dietary Reference Intakes (DRIs) are available and may be used to evaluate both nutrient adequacy and nutrient excess. The number of nutrients included in the new standards and the recommended intakes of many of the nutrients have changed. The *Dietary Guidelines for Americans* have been published

every five years since 1980; each revision considers the most recent scientific knowledge to provide guidance on dietary patterns that promote health.

Despite the external changes that have occurred since the inception of the WIC program, the only recent change in the WIC food packages was a small revision in the package for exclusively breastfeeding women.

In proposing effective WIC food packages, the Committee is faced with many challenges that arise from the scientific, market, social, and health changes described above. Challenges also arise from other considerations such as current food safety concerns; participants' access to transportation, storage, and cooking facilities; and the impact on WIC administration and vendors related to modifications to established procedures.

COMMITTEE'S TASK

The U.S. Department of Agriculture's Food and Nutrition Service has charged the Committee, through the Institute of Medicine's Food and Nutrition Board, to conduct a two-phase evaluation of the WIC food packages. In Phase I, summarized in this preliminary report, the Committee's specific tasks are to review nutritional needs of the population subgroups participating in the WIC program using scientific methods summarized in the Dietary Reference Intake reports, assess supplemental nutrition needs of these subgroups, and propose priority nutrients and general nutrition recommendations for the WIC program. In Phase II, the Committee will apply the findings of this assessment to develop recommendations for specific changes to the WIC food packages. This preliminary report presents the results of the Phase I tasks, and proposes the priorities and criteria that will be used to recommend changes to the WIC food packages during Phase II of the project.

In Phase I of the project, the Committee considered evidence of three major types: analyses of the nutrient intake of WIC-eligible populations (described in Chapter 3); analyses of the food intake of WIC-eligible populations (described in Chapter 4); and nutrition-related health risks and outcomes of WIC-eligible populations (described in Chapter 5). By utilizing and integrating all three of these approaches, when possible, the Committee attempted to overcome the limitations of any one approach applied individually. It was not feasible to include all categories of WIC participants in every type of analyses because the appropriate data set was not always available. For example, sufficient dietary intake data for breastfed infants were not available for the nutrient analyses described in Chapter 3; however, breastfed infants were considered in the analyses of nutrition-related health risks and outcomes described in Chapter 5. It was not feasible to include all nutrients in every type of analyses because the appropriate data were not available. For example, intake data for vitamin D and folate were not available for the nutrient analyses described in Chapter 3; however, vitamin D and folate were considered in the analyses of nutrition-related health risks and outcomes described in Chapter 5.

NUTRIENT INTAKE OF WIC-ELIGIBLE POPULATIONS

Because published evaluations comparing the nutrient intakes of WIC-income-eligible populations to the new DRIs were not available, the Committee conducted analyses of the nutrient adequacy of the diets of WIC-income-eligible subgroups—infants under one year of age, children ages 1 through 4 years, and women of reproductive age—from households with incomes in the range that is eligible for the WIC program. Although many of these households are already receiving WIC benefits, the intent of the analyses was to identify nutrients of concern to guide

the Committee in recommending specific changes in the food packages during phase II of the project. The term "nutrient of concern" signifies that, if feasible, the revised food packages will improve intake of that nutrient. The analyses conducted for this report utilized 24-hour dietary recall data from the 1994-1996 and 1998 Continuing Survey of Food Intakes by Individuals (CSFII) and methods recently published by the Institute of Medicine to assess the nutrient adequacy of diets. Nutrient adequacy was examined by determining the estimated prevalence of inadequate intakes for eight micronutrients (calcium, iron, zinc, magnesium and vitamins A, C, E, and B_6), potassium, dietary fiber, and protein. Possible excessive intakes were examined for food energy (the caloric content of the diet), percentage of food energy from fat, and intakes of sodium, added sugar,[1] and several micronutrients (calcium, iron, zinc and vitamins A, C, and B_6).

Although intake data are biased to some extent by under-reporting in data for adults and over-reporting in data for children, these data permit a ranking of nutrients likely to be inadequate or excessive within each of the WIC target populations. For example, although there are limitations to intake estimates for vitamin E, the very high prevalence of inadequate intakes cannot be ignored. Additionally, although the application of the DRIs has not been thoroughly tested and enhanced in the iterative process envisioned, it provides the Committee with the best documented approach to identifying nutrients of concern.

Based on the Committee's analyses of available data, priority nutrients of concern because of *inadequate intake* are:

- *Infants, non-breastfeeding*: none
- *Children 1 through 4 years of age*: vitamin E, potassium, and fiber
- *Adolescents and adult women of reproductive age*:

  Highest priority—calcium, magnesium, vitamin E, potassium, and fiber

  Next in priority—vitamins A, C, and B_6

Based on the Committee's analyses of available data, nutrients that may be *excessive* in diets are:

- *Infants, non-breastfeeding:* zinc and preformed vitamin A. Food energy intake may exceed energy needs.
- *Children 1 through 4 years of age*: zinc, preformed vitamin A, and sodium. Food energy intake may exceed energy needs.
- *Adolescent and adult women of reproductive age:* sodium, food energy, and total fat intake as a percentage of food energy.

FOOD INTAKE OF WIC-ELIGIBLE POPULATIONS

The *Dietary Guidelines for Americans* provide science-based advice to promote health and to reduce risk for major chronic diseases through diet and physical activity. They are targeted to healthy people two years of age and older. According to Public Law No. 101-445 (U.S. Congress, 1990), the *Dietary Guidelines* form the basis of federal food assistance, nutrition education, and information programs, including the WIC program. The USDA food pattern recommendations that accompany the Food Guide Pyramid, issued in 1992, were designed to reflect the *Dietary Guidelines*.

The Committee compared food group intakes with recommendations from the Food Guide Pyramid to assess food patterns of low-income children and women of childbearing age. In

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[1] Added sugars have been defined by USDA as sugars and syrups that are added to foods during processing or preparation. See Chapter 3 for a description of the term "added sugars."

general, for four of the food groups (grains, vegetables, fruits, and dairy) fewer than 50 percent of children, adolescents, and women met the recommended minimum. Also, fewer than 50 percent of the adolescents and women met the recommended minimum for the meat and meat alternatives group. For children 2 to 5 years of age, percentages meeting the recommended minimum were lowest for the *vegetable group*. For women of childbearing age, percentages meeting the recommended minimum were lowest for the *fruit and dairy groups*. Compared to Food Guide Pyramid allowances, intakes of added sugars were high for all groups for which data were available.

Since children under the age of two years are not generally included in dietary guidance for the general population, different sets of guidance were considered. A major finding for infants was that breastfeeding rates for WIC mothers have increased—more than 50 percent of WIC women now initiate breastfeeding—but the duration of breastfeeding was much shorter than the American Academy of Pediatrics recommendation of one year (see Chapter 4). Another finding that impacts children ages 12 to 24 months is that their diets lack variety and the mechanisms that promote acceptance of a variety of foods are lacking. For example, juice is by far the major form of food ingested from the fruit group but only a few select juices are consumed on a regular basis.

Priorities for the revised WIC food packages include improving the contribution of the package to an overall dietary pattern that is consistent with the *Dietary Guidelines* (emphasizing the vegetable group for children, emphasizing the fruit and dairy groups for women, limiting the amount of added sugars, saturated fat, cholesterol, and *trans* fatty acids), further promoting breastfeeding of infants, and keeping juice allowances within recommendations.

NUTRITION-RELATED HEALTH RISKS AND OUTCOMES OF WIC-ELIGIBLE POPULATIONS

Nutrients of concern in the WIC-eligible populations also were identified by examining health risks that are specific to infants, young children, and women of reproductive age. Growing rates of overweight and obesity among low-income adolescent and adult women are of particular concern. Although the cause of obesity has many facets, the common denominator is positive energy balance. In order to promote a healthy body weight at each life stage, the overall energy balance between physical activity and food energy intake must be considered in prescribing an appropriate food package for each individual. Thus, flexibility to promote food energy intakes over a healthy range should be considered in formulating the food package allowances from which an individual's prescription will be drawn.

Although intakes of folate and vitamin D could not be evaluated using data from the CSFII, information from other sources indicates that these should be priority nutrients in the WIC food package. Adequate dietary folate prior to and early in pregnancy is crucial for reducing the risk of neural tube defects, yet many women fail to obtain recommended intakes. Vitamin D is needed for bone health in women, yet evidence suggests that intakes are low. Although *dietary iron* inadequacy was not identified as a significant problem in WIC-income-eligible children, there is biochemical evidence from clinical laboratory data that *iron deficiency* remains above the goal for reduction of iron deficiency in children as outlined it the *Healthy People 2010* initiative (see Chapter 5). Although dietary iron inadequacy was identified at a low level of concern for low-income women of reproductive age, biochemical evidence from clinical laboratory data that iron deficiency remains a problem with women in this life stage raises iron to a nutrient of concern (see Chapter 5).

Health risks related to environmental exposures are also a concern for the WIC food package. Recent recommendations to reduce exposure to dioxin and dioxin-like compounds suggest that low-fat and non-fat dairy products should replace higher-fat alternatives, particularly for girls and women throughout the pre-reproductive and reproductive years. Exposure to methylmercury can be reduced by limiting intakes of certain types of fish that accumulate these compounds. The adverse effects of lead exposure may be somewhat mitigated by a diet that contains at least the recommended intake of calcium.

PROPOSED PRIORITY NUTRIENTS AND FOOD GROUPS FOR THE WIC FOOD PACKAGES

The Committee considered the results from each type of analysis (analyses of nutrient intakes of WIC-eligible populations, analyses of food intake of WIC-eligible populations, and consideration of nutrition-related health risks and outcomes in the WIC population). After evaluating the strengths and weaknesses of each approach, the proposed priority nutrients and food groups were selected, and are summarized in Table ES-1.

TABLE ES-1 Proposed Priorities for the WIC Food Packages

Participant Category	Proposed Priority Nutrients	Proposed Priority Food Groups	Nutrients of Concern with Regard to Excessive Intake	Nutrients to Limit in the Diet
Infants, less than 1 year of age, non-breastfed				
		N/A	Zinc Vitamin A, preformed [1] Food energy	
Infants, 6 through 11 months of age, breastfed				
	Iron Zinc	N/A		
Children, 12 through 23 months of age				
	Iron Vitamin E Potassium Fiber	Vegetables	Zinc Vitamin A, preformed [1] Sodium Food energy	
Children, 2 through 4 years of age				
	Iron Vitamin E Fiber Potassium	Vegetables	Zinc Vitamin A, preformed [1] Sodium Food energy	Saturated fat Cholesterol
Adolescent and adult women of reproductive age				
	Highest priority: Calcium Iron Magnesium Vitamin E Fiber Potassium *Also consider:* Vitamin A Vitamin C Vitamin D Vitamin B_6 Folate	Fruit Dairy products, low-fat or nonfat	Sodium Food energy Total fat	Saturated fat Cholesterol *Trans* fatty acids [2]

NOTE: N/A = not applicable from available data.

[1] The UL applies only to preformed vitamin A (i.e., retinol) ingested from the combined sources of animal-derived foods, fortified foods, and dietary supplements.

[2] *Trans* fatty acids have not specifically been identified as a hazard for infants and children, and thus are shown in the table as nutrients to limit only in the diets of adolescents and adults. However, the recommendation to limit *trans* fatty acids from processed foods in the diet is presumed to apply to all individuals regardless of age.

PROPOSED APPROACH FOR SELECTING THE WIC FOOD PACKAGES

The criteria shown in Box ES-1 are proposed for use in selecting the revised WIC food packages. Both a cost evaluation and an evaluation of benefits and risks will be performed for the proposed revisions to the WIC food packages. The goal is to propose food packages that improve the health of the WIC population with minimal impact on costs, vendors, and WIC agencies.

The identification of these proposed priority nutrients and food groups and these proposed criteria represents the first phase in the Committee's two phase task of recommending specific changes to the food packages.

BOX ES-1 Proposed Criteria for a WIC Food Package, if Consumed as Specified

1. The package reduces 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 two 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 two years of age, including encouragement and support for breastfeeding.
4. The foods in the package are available in forms 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 maintain the incentive value of the food packages 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.

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Introduction and Background

Since the inception of the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) in 1974, the primary nutritional problems of low-income women, infants, and children have changed from concerns about undernutrition to concerns about consumption of excessive food energy [1] and obesity. Yet, with the exception of the food package for exclusively breastfeeding women, no substantial changes to the WIC food packages have occurred since the WIC program was first begun. This report is the first step in developing recommendations for revisions to the WIC food packages. It reviews the nutritional needs and assesses the dietary adequacy of the WIC target population and proposes priority nutrients and food groups and general nutrition recommendations for the WIC food packages.

This chapter reviews the reasons why a systematic evaluation and revision of the food packages is timely. These reasons include profound changes since the inception of the WIC program in (a) the population served by the program, (b) the food supply and the dietary patterns of the WIC-eligible population, (c) the major health risks facing the WIC-eligible population, and (d) the dietary guidance and recommendations and the science underlying those recommendations.

THE WIC PROGRAM

The WIC program is a nutrition education and food assistance program for low-income individuals with at least one nutritional risk factor for a poor health outcome during the critical periods of growth and development during pregnancy, infancy, and early childhood. The underlying premise for the WIC program is that substantial numbers of pregnant, postpartum and breastfeeding women;[2] infants;[3] and children[4] from households with insufficient income are at

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[1] In this report the term "food energy" is used to refer to the metabolic energy that can be released from utilization of the macronutrients in foods (protein, fat, and carbohydrate). The typical units for expressing food energy are calories.

[2] For the purposes of describing WIC participants above the ages of infants and children, the term 'women' is generally used; however, this category of participants includes both female adolescents and female adults, all of reproductive age.

special risk with respect to their physical and mental health by reason of inadequate nutrition and/or health care (U.S. Congress, 7 C.F.R. § 246.1). The WIC program serves as an adjunct to good health care during critical times of growth and development in order to prevent the occurrence of both short- and long-term health problems. The WIC program helps meet the special needs of these individuals by providing three main benefits: (1) supplemental food; (2) nutrition education; and (3) referrals to health and social services.

Although all three types of benefits are central to the WIC program's mission to safeguard the health of vulnerable subgroups and prevent adverse health outcomes, supplemental foods are the distinctive benefit in the WIC program. About three-quarters of WIC funds are used to provide supplemental foods. Supplemental foods are provided in food packages selected to provide specific nutrients that appeared to be lacking in the diets of eligible WIC participants—calcium, iron, vitamin A, vitamin C, and protein. Supplemental food is provided in the form of a food instrument (usually either a voucher or check) that can be exchanged for specific foods in participating grocery outlets.[5] This food instrument lists the quantities of food items, sometimes including brand names, that can be obtained. WIC food packages provide tailored selections of foods from the following list: iron-fortified infant formulas, milk, cheese, eggs, iron-fortified breakfast cereals (hot or cold) or infant cereals, fruit and vegetable juices, dried peas or beans, and peanut butter. Carrots and canned tuna are also provide for some breastfeeding women (the enhanced package). Tailoring of food packages at the local level with regard to the specific nutritional needs of an individual may involve decreasing the amount of a food item below the maximum allowance at the federal level. Nutritional standards have been set for some of the food items allowed in the WIC food packages. Examples include the standard that juice produces must be 100% fruit or vegetable juice and must contain a minimum quantity of vitamin C; breakfast cereals must not exceed a maximum quantity of sugar. There are currently seven food packages designed for WIC participants by categories: (1) infants from birth through three months of age; (2) infants 4 through 11 months of age; (3) children and women with special dietary needs; (4) children 1 through 4 years of age; (5) pregnant and breastfeeding women (basic); (6) postpartum, non-breastfeeding women; and (7) exclusively breastfeeding women (enhanced).

Within federal regulatory maximum quantities, each WIC state agency is required to develop food prescriptions that specify the types or brands of WIC foods and the quantities allowed. At the local level, members of the professional staff assess each participant's nutritional needs and food preferences, and prescribe an individually tailored food package that best fits the participant's needs and circumstances.

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[3] For the purposes of describing WIC participants the term 'infants' is used exclusively for individuals from birth to the first birthday.

[4] For the purposes of describing WIC participants the term 'children' is used for individuals from the first birthday to the fifth birthday (ages one year through four years). Five-year-olds are not eligible to participate in the WIC program.

[5] Two states currently have different distribution systems. Home delivery of the prescribed items is utilized in Vermont. In Mississippi participants come to a designated site to pick up their food items rather than purchasing through retail outlets.

Current Definition of Supplemental Foods

In the federal regulations governing the WIC program, supplemental foods are defined as those "foods containing nutrients determined to be beneficial for pregnant, breastfeeding, and postpartum women, infants, and children" (U.S. Congress, 7 C.F.R. § 246.2).[6] For all packages, the WIC regulations state that the quantities and types of supplemental foods prescribed shall be appropriate for the participant taking into consideration the participant's age and dietary needs (FNS, 2003).

Historical Perspective on the WIC Food Package

The WIC program was launched at a time when a predominant concern was undernutrition in low-income populations. The early legislation (U.S. Congress, Pub. L. No. 92-433, 1972; U.S. Congress, Pub L. No. 94-105, 1975) directed the program to focus on calcium, iron, vitamin A, vitamin C, and high-quality protein as target nutrients of concern in the WIC population. Later reauthorization legislation (U.S. Congress, Pub. L. No. 95-627, 1978) was more general. Supplementation was described as providing "nutrients determined by nutritional researchers to be lacking in the diets of the targeted population." That law also stipulated that the fat, sugar, and sodium content of WIC foods be appropriate. A WIC Food Package Advisory Panel, convened in 1978, recommended retaining calcium, iron, vitamin A, vitamin C, and high-quality protein as the target nutrients. WIC food package regulations published in 1980 created six different monthly packages that were consistent with Public Law 95-627 but continued to provide foods that are nutrient-rich in calcium, iron, vitamin A, vitamin C, and high-quality protein. An additional food package for exclusively breastfeeding women, including carrots and canned tuna, was developed in 1992. States are given some flexibility, on a case by case basis, to substitute more culturally appropriate foods if they are nutritionally equivalent and cost-neutral. However, very few substitutions have been approved at the federal level.

Percentage of Target Dietary Needs Supplied by WIC Foods

The Committee found that there was no clear definition of the WIC food packages regarding what percentage of a participant's dietary needs were to be supplied by the food package. Although there are no published comparisons of the nutrients supplied in the WIC food packages to current dietary reference values, some comparisons can be made. For example, the food energy that could be provided by the maximum allowances of the food packages can range from about one-third of energy needs for an active postpartum woman to over 100 percent of energy needs for an 11-month-old girl (IOM, 2002a; FNS, 2003). Thus, although the goal of the WIC program is to supplement the diet, rather than provide a complete diet, the extent to which that goal can be realized varies among the categories of participants served.

Table 1-1 shows the percentage of Food Guide Pyramid servings supplied by the maximum allowances in the current WIC food packages (GAO, 2002; USDA/DHHS, 1992). For all categories, the WIC food packages provide more than 100 percent of recommended servings

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[6] Another statement of the definition of supplemental foods is written as "foods containing nutrients determined by nutritional research to be lacking in the diets of pregnant, breastfeeding, and postpartum women, infants, and children" [U.S. Congress, 42 U.S.C. § 1786(b)(14)]. This definition was amended in June, 2004 by addition of the wording "and 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" (U.S. Congress, Pub L. No. 108-265, 2004).

TABLE 1-1 Percentage of the Minimum Recommended Servings from the Food Guide Pyramid Supplied by the Current Maximum Allowances for the WIC Food Packages by Category of Participant

Participant Category	Grains	Vegetables	Fruit (juice)	Dairy	Meat and Meat Alternatives
Pregnant or lactating women	13%	0%	50%	123%	27-28%
Breastfeeding women, enhanced	13%	9%	60%	137%	50%
Postpartum women	20%	0%	50%	160%	24%
Children, 2 through 3 years	30%	0%	115%	160%	46-49%
Children, 4 years	20%	0%	75%	160%	32-34%

SOURCE: GAO, 2002; USDA/DHHS, 1992.

from the dairy group. For the dairy group the recommended number of servings is two servings per day for children and women 19 years and older and three servings per day for adolescents; this is equivalent to 16 to 24 oz of milk per day. Yet the maximum allowance for the dairy group is equivalent to 25 to 30 oz per day. For children ages 2 through 3 years, the package also provides more than 100 percent of the recommended servings of fruit, as juice only.

THE WIC POPULATION HAS CHANGED SINCE THE INCEPTION OF THE WIC PROGRAM

Over the past several decades, the WIC program has expanded considerably and the population the program serves has changed in important ways. The WIC program has been one of the fastest growing food and nutrition assistance programs (see Figure 1-1). In fiscal year 1974, the WIC program served an average of 88,000 women, infants, and children per month. During 2003, the WIC program served an average of 7.6 million women, infants, and children per month at a cost of $4.5 billion for the fiscal year. Currently, about one half of all U.S. infants and one quarter of children 1 through 4 years of age receive WIC benefits. Children make up just over one-half of the total caseload (Figure 1-2, data for 2002).

The program's growth has been disproportionately in the western states, which accounted for 13 percent of total WIC participants in 1988 and 24 percent in 1998. California alone accounted for 16.7 percent of WIC participants in 2003. This regional shift is reflected in the ethnic composition of the WIC population, with Hispanics constituting a growing proportion. Hispanics constituted 38.1 percent of the WIC caseload in 2002, up from 21 percent in 1988. Asians and Pacific Islanders have become a substantial part of the WIC population in several states over the same time period. There is substantial variability among geographic areas, even within states, with some programs serving much more ethnically diverse populations than others.

The proportion of women participating in the WIC program who are in the work force has increased since 1974. By 1998, about 25 percent of the women who were certified or who certified a child for the WIC program were employed (Cole et al., 2001). Data from the Bureau of Labor Statistics show that work activity has increased recently in low-income households with

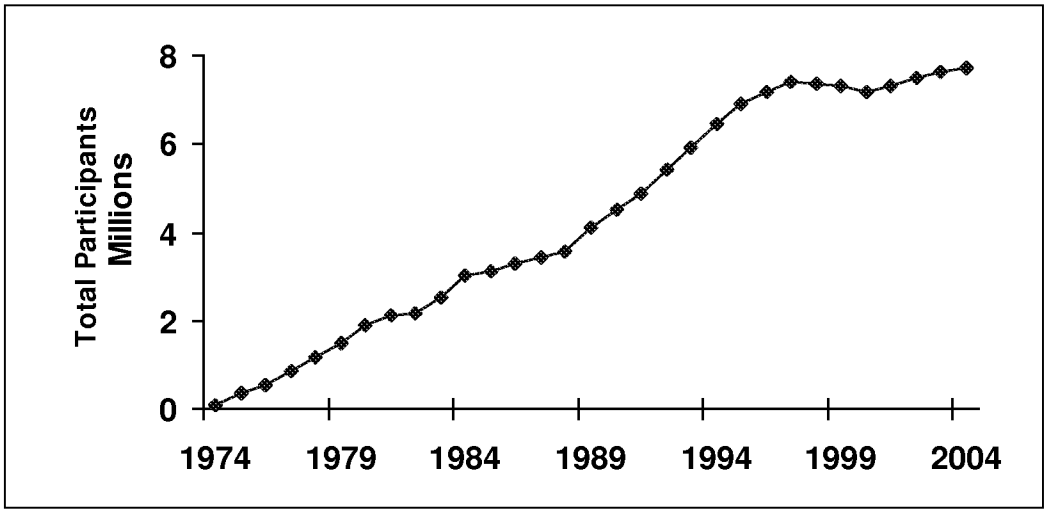

FIGURE 1-1 Annual Number of Participants in the WIC Program Constructed from Monthly Averages of Participants, Fiscal Years 1974-2004.
SOURCE: FNS, 2004a (USDA website). FY 2002 is the latest complete data. Data for FY 2003 (12 months) and FY 2004 (February alone) may be incomplete.

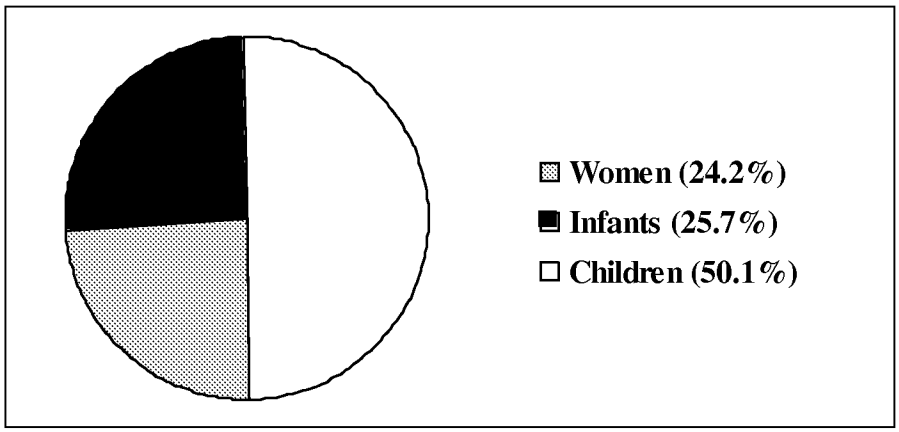

FIGURE 1-2 The WIC Population by Participant Category, 2002
SOURCE: Bartlett et al., 2003; FNS, 2004d (USDA website). FY 2002 is the latest complete dataset.

children. Between 1990 and 1999, the proportion of children in families with income below the poverty level who lived with both parents with at least one parent employed full-time increased from 44 to 52 percent (GAO, 2001). The proportion of poor children living in families with a single mother employed full-time doubled, from 9 to 18 percent (GAO, 2001).

THE FOOD SUPPLY AND DIETARY PATTERNS HAVE CHANGED SINCE THE INCEPTION OF THE WIC PROGRAM

Increased Variety in the Food Supply

The number of food products in U.S. food retail outlets has increased approximately 60 percent since 1990. Between 1997 and 2001 an average of 10,513 new food products were introduced into the market each year (Food Institute, 2002). Many of these were existing products that were repackaged/relabeled or simple line extensions; the introduction of some of these products some was heavily advertised. Recent new food products include consistent-weight packages of fresh fruits and vegetables that were formerly purchased as bulk, random-weight items. Even though many of the new products fail to stay on the shelves for more than two years, there has been a steady increase in the total number of products available. Each product is referred to as a stock-keeping unit (SKU) by food manufacturers and vendors. The average number of SKU's in a typical supermarket has increased from 20,000 in 1990 to over 32,000 in 2002 (Food Institute, 2002).

The variety of foods available has increased with a number of new products introduced as the result of global sourcing of fresh fruits and vegetables. A wider variety of fresh produce is now available year-around at reasonable prices and in many more locations. Variety in the forms of food products also has increased due to changes in lifestyles and a preference for very individualized types of foods. For example, consumers with particular health interests are selecting foods fortified with particular nutrients such as calcium in orange juice or iron in oatmeal. Variety also has increased due to the increase in "store brands." Supermarkets are differentiating themselves from competition and building store loyalty through expansion of their own brands. The percentage of SKU's in a typical supermarket that are store-brand products rose from 18.6 percent in 1995 to 20.7 percent in 2001 (Food Institute, 2002). These store-brand products are priced between 15 and 50 percent lower than national branded products of similar quality (Food Institute, 2002).

Changes in Food Consumption

The percentage of personal disposable income spent for food from retail stores has fallen over the last several decades. The average American household spent 7.8 percent of their disposable income on food eaten at home in 2001, compared to over 10 percent in 1970 (BLS, 2003). Despite this trend, households in the lowest income quintile, which would include most WIC households, spend 25 percent of their disposable income for food at home (Blisard, 2001). Research by USDA on food spending by households reveals that low-income households economize using their food dollars. Despite often facing higher food item prices, they tend to spend less per pound for nearly all food groups by purchasing lower cost items within the food groups (Kaufman et al., 1997).

Food consumption trends are available for women regarding the consumption of 12 categories of food between 1977 and 1995 (see Table 1-2). The trends in mean dietary intakes for women 20 years of age and older reveal substantial increases in beverages (114 percent for

TABLE 1-2 Trends and Changes in Food Consumption from Selected Food Groups: Mean Intakes for Women 20 Years and Older

Food Group	Mean Intake (grams per day)			% change, 1997-1978 to 1994-1995
	1977-1978	1989-1991	1994-1995	
Grain products	177	234	255	44%
Vegetables	205	187	189	-8%
Fruits	142	150	156	10%
Milk and milk products	203	206	202	-0.5%
Meat, poultry, and fish	184	167	168	-9%
Eggs	24	16	16	-33%
Legumes	18	17	19	6 %
Fats and oils	13	16	16	23%
Sugars and sweets	17	17	19	12%
Beverages (nonalcoholic)	698	753	854	22%
Fruit drinks and ades	29	46	58	100%
Carbonated soft drinks	137	238	293	114%

NOTE: An ade in a sweetened drink made from water and fruit juice.
SOURCE: NFCS 1977-1978, CSFII 1989-1991, CSFII 1994-1995 (Enns et al., 1997).

carbonated beverages), grain products (44 percent), and sugars and sweets (22 percent) (Enns et al., 1997). Intake of eggs decreased the most for women (33 percent) (Enns et al., 1997). Similar trend data were available for children ages 6 through 11 years (Enns et al., 2000). No trend data of this type were available for children in age ranges eligible for the WIC program.

THE HEALTH RISKS OF THE WIC-ELIGIBLE POPULATION HAVE CHANGED SINCE THE INCEPTION OF THE WIC PROGRAM

Since the inception of the WIC program, there have been fundamental changes in the predominant health and nutrition risks faced by the WIC-eligible population, and in the context of these risks. Several problems that were high on the list of public health problems in the 1970s have receded. Access to health care for WIC participants is now better than in the early years of the program (Fox et al., 2003); at present more than 80 percent of WIC participants report some kind of health care insurance, primarily Medicaid or employer-sponsored insurance (Cole et al., 2001). Further, there is evidence that the Medicaid-enrolled children who participate in the WIC program have greater use of all health services, including preventive services and effective care of common illnesses, than the Medicaid-enrolled children who are not WIC participants (Buescher et al., 2003). The situation with regard to breastfeeding[7] has improved since the early days of the WIC program, with more than two-thirds of mothers initiating breastfeeding presently. However, average duration remains short, and WIC participants remain somewhat less

[7] In the WIC program, a mother is considered to be breastfeeding as long as breastfeeding occurs at least once per day.

likely to breastfeed their babies than other mothers (Abbott Laboratories, 2002, 2003). Diets have improved in many respects, and nutrients for which intakes often appeared to be low in the 1970s (vitamins A and C, and calcium) are less problematic, particularly for children. Iron deficiency has declined considerably, probably at least partly as a positive effect of the WIC program (Sherry et al., 2001), but remains a problem to be actively addressed, with prevalence hovering 2 to 5 percentage points above the 2010 national health objectives (CDC, 2002). Infants in the WIC program (Kahn et al., 2002) and low-income postpartum women (Bodnar et al., 2002) have been demonstrated to be particularly at risk.

At the same time, new risks have emerged. By far the most dramatic of these is the rapidly increasing prevalence of overweight and obesity in adults, adolescents, and children, with the attendant health risks. Excess body fat and physical inactivity are associated with the development of hypertension, dyslipidemia, type 2 diabetes, coronary heart disease, osteoarthritis, respiratory ailments, sleep problems, certain cancers (e.g., breast cancer), and all-cause mortality. The negative health effects and economic costs associated with excess body fat and physical inactivity are second only to smoking, and likely to overtake tobacco as the leading cause of death from modifiable behavioral factors in the near future (Mokdad et al., 2004).

While there is no firm evidence that the WIC participant population is any more prone to overweight than non-WIC populations (CDC, 1996), neither are they protected. The number of overweight and obese women in the U.S. has risen substantially, with age-adjusted prevalence increasing approximately 30 percent between 1960 and 1994 (Kuzmarski et al., 1994). In 1994 28 and 27 percent of women aged 25 years and older were overweight and obese, respectively (Flegal et al., 1998). Over the same period the percentage overweight among women of childbearing ages (20 through 39 years) almost doubled (Kuzmarski et al., 1994; Flegal et al., 1998). Data from the National Health and Nutrition Examination Survey (NHANES) 1999-2000 indicated that 28 percent of non-pregnant women aged 20 through 39 years are obese (Flegal et al., 2002). More recent data from NHANES 2001-2002 indicates that the prevalence of obesity among these women remains high at 29 percent (Hedley et al., 2004).

Overweight and obesity are prevalent among minority groups, except for Asian-Americans. Data from the most recent NHANES multistage probability sampling (1999-2002) estimate the overall prevalence of overweight and obesity at 70 and 47 percent for non-Hispanic black women, 62 and 31 percent for Mexican-American women, and 55 and 25 percent for non-Hispanic white women (Hedley et al., 2004). Of particular concern is the prevalence of Class 3 obesity (body mass index > 40), which affects 15 percent of non-Hispanic black women ages 20 and over, a prevalence nearly double that (7.9 percent) reported in the 1988-1994 NHANES (Flegal, et al, 2002). However, women of low socioeconomic status disproportionately bear the burden of obesity and overweight regardless of race or ethnicity. Among individuals with less than a high school education the prevalence is roughly twice that of college graduates (Mokdad et al., 1999).

The prevalence of overweight for children in the U.S. also has steadily risen over the last several decades. Data from the most recent NHANES national survey (1999-2000) indicate that the prevalence of overweight was 13 percent in children ages 6 through 11 years as compared to 4 percent in 1965 (Ogden et al., 2002). In children ages 2 through 5 years, 10 percent were overweight. A 1998 survey of children participating in the WIC program found that 13 percent of these children were overweight (Cole, 2001). Overweight children and adolescents are at increased risk for overweight in adulthood (Ogden et al., 2003). Childhood overweight has been linked to adverse health outcomes including elevated blood pressure, hyperinsulinemia, glucose

intolerance, type 2 diabetes, dyslipidemia, and other early risks for chronic disease, as well as to psychosocial problems including depression, social isolation, and low self-esteem (Dietz, 1998b; Must and Strauss, 1999). A recent analysis of NHANES data from 1971 to 2000 indicates that the extent of overweight (i.e., the degree of overweight among those who are overweight) has increased even more rapidly than the prevalence of overweight among U.S. children and adolescents (Jolliffe, 2004).

DIETARY GUIDANCE AND RECOMMENDATIONS HAVE CHANGED SINCE THE INCEPTION OF THE WIC PROGRAM

New Nutrient Recommendations

Over the past decade, knowledge of nutrient requirements has increased substantially, resulting in a set of new dietary reference values called the Dietary Reference Intakes (DRIs) (IOM, 1997, 1998, 2000b, 2001, 2002a, 2004). The DRIs replace the 1989 Recommended Dietary Allowances (RDAs) as nutrient reference values for the U.S. population (NRC, 1989b). Based on the new DRIs, many of the recommendations for individual intakes (RDAs) have changed substantially since the WIC food packages were originally formulated. Although basic concepts of nutrition have not changed, there has been a substantial increase in knowledge of specific concepts such as bioavailability, nutrient-nutrient interactions, and the distribution of dietary intake across subgroups of the population. In addition, the DRIs include appropriate standards to use in determining whether diets are nutritionally adequate without being excessive. The DRIs differ from the old RDAs in several respects: (1) they consider reduction in the risk of chronic disease, rather than merely the absence of signs of deficiency; (2) for most nutrients, both RDA and Estimated Average Requirement (EAR) values are given—the EAR makes it possible to estimate the prevalence of inadequacy within a population; (3) Tolerable Upper Intake Levels (ULs) have been set to aid in evaluation of the risk of adverse effects from excess consumption; (4) appropriate ranges of macronutrient densities are given as Acceptable Macronutrient Distribution Ranges (AMDRs); and (5) when data are available, reference values are provided for other food components.

New Food Intake Recommendations

New guidance on food intakes also is available. At the time the WIC program was established, there was no systematic process for the development and revision of science-based dietary guidance for the U.S. population. Nutrition education tools such as the "Four Food Groups" focused on eating enough of various types of foods to assure nutrient adequacy. The original selection of foods for the WIC food packages was based on food consumption data that indicated that calcium, iron, vitamin A, and vitamin C were the nutrients most likely to be low in the diets of low-income women and young children. Understanding of the necessity for adequate high-quality protein in periods of rapid growth and development provided the basis for inclusion of protein as a priority nutrient. The specific foods selected for the food packages were good sources of the nutrients listed above, available, generally acceptable, and reasonable in cost.

As deficiency diseases became less common, scientific research into the relationships between various dietary components and chronic diseases expanded. In 1977, the U.S. Senate Select Committee on Nutrition and Human Needs published dietary goals for the U.S., which for the first time set forth dietary guidance that included a focus on the total diet and recommendations for minimizing risk of chronic disease and for ensuring nutritional adequacy

(U.S. Senate, 1977). There was a great deal of controversy over these goals, not only because of the lack of agreement among scientists on many of the issues but also surrounding the process for arriving at the goals (McMurry, 2003). A period of intense activity culminated in a 1979 Surgeon General's Report on Health Promotion and Disease Prevention (DHEW/PHS, 1979). The report relied heavily on the findings of a panel of the American Society for Clinical Nutrition that examined the association between dietary components and chronic disease (ASCN, 1979). Then in 1980, USDA/DHHS jointly issued the first edition of *Dietary Guidelines for Americans* (USDA/DHHS, 1980). The purpose was to provide the public with authoritative, consistent guidelines on diet and health.

Since 1980, the *Dietary Guidelines* have been revised every five years; the most recent version was released in May 2000 (USDA/DHHS, 2000) and the 2005 revision is expected to be available in preliminary form in time to inform the deliberations of the current Institute of Medicine (IOM) Committee to Review the WIC Food Packages. Over time, the *Dietary Guidelines* have evolved to incorporate the evidence that has developed about the relationships between diet and chronic disease. The 2000 version of the *Dietary Guidelines* (USDA/DHHS, 2000) recommends a total dietary pattern that is largely plant-based, with emphasis on whole grains, fruits and vegetables; limitation or moderation in consumption of fats, sugars, sodium, and alcohol; food safety; and physical activity.

The *Dietary Guidelines* form the basis for widely-used nutrition education tools and dietary evaluation processes. The Food Guide Pyramid, a nutrition education tool based on the *Dietary Guidelines*, was first issued by USDA and DHHS in 1992. The Pyramid has become a widely recognized representation of dietary guidance by the public. Currently, USDA is evaluating the Food Guide Pyramid system to respond to new Dietary Reference Intakes, new *Dietary Guidelines*, and current information on food consumption patterns and consumer perceptions and understanding.

THE COMMITTEE'S TASK

In view of the substantial changes in the nutritional context for the WIC program since its inception, the Food and Nutrition Service of USDA asked the Institute of Medicine to present a proposal to conduct a review of the WIC food packages. The project was undertaken by the Food and Nutrition Board in September 2003. The Committee to Review the WIC Food Packages was formed to conduct the review and the statement of task for the project follows.

The committee's focus is the population served by the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). Specific tasks for the committee are: (Phase I) review nutritional needs using scientific data summarized in Dietary Reference Intake reports (IOM, 1997, 1998, 2000b, 2001, 2002a, 2004), assess supplemental nutrition needs (by comparing nutritional needs to recent dietary intake data for pertinent populations), and propose priority nutrients and general nutrition recommendations for the WIC food packages; and (Phase II) based on this assessment, recommend specific changes to the WIC food packages. Recommendations are to be cost-neutral, efficient for nationwide distribution and vendor check-out, non-burdensome to administration, and culturally suitable. The committee will also consider the supplemental nature of the WIC program, burdens/incentives for eligible families, and the role of WIC food packages in reinforcing nutrition education, breastfeeding, and chronic disease prevention.

The remainder of this preliminary report presents the basis for the Committee's proposed approach to designing WIC food packages during Phase I of the project. Chapter 2 identifies

some of the challenges the Committee faces in designing an effective set of WIC food packages. To assess supplemental nutrition needs, the Committee considered several types of evidence: distributions of nutrient intakes for WIC populations were examined to identify the prevalence of inadequate or excessive intakes (Chapter 3); published information on food intakes was compared to dietary recommendations for the target populations (Chapter 4); and published evidence of nutrient inadequacy for these populations, based on physiological or biochemical evidence, was examined (Chapter 5). All of these sources of data have strengths and weaknesses, so a combination was used to identify the nutrients and food groups of the most concern. Although breastfed infants must be excluded from certain analyses because the data are limited or lacking, breastfed infants were considered when feasible, primarily in the analyses described in Chapter 5. Chapter 6 presents the Committee's preliminary synthesis of information related to nutritional needs and to priority nutrients and food groups to be considered for the food package. The proposed criteria and a general description of the process to be used in selecting the WIC food packages during Phase II of the project are also presented.

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2

Challenges to Selecting an Effective Set of WIC Food Packages

INTRODUCTION

The WIC program involves a wide variety of stakeholders including the women, infants, and children who participate; the approved grocery vendors; and the various state and local WIC agencies. Effective WIC food packages must consider these multiple stakeholders' needs. The Committee recognizes the challenges inherent in recommending changes in the WIC food packages and will consider the wide variety of factors listed in this chapter. The goal is to propose a set of food packages that will be effective in supplementing the nutritional needs of the participants without creating undue burdens on the stakeholders in the WIC program.

ADDRESSING BOTH OVERNUTRITION AND UNDERNUTRITION

At the time of the original design of the WIC program, problems of undernutrition were paramount. Today, these concerns must continue to be addressed in the context of the concomitant rise in risk for overweight and obesity. Excess body weight gain results from positive energy balance and can be associated with excess intakes of some food components (e.g., added sugars, high-fat foods, total food energy). However, such a diet can result in inadequate intakes of essential micronutrients and other beneficial components of food. A diet can be characterized by both inadequate intake of some micronutrients due to poor food choices and excessive intake of other micronutrients (i.e., intake above the Tolerable Upper Limit Level) due to inappropriate use of fortified foods. Thus the potential impact of the amount and bioavailability of nutrients in fortified foods (e.g., juice fortified with vitamin C, breakfast cereal fortified with iron and zinc) in the WIC food packages will be considered with regard to improving both inadequate intakes and excessive intakes. Designing supplemental food packages that optimize the potential benefit for long-term health thus poses mixed challenges.

PARTICIPANT DIVERSITY

Ethnic and geographic diversity pose challenges to selecting the WIC food packages. The WIC food packages must be suitable for participants in all 50 States and the District of Columbia as well as Puerto Rico, Guam, American Samoa, the American Virgin Islands, and 33 Indian Tribal Organizations (Kresge, 2003). In addition, the WIC food packages need to be suitable to a

growing number of migrant farm workers, particularly in California, Florida, and Texas (Kresge, 2003).

The percentage of Hispanic participants is now higher than that of any other racial/ethnic group. The ethnic and racial diversity of the WIC population in 2002 is illustrated in Figure 2-1. The diversity of the WIC population is actually greater than Figure 2-1 suggests, since each of these major racial/ethnic groups is composed of numerous subgroups. For example, people with a cultural heritage from anywhere in Mexico, Central America, South America, the Caribbean, or Spain may self-identify as being of Hispanic origin.

The need to consider culturally diverse preferences applies across all regions, and to food preferences of larger and smaller cultural groups. Here, the term "culture" is used to distinguish groups of people who have shared beliefs, values, and behaviors and therefore may have needs differing from those of the general population (NWA, 2003). Culture may be defined by national, regional, and ethnic origins; religious affiliations; lifestyle (e.g., vegetarian); generation; or overlapping residence and socioeconomic variables.

Providing culturally acceptable foods does not necessarily mean that foods consumed most frequently by a cultural group will be offered in the WIC food package. Some of those foods may be very low in the target nutrients or contain too much fat, sugar, cholesterol, or sodium. Also, WIC participants may consume enough of the staple or core cultural foods, such as rice or bread, regardless of the WIC program. Instead, the WIC food packages might be more effectively selected to complement these core foods and serve as incentives to participate in the WIC program as a whole. "Culturally acceptable" also implies that the foods are not regarded as "inferior" or prohibited due to religious or other beliefs. Table 2-1 summarizes some cultural issues related to WIC foods from studies among WIC participants. To formulate culturally acceptable WIC food packages may necessitate greater use of options and substitutions than the current packages allows as suggested in the scientific literature (Table 2-1) and other literature from a professional organization (NAWD, 2000; NWA, 2003).

Among ethnic subgroups, acculturation to the mainstream American culture results in dietary change (Lee et al., 1999; Neuhouser et al., 2004; Romero-Gwynn, et al., 1993). While dietary change often means that nutritious traditional foods are consumed less often, some changes can be positive. For example, a study among Korean Americans found that acculturation is correlated

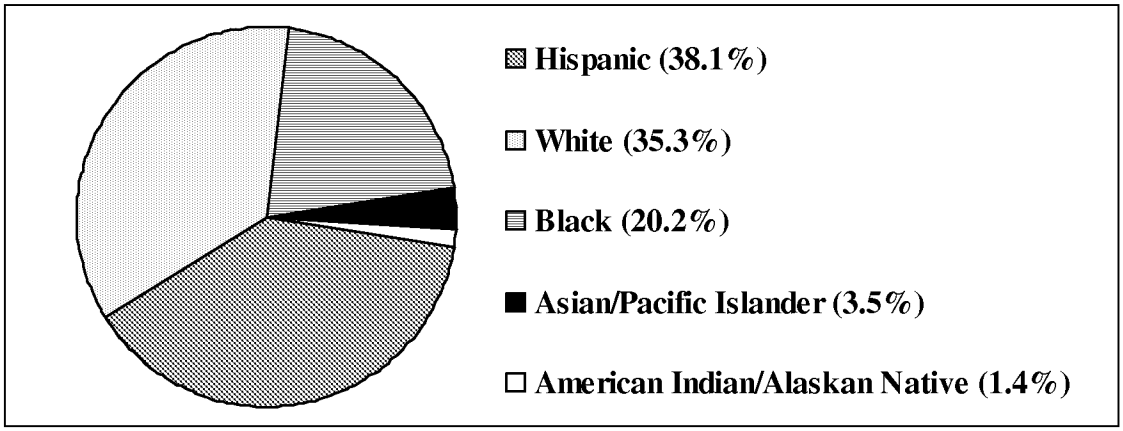

FIGURE 2-1 Ethnic Composition of the WIC Population, 2002 (Percent of Total).
SOURCE: Bartlett et al., 2003.

TABLE 2-1 Cultural Attitudes Among WIC Participants Related to the Current Food Packages

Cultural Group	Attitudes to WIC Food Items	Suggested Alternatives	Reference
Pregnant Chinese women in California	Most WIC foods, although atypical of the traditional diet, were consumed. Cheese was a notable exception.	Offer calcium-fortified tofu and dark greens in place of cheese.	Horswill and Yap, 1999
Pregnant teenagers in Guam	Dairy products were not traditionally consumed. Diets were low in calcium.	Offer fish with bones and coconut juice.	Pobocik et al., 2003
Southeast Asian adult women (Cambodian and Hmong) in Minnesota	Most subjects report a dislike of cheese (73%), compared to other WIC foods (40% dislike milk, 25% dislike cereal). Preferred WIC foods included eggs and orange juice.	Not discussed	Story and Harris, 1989
Postpartum Vietnamese women in California	WIC foods (i.e., milk, juice) provided to mothers in the first month postpartum were not perceived to be optimal while breastfeeding.	Provide higher-status (e.g., chicken) foods that are culturally viewed as more compatible with breast milk production.	Fishman et al., 1988

with increased consumption of oranges, tomatoes, low-fat milk, and bread (Lee et al., 1999). Promotion of positive dietary changes while supporting the beneficial components of a traditional diet is another challenge in selecting foods for a WIC food package.

Another closely related issue is the diversity of WIC participants regarding special needs (such as milk allergies and lactose intolerance) and preferences (such as choosing to avoid milk and other animal products for personal reasons unrelated to ethnicity or cultural heritage). Employing flexibility in allowable substitutions to account for the needs and preferences of small numbers of participants (or potential participants) may be a remedy to the numerous aspects of the wide diversity of the WIC participant population as a whole.

EMPLOYMENT

WIC authorized foods need to be suitable to fit the lifestyle of both working and non-working pregnant women and mothers of small children. In 1998, approximately 25 percent of women participating in the WIC program were currently employed (Cole et al., 2001). However, of those who were unemployed, 52 percent had been employed in the last 12 months (Cole et al., 2001). The highest rate of employment is among WIC pregnant women (32 percent) (Cole et al., 2001). As noted in a 2001 report on challenges to providing WIC services, work activity has increased in low-income households with children (GAO, 2001). Time constraints may push individuals, especially working parents, to use convenient, ready-to-heat, and ready-to-eat foods.

In evaluating food items in the WIC food packages it is important to recognize that WIC participants are no more likely to desire or be able to spend considerable time in food preparation than the rest of the population. The items in the WIC food packages should not include options that increase the burden of food preparation for working parents.

FOOD AVAILABILITY

In selecting new WIC food packages, the Committee may need to consider the impact of the types of stores located in low-income communities. Studies of WIC food vendor management practices, conducted by the Food and Nutrition Service in 1991 and 1998, found that larger vendors carry more WIC items than smaller vendors (Singh et al., 2003). Although the percentage of vendors maintaining a sufficient stock of WIC-authorized foods for women and children substantially increased from 1991 to 1998, vendors carrying sufficient stocks of infant package items decreased from 9.3 to 7.9 percent (Singh et al., 2003). Additionally, in both 1991 and 1998, smaller vendors (stores having 1 to 5 cashier registers) were more likely than larger vendors (six or more cashier registers) to have insufficient stocks of WIC-authorized foods, despite an increase in the percentage of both types of stores that met inventory requirements overall. In a recent study on barriers to the use of WIC services in the state of New York, of the 3,144 WIC participants in the study, 16 percent noted that they sometimes or frequently find WIC-authorized food out of stock (Woelfel, et al, 2004).

Local food availability can influence dietary quality. As an example, vendors in low-income neighborhoods are predominantly small, independent grocery outlets and convenience-type establishments that stock fewer healthful food selections than do the larger, chain grocery outlets that predominate in more affluent communities (Fisher and Strogatz, 1999; Morland et al., 2002a; Morland et al., 2002b; Cummins, 2003; Morland et al., 2003; Sloane et al, 2003). The presence of supermarkets in a community has been associated with increased intakes of fruits and vegetables by the local residents (Morland et al., 2002a). The greater the distance individuals live from a large chain grocery store, the poorer is their dietary quality (Laraia, 2004).

Food cost also may be influenced by local food availability. The cost of the current WIC food packages varies greatly across the geographic regions, with average monthly food costs per person ranging from $24.40 for the Choctaw in Mississippi to $63.35 for the Omaha/Santee Sioux in Nebraska (FNS, 2004c; preliminary 2003 data).

LIMITATIONS IN TRANSPORTATION, STORAGE, OR COOKING FACILITIES

Logistics and food safety are other important challenges in choosing the package sizes and types of foods provided by the WIC program. In the 1998 WIC participant survey, 15 percent of WIC participants reported that limited transportation to grocery stores was a problem (Cole et al., 2001). Participants without automobiles may need to purchase only what they can carry, losing some value of their WIC food package. If it takes a long time to transport food to the home, perishable items, such as milk, may spoil, especially in hot weather. Spoilage may also occur if space, sanitation, or refrigeration is lacking. Where families share kitchen facilities and keep their foods locked in a private space, safely storing large quantities of food may be an issue. If foods (e.g., dried beans) need extensive cooking or preparation, lack of kitchen facilities and/or cooking knowledge can also be a barrier to getting the nutritional value from those foods.

FOOD SAFETY CONSIDERATIONS

The packaging of food products may need to be considered in making selections for the WIC food packages. For example, if a household uses only a part of a perishable food in a package on one occasion, the remainder may become contaminated by microorganisms before being consumed on a later occasion. Re-sealable packages or single-serving size packages may lessen the chance of contaminating the food in some situations. Following recommended cooking instructions is also important in order to keep foods safe. Proper cooking inactivates heat labile food borne pathogens and toxins that occur naturally in raw foods.

Food borne illness may need to be considered in selecting the WIC food packages. Of particular interest are illnesses that both (a) result from the contamination of certain types of food and (b) result in serious adverse effects that are specific to a population that benefits from the WIC program. As an example, listeriosis is a food borne illness considered potentially dangerous during pregnancy because it is associated with increased risk of spontaneous abortion, preterm birth, and fetal death. A surviving baby may succumb to respiratory distress and circulatory failure. New scientific knowledge about listeriosis as a hazard during human gestation has generated changes in recommendations about the use of certain foods during pregnancy (CFSAN, 2003). Common foods that carry *Listeria monocytogenes* are ready-to-eat luncheon meats, hotdogs, and soft cheeses. Proper handling and cooking of food help to lower the hazard of listeriosis; in some cases, especially where cooking is unlikely or inappropriate, certain foods may need to be avoided during pregnancy (FSIS, 2001; Kaiser and Allen, 2002; CFSAN, 2003). Undercooked meat and chicken are vectors for various microorganisms; all raw meat, fish and poultry products should be thoroughly cooked to avoid food borne illnesses.

ADMINISTRATIVE IMPACTS

Vendor Impacts

Increased vendor or administrative impacts are potential costs incurred by changes or increased flexibility in the WIC food packages. Efficiency in food distribution and vendor checkout, and nonburdensome administrative procedures enhance the ease of program administration (Kirlin et al., 2003).The store that sells food to WIC participants must: (1) have the right types and package sizes of food available; (2) train checkout clerks to recognize the appropriate WIC approved foods; (3) treat the WIC customers with respect; (4) organize an appropriate number of checkout stands to accept WIC customers; (5) train personnel to handle the redemption of WIC coupons; and (6) carry the already sold inventory on their accounts until state payments are received. Implementation of specific changes in the WIC food packages has the potential to impact vendors to varying degrees in each of these areas.

Some changes in the WIC food packages would increase vendor costs. Requirements to procure a new business license to sell perishable (non-packaged) food could subject vendors to an increased frequency of inspection by state health departments (DHHS/PHS/FDA, 2001). In small stores or those that only serve WIC customers, arranging to have small loads of perishable products delivered on a regular basis has the potential to increase costs and affect the quality and cost of fresh fruits and vegetables, meats, and other perishables. With the need for refrigeration and rapid turnover of perishables, the cost of distribution and inventory increases. In addition, special handling to ensure the safety of perishable products is needed.

In the future, changes may be easier due to the on-going initiative that will install EBT (electronic benefit transfer) systems in more locales. At present, efficiencies gained through such electronic systems may ease the transitions necessary in making changes to the WIC food packages but these efficiencies can not be counted on in all vendor locations.

Administrative Impacts at WIC Agencies

Changing the items in the WIC food packages or allowing greater flexibility in choice could pose administrative challenges at the state and the local level. States and tribal organizations need to train vendors and monitor their compliance in allowing only WIC-approved foods. Local agencies must instruct participants, often with limited literacy skills, how to choose the allowed foods at the market. Increased complexity of the WIC food packages (i.e., number of items or options) could increase counseling time and consequently affect waiting time at the local agencies. In a study of New York State WIC agencies, the most commonly cited barrier for participants was waiting too long at the clinic to receive WIC services (Woelfel, 2004).

Many state and local WIC agencies may already be burdened by providing services to a large number of participants without the assistance of efficient electronic information technology. It has been reported that in 2001 over 50 percent of WIC state agencies had management information systems that were not capable of efficiently performing key program tasks, such as tailoring food packages, assessing applicants' income, or printing food checks (GAO, 2001). Thus, at present, efficient information technology systems can not be counted on in every location to ease the transitions necessary in making changes to the WIC food packages. In the future, changes may be easier due to efficiencies gained through efficient information technology systems in more locales.

INCENTIVES

The WIC food packages serve as incentives for healthy behaviors by participants. The packages should be viewed as valuable enough to promote enrollment in the WIC Program and thus the receipt of educational and health benefits that the WIC Program provides. The food packages also should reinforce the WIC educational messages and promote long-term dietary quality. Ideally, the food packages should also encourage both initiation of breastfeeding and sustained breastfeeding through at least the infant's first year.

SUMMARY

In addition to considering nutrients and food components most likely to provide health benefits, food packages must take into account the incentive value of the WIC food packages; variability in culture and food habits; lifestyle; access to transportation, storage and cooking facilities among WIC participants; economic constraints; availability of recommended foods; food safety; and changes in administrative requirements both for food vendors and for WIC agencies. The new WIC food packages will need to strike a balance between providing culturally acceptable, nutrient-dense, readily available, low-cost food items that maintain the incentive value of the WIC food package and administrative feasibility for vendors and state and local agencies. In deciding on criteria for recommending changes in the WIC food packages, the Committee will take all of these factors into account.

3

Nutrient Intake of WIC-Eligible Populations

INTRODUCTION

A major task in Phase I is to identify nutrients of concern among WIC-eligible subgroups. This task involves using the new Dietary Reference Intakes (DRIs) and the methods recently published by the Institute of Medicine (IOM, 2000a) to assess the nutrient adequacy of the diets of WIC-eligible subgroups. To date, no published studies have reported such analyses. As a result, the Committee conducted analyses applying the DRIs and the recommended methods to assess the nutrient adequacy of the diets of WIC-income-eligible subgroups—infants under age one year, children 1 through 4 years of age, adolescent women 14 through 18 years of age, and adult women 19 through 44 years of age—all from households with incomes in the range to be eligible for the WIC program (WIC-income-eligible subgroups). Although many of these households are already receiving WIC benefits, the intent of the analyses was to determine nutrients of concern to guide the Committee in recommending specific changes in the food packages during phase II of the project.

Nutrient adequacy involves determining whether the diets of the various subgroups meet their nutrient requirements without being excessive. This chapter first describes the DRIs and then discusses how they were used in assessing the diets of WIC-income-eligible subgroups. The final sections of the chapter describe the data set used in the analyses and present the results of the analyses.

DIETARY REFERENCE INTAKES (IOM, 1997-2004)

Over the past decade, knowledge of nutrient requirements has increased substantially, resulting in a set of new dietary reference standards called the Dietary Reference Intakes (DRIs) (IOM, 1997, 1998, 2000b, 2001, 2002a, 2004). The DRIs replace the earlier Recommended Dietary Allowances (NRC, 1989b) and are the appropriate standards to use in determining whether diets are nutritionally adequate without being excessive.

Using the DRI for Micronutrients

For micronutrients the DRIs include four reference standards—the Estimated Average Requirement, the Recommended Dietary Allowance, the Adequate Intake, and the Tolerable Upper Intake Level (IOM, 1997, 1998, 2000b, 2001, 2003a):

- *Estimated Average Requirement (EAR)*: an average daily nutrient intake value that is estimated to meet the requirement, as defined by the specified indicator of adequacy, of half the healthy individuals in the specified life stage and gender group. At this level of intake, the other half of the healthy individuals in the specified group would not have their nutrient needs met. Thus, the EAR is the estimated midpoint (i.e., median) of the distribution of the nutrient requirements for the population in question.
- *Recommended Dietary Allowance (RDA):* an average daily dietary nutrient intake level that is sufficient to meet the nutrient requirement of nearly all (97 to 98 percent) healthy individuals in the specified life stage and gender group. If the distribution of requirements in the specified group is assumed to be normal, the RDA is computed by adding two standard deviations to the EAR.
- *Adequate Intake (AI):* When available scientific evidence is not sufficient to determine an EAR (and, thus, an RDA cannot be determined), then an AI that is assumed to be adequate is set for the nutrient. 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 (or groups) of apparently healthy people who are maintaining a defined nutritional state or criterion of adequacy.[1]
- *Tolerable Upper Intake Level (UL):* Many nutrients have a UL, which is the highest average daily nutrient intake level that is likely to pose no risk of adverse health effects to almost all individuals in the specified life stage and gender group. As intake increases above the UL, the potential risk of adverse effects increases. The absence of a UL does not imply that there is no potential for adverse effects resulting from high intake of the nutrient, but, rather, that the scientific evidence available at this time does not permit estimation of a UL.

Three of the four DRIs—the EAR, UL, and, to a lesser extent, the AI—are appropriate to use in assessing the nutrient intakes of population subgroups (IOM, 1997, 1998, 2000b, 2001, 2002a, 2004). The RDA is intended to be used as a goal for daily intake by individuals and should not be used in assessing group intakes (IOM, 1997, 1998, 2000b, 2001, 2002a, 2004). Table 3-1 presents the DRIs for the micronutrients examined in the assessment of the nutrient adequacy of the diets of WIC-income-eligible populations. Age ranges in the table are inclusive of both the lower and upper ages (e.g., 1-3 years includes children from 1.0 through 3.9 years of age). Age groups used for the DRI reports are somewhat different from the participant groups in the WIC program and appropriate adjustments have been made in the calculations presented in this report to account for these differences.[2]

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[1] Examples of defined nutritional states include normal growth, maintenance of normal circulating nutrient values or biochemical indices, or other characteristics of nutritional well-being or general health (IOM, 1997, 1998, 2000b, 2001, 2003a).

[2] Tables in the report list the appropriate DRI values for each subgroup within a WIC participant group. The age-appropriate and life stage-appropriate DRI values were used for each individual within a WIC participant group.

TABLE 3-1 Dietary Reference Intakes Used for Assessing Micronutrient Intakes of WIC-Eligible Subgroups

	Dietary Component							
	Calcium (g/d)	Iron (mg/d)	Zinc (mg/d)	Magnesium (mg/d)	Vitamin A (mcg/d, RAE)	Vitamin C (mg/d)	Vitamin E (mg/d)	Vitamin B_6 (mg/d)
Infants 0 through 6 mos								
AI*	0.32*[d]	0.27*	2*	30*	400*	40*	4*	0.1*
UL	ND	40	4	ND	600[a]	ND	ND	ND
Infants 7 through 11 mos								
EAR/AI*	0.34*[d]	6.9	2.5	75*	500*	50*	5*	0.3*
UL	ND	40	5	ND	600[a]	ND	ND	ND
Children 1 through 3 y								
EAR/AI*	0.5*	3.0	2.5	65	210	13	5	0.4
UL	2.5	40	7	65[e]	600[a]	400	200[b,c]	30
Children 4 through 8 y								
EAR/AI*	0.8*	4.1	4.0	110	275	22	6	0.5
UL	2.5	40	12	110[e]	900[a]	650	300[b,c]	40
Females 14 through 18 y								
EAR/AI*	1.3*	7.9	7.3	300	485	56	12	1.0
UL	2.5	45	34	350[e]	2800[a]	1800	800[b,c]	80
Females 19 through 30 y								
EAR/AI*	1.0*	8.1	6.8	255	500	60	12	1.1
UL	2.5	45	40	350[e]	3000[a]	2000	1000[b,c]	100
Females 31 through 44 y								
EAR/AI*	1.0*	8.1	6.8	265	500	60	12	1.1
UL	2.5	45	40	350[e]	3000[a]	2000	1000[b,c]	100
Pregnant females < 19 y								
EAR/AI*	1.3*	23	10.5	335	530	66	12	1.6
UL	2.5	45	34	350[e]	2800[a]	1800	800[b,c]	80
Pregnant females 19 through 50 y								
EAR/AI*	1.0*	22	9.5	290	550	70	12	1.6
UL	2.5	45	40	350[e,f]	3000[a]	2000	1000[b,c]	100
Lactating females < 19 y								
EAR/AI*	1.3*	7	10.9	300	880	96	16	1.7
UL	2.5	45	34	350[e]	2800[a]	1800	800[b,c]	80
Lactating females 19 through 50 y								
EAR/AI*	1.0*	6.5	10.4	255	900	100	16	1.7
UL	2.5	45	40	350[e,f]	3000[a]	2000	1000[b,c]	100

NOTE: EAR = Estimated Average Requirement, used when available AI = Adequate Intake, used when necessary, followed by an asterisk (*); ND = not determined, UL not determined due to lack of data of adverse effects; UL = Tolerable Upper Intake Level.

[a] The UL applies to preformed vitamin A only.

[b] The UL applies to synthetic forms of vitamin E obtained from dietary supplements, fortified foods, or a combination.

[c] As α-tocopherol; applies to any form of synthetic α-tocopherol.

[d] For infants 0 through 11 months of age, the AI for calcium presented in the table is for formula-fed infants.

[e] The UL for magnesium represents intake from pharmacological agents only and does not include intake from food and water.

[f] The UL for pregnant females 31 through 50 years of age is 300 mg magnesium/d and for lactating females 31 through 50 years of age is 265 mg/d.

SOURCES: IOM (1997, 1998, 2000b, 2001).

TABLE 3-2 Acceptable Macronutrient Distribution Ranges of WIC-Eligible Subgroups

Macronutrient	Range (percent of food energy intake)		
	Children 1 through 3 y	Children and adolescents 4 through 18 y	Adults
Fat	30-40	25-35	20-35
Carbohydrate	45-65	45-65	45-65
Protein	5-20	10-30	10-35

Using the DRI for Macronutrients

For macronutrients, a somewhat different set of DRIs has been developed (IOM, 2002a). In the case of food energy, dietary requirements are expressed in terms of estimated energy requirements (EER). An adult EER is defined as the dietary energy intake needed to maintain energy balance in a healthy adult of a given age, gender, weight, height, and level of physical activity. In infants and children, the EER is defined as the sum of the dietary energy intake predicted to maintain energy balance for an individual's age, weight, height, and activity level, plus an allowance for normal growth and development. For fat, protein, and carbohydrate, the DRIs include Acceptable Macronutrient Distribution Ranges (AMDRs) for intakes as a percentage of dietary energy intakes (Table 3-2). In addition, the DRI reports recommend limiting the amounts of saturated fats and cholesterol for all individuals over the age of two years (IOM, 2002a). While *trans* fatty acids increase the risk of coronary heart disease in adults, they have not been specifically identified as a hazard in infants and children. However, the recommendation to limit *trans* fatty acids from processed foods in the diet (IOM, 2002a) is presumed to apply to all individuals regardless of age. The WIC Program, in general, and WIC food packages, specifically, should encourage participants to follow these general recommendations.

Using the DRI for Other Dietary Components

In addition to micronutrients and macronutrients, other dietary components have DRIs relevant to the this analysis of the dietary intakes of the WIC-eligible population. Potassium and fiber have an AI; sodium has an AI for infants under the age of one year and a UL for the other WIC-eligible subgroups; and the category of added sugars[3] has a recommendation that the percentage of food energy from added sugars not exceed 25 percent. There is no dietary requirement for added sugars.

[3] Added sugars have been defined by USDA as sugars and syrups that are added to foods during processing or preparation (Welsh et al., 1992). This definition is used in assessing dietary intake and is part of the tip of the Food Guide Pyramid—the part of the diet consumers are advised to use sparingly (USDA/DHHS, 1992). Examples of added sugars are granulated sugar, powdered sugar, brown sugar, raw sugar; corn syrup, high-fructose corn syrup, fructose sweetener, liquid fructose; maple syrup, pancake syrup; molasses, and honey. Examples of foods with added sugars are soft drinks, fruit punches, and similar beverages; cookies, cakes, pies; dairy desserts; and candy.

USING THE DRI TO ASSESS NUTRIENT ADEQUACY

To assess the nutrient adequacy of population subgroups, two main questions are of interest:

1. What is the prevalence of inadequate intakes of particular nutrients?
2. What is the prevalence of excessive intakes of particular nutrients?

In order to do this assessment the Committee needs to know the characteristics of the usual nutrient intake distribution. The population subgroups of interest are the WIC-income-eligible subgroups.

What are the characteristics of the usual nutrient intake distributions?

In order to describe the characteristics of the usual intake distribution, and to use the DRIs in assessing diets, it is important to have information on the distribution of usual nutrient intakes. The usual intake of a nutrient is defined as the long-run average intake of the nutrient by the individual (NRC, 1986). Usual intake is not observed; rather, dietary recalls provide data on observed nutrient intakes over some specified period of time. Observed daily intake measures usual intake with error (i.e., error has been introduced into the measurement) (NRC, 1986). Nutrient intake varies from day to day within an individual. This day-to-day variability is "noise," since what investigators are typically interested in is the individual-to-individual variability in usual nutrient intake. Because for most nutrients, the day-to-day variability in intakes can be larger than the individual-to-individual variability, it is very important to "remove" the effect of this additional variability when estimating the distribution of usual intakes (Beaton et al., 1979).

The National Research Council (NRC, 1986) proposed a simple additive measurement error model that permits adjusting the data for the presence of the day-to-day variability of intakes. The NRC model assumes that the observed daily intake for an individual can be written as a deviation from the individual's usual intake. Researchers at Iowa State University (ISU) have developed and modified approaches that permit estimating the usual intake distributions with a higher degree of accuracy (Dodd, 1996). The method proposed by Nusser et al. (1996) is known as the ISU method for estimating usual nutrient intake distributions, and is now widely used by the nutrition community (see, for example, Beaton, 1994; Carriquiry, 1999; IOM, 2000a). Software packages are available that produce estimates of the mean and variance of usual intake in the group, as well as of any percentile of interest (see, for example, ISU, 1997). It is important to note that these software packages produce estimates of the usual intake distributions of *groups* and are typically not used to estimate usual intake of *individuals* (ISU, 1996).

What is the prevalence of inadequate intakes of particular nutrients?

Assessing the prevalence of nutrient inadequacy in a group requires estimating the proportion of individuals in the group whose usual intakes of a nutrient do not meet requirements. The Committee used the EAR cut-point method to estimate the prevalence of inadequacy among WIC-income-eligible subgroups. The EAR cut-point method involves estimating the proportion of individuals in a group whose usual nutrient intakes are less than the EAR. It has been shown that, under certain assumptions, the proportion with usual intakes less than the EAR is an estimate of the proportion of a group whose usual intakes do not meet requirements (Beaton, 1994; Carriquiry, 1999; IOM, 2000a). In the case of any nutrient with more than one EAR that applied to a WIC participant group, the analytic approach to estimating the percentage with usual

intakes less than the EAR involved (1) dividing individual-level observed intakes by the applicable EAR to obtain this ratio for each individual, (2) adjusting the distribution of the intake:EAR ratio using the usual intake adjustment software, and (3) estimating the percentage with the adjusted ratio less than 1. The Committee used this approach in the calculations for children 1 through 4 years of age,[4] for vitamin C in smokers and non-smokers,[5] and, in some cases, for pregnant and lactating women.[6]

Given the available information about the distribution of requirements for most nutrients, it appears that the underlying assumptions of the EAR cut-point method hold for most nutrients except iron in pre-menopausal women and food energy. To assess iron adequacy, the probability approach proposed in the NRC report (1986) was used as recommended in the DRI report on iron (IOM, 2001). The probability approach takes account of both the distribution of requirements and the distribution of usual intakes in estimating the prevalence of dietary iron inadequacy in a group (NRC, 1986; IOM, 2001).[7] In applying the probability approach to estimating the prevalence of iron inadequacy, the Committee used recent data on the distribution of iron requirements (IOM, 2001). The distribution of iron requirements were not reported for pregnant or lactating women (IOM, 2001); therefore, the percentage of inadequacy of iron intakes was not estimated for these women.

In the case of food energy, requirements are expressed in terms of estimated energy requirements (EERs). Since populations in balance should have usual intake and EER distributions with roughly equal mean values, the analysis compares the mean usual intake of food energy with the mean EER for each subgroup to assess energy adequacy. In addition, for fat, protein, and carbohydrate, tables present the usual distributions of intake as a percentage of food energy intake and estimates of the proportion less than the AMDR.

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[4] The DRI subdivide children into two life stage groups, (1) one through three years of age and (2) four through eight years of age. Thus WIC-eligible children, one through four years of age, fall into two life stage groups with the result that more than one EAR applies to this WIC participant group for most of the nutrients used in these analyses (iron, zinc, magnesium, vitamin A, vitamin C, vitamin E, vitamin B_6, and protein) (IOM, 1997, 1998, 2000b, 2001, 2002a, 2004).

[5] Because oxidative stress and metabolic turnover of vitamin C are increased in smokers, the recommended intake of vitamin C is increased by 35 mg per day (IOM, 2000b). Thus more than one EAR applies to WIC participant groups that include smokers and non-smokers.

[6] EAR are different during pregnancy and lactation for some of the nutrients used in these analyses (iron, zinc, magnesium, vitamin A, vitamin C, vitamin E, vitamin B_6, vitamin B_{12}, and protein,) (IOM, 1997, 1998, 2000b, 2001, 2002a, 2004). Although, the data for pregnant and lactating women are combined for these analyses (Tables 3-8 and 3-10), the applicable EAR was used in the calculation for each individual. Additionally, EAR during pregnancy or lactation vary according to the woman's age for a few nutrients used in these analyses (vitamin C, iron, magnesium, and zinc) (IOM, 1997, 1998, 2000b, 2001, 2002a, 2004). Again, the applicable EAR was used in the calculation for each individual.

[7] In the technique (IOM, 2001) used for the analyses in this report for applying the probability approach, a probability of inadequate iron intake (IOM, 2001; Table I-7) is associated with the estimated usual intakes that fall within a certain range (percentile) of observed intakes (IOM, 2001; Table I-4). Combining the associated probabilities of inadequacy across a subgroup then gives the overall percentage of the subgroup with inadequate usual intakes. For the analysis of iron intakes for women, the Committee used the probabilities of inadequacy associated with the ranges of usual intake distribution for mixed populations of menstruating women, either adolescent (IOM, 2001; Table I-6) or adult (IOM, 2001; Table I-7). These mixed populations represent 17 percent oral contraceptive users and 83 percent non-oral contraceptive users as found appropriate from 1995 national survey data (Abma et al., 1997; IOM, 2001).

For micronutrients without an EAR—that is, for nutrients with an AI—usual intake distributions are presented and mean intakes are compared with the AI. However, for nutrients with an AI, it is important to note that limited inferences can be made regarding the prevalence of inadequacy. If mean intake levels are equal to or exceed the AI, it is likely that the prevalence of inadequacy is low; but if mean intakes are less than the AI, no conclusions can be drawn about the prevalence of inadequacy (IOM, 2000a). In addition, it is possible to infer that the proportion of individuals with usual intakes that exceed the AI is a lower boundary on the prevalence of nutrient *adequacy* in the group.

Most of the AIs for infants are based on the nutrient content of human milk. One exception is calcium, where separate AIs are specified for formula-fed infants (0.32 g/d for 0 through 6 months of age; 0.34 g/d for 7 through 11 months of age) (Table 3-1) versus breastfed infants (0.21 g/d for 0 through 6 months of age; 0.27 g/d for 7 through 11 months of age). Other exceptions are the iron and zinc requirements for infants 7 through 11 months of age, where the content of breast milk is inadequate for most infants (Krebs, 2000; Dewey, 2001; Krebs and Westcott, 2002). Therefore, foods supplying both iron and zinc are needed for all 7- through 11-month old infants, whether breastfed or not. Sources of fortificant zinc should not exceed the UL; this may be a problem with formula-fed infants.

What is the prevalence of excessive intakes of particular nutrients?

The proportion of WIC-income-eligible subgroups with usual intakes exceeding the UL is an estimate of the proportion of each subgroup at risk of excessive intake levels. This research question of estimating the risk of excessive intake levels can be addressed only by using ULs; however, ULs have not been established for all nutrients. In addition, since some ULs refer to intakes from supplements, and since the data used in the analyses presented in this chapter (see below) do not include intakes from supplements, those nutrients could not be thoroughly evaluated with respect to the percentage exceeding the UL. Specifically, the Committee estimated the proportion at risk of excessive intake levels for calcium, iron, zinc, preformed vitamin A, vitamin C, and vitamin B6, but not for magnesium and vitamin E. In addition, for fat, protein, and carbohydrate, the committee analyzed the usual distributions of intakes as a percentage of food energy intake and estimated the proportion above the AMDR.

Data Set

The primary data sets used in these analyses are the 1994-1996 and 1998 Continuing Survey of Food Intakes by Individuals (CSFII) (FSRG, 2000).[8] The 1994-1996 CSFII provides information on food and nutrient intake over two non-consecutive days for 16,103 individuals of all ages and gender, and of a variety of income levels, racial and ethnic groups, and sociodemographic characteristics (Tippett and Cypel, 1997). The survey, conducted over three years, was designed so that the information collected on any one year would constitute a nationally representative sample of individuals of all ages. The samples were selected using stratified, clustered multi-stage sampling procedures, with an over-sampling of low-income individuals. Food intake data were collected using 24-hour dietary recalls, which included information on the type and quantities of all foods consumed by individuals over two non-consecutive days and the nutrients derived from those foods. The CSFII data sets do not include

[8] Dietary supplement use was not part of the analyses on this data set.

intake from dietary supplements such as multivitamin and mineral preparations. In addition, the 1994-96 CSFII survey provides sociodemographic information, including income and participation in food assistance programs (Tippett and Cypel, 1997). The overall response rates for the 1994-96 CSFII were 80% for the day-1 and 76% for the 2-day portions of the survey (Goldman and Nowverl, 1997).

The 1998 Supplemental Children's Survey was designed to be a one-time supplement to the 1994-1996 CSFII, using the same design and survey methodology of the CSFII (Tippett and Cypel, 1997). Dietary intake data were collected from 5,559 infants and children aged 0 through 9 years over two non-consecutive days between November 1997 and October 1998. The sample was designed to be a stand-alone, nationally representative sample of children in that age range; also, however, it could be combined with the dietary information collected for infants and children up to nine years of age in the 1994-1996 CSFII. Combining the data from the 1998 Supplemental Children's Survey sample and the 1994-1996 CSFII provides a large sample of children for the Committee's analyses.[9]

Analysis Sample

The analysis sample includes WIC-income-eligible respondents from the CSFII 1994-1996 and 1998 (FSRG, 2000) who completed 24-hour dietary recalls either for day-1 and day-2, or day-1 only. WIC-income-eligible respondents lived in households with income less than or equal to 185 percent of the federal poverty threshold and were in one of the following categorical subgroups:

- *Infants less than one year of age, non-breastfed:* total (n = 626); WIC participants (n = 443); and income-eligible nonparticipants (n = 176).[10] Because data on the quantity of breast milk consumed are not available, breastfeeding infants were excluded. Although breastfed infants must be excluded from the analyses in this chapter, breastfed infants were considered when feasible in the overall project, primarily in the analyses of nutrition-related health risks and outcomes described in Chapter 5. Because, iron, zinc, and protein have EARs for infants 7 through 11 months of age, this age group (n = 276) was analyzed separately for these nutrients in estimating the percentage with usual intakes less than the EAR.
- *Children 1 through 4 years of age:* total (n = 2,800); WIC participants (n = 1,038); and income-eligible nonparticipants (n = 1,739). Breastfeeding children were excluded from the analyses.
- *Women of reproductive ages* divided into three groups: 14 through 18 years of age not pregnant or lactating (n = 176); 19 through 44 years of age not pregnant or lactating (n = 751); and pregnant or lactating women 14 through 50 years of age (n = 57). Because of small sample sizes, pregnant and lactating women could not be analyzed separately. In addition, because of the small sample of pregnant and lactating women, the Committee placed more weight on the results for low-income women of reproductive age.

Although the Committee analyzed both WIC-participant and eligible-nonparticipant subgroups, no noteworthy differences were observed in the data. The data were not analyzed to

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[9] The response rates are not readily available for the children participating in the 1994-96 CSFII (Tippett and Yasmin, 1997; Goldman and Nowverl, 1997) or the 1998 Supplemental Children's Survey (BARC, 2004).

[10] The discrepancy between the total sample size of low-income infants under the age of one year and the sum of the sample sizes of WIC participants and income-eligible nonparticipants is because some respondents have missing data on WIC participation.

see if any small differences between the WIC participant and income-eligible-nonparticipant subgroups were statistically significant. The complete set of data is represented in Appendix A; however, only data on the total group (WIC-participants and income-eligible-nonparticipants combined) are presented in the body of the report.

Nutrients and Dietary Components Selected for Analysis

In order to choose which nutrients to consider in these analyses the Committee turned to several recent reports to find nutrients considered to be of public health concern (LSRO, 1995a, 1995b; FNS, 2003; IOM, 1997, 1998, 2000b, 2001, 2002a, 2002b). The following nutrients and dietary components were selected to be examined:

- Nutrients previously targeted by the WIC program—calcium, iron, vitamin A, vitamin C, and protein (FNS, 2003);
- Other nutrients considered of public health significance—magnesium, vitamin D, vitamin E, vitamin B_6, folate, potassium, sodium, and fiber (LSRO, 1995a, 1995b; IOM, 1998, 2000b, 2004; Calvo and Whiting, 2003);
- Macronutrients—food energy and the percentage of food energy from fat, carbohydrate, and protein (LSRO, 1995a, 1995b; IOM, 2002a); and
- Components of dietary fat (LSRO, 1995a, 1995b; IOM, 2002a, 2002b; WHO, 2003),
- Added sugars as a percentage of food energy (LSRO, 1995a, 1995b; IOM, 2002a; WHO, 2003).

The following is an illustration of the route the Committee used to choose which nutrients to consider for analysis. The most recent report of the Interagency Board for Nutrition Monitoring and Related Research (LSRO, 1995a, 1995b) classified all of the food components listed in the bullets above as current or potential public health issues. The Committee found at least one other published report that also considered each of these nutrients as a current or potential public health issue.

A second set of nutrients were also identified in theLSRO report as potential public health issues but were not examined by the Committee because other reports indicated the nutrients in this second set were not current or potential public health issues that are relevant to the WIC participants. The following are the nutrients listed in the LSRO report that were not analyzed by the Committee and the reasons are indicated: selenium intakes appear to be adequate in the U.S.[11] (IOM, 2000; ATSDR, 2003a); fluoride is commonly ingested in water or oral health

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[11] Dietary selenium varies depending on the selenium content of the soil in which plants are grown for human consumption or animal feed. There is substantial variability in the selenium content of any given food product. Food composition tables are based on average content of items from various sources; thus evaluation of dietary intakes in of selenium is inherently inaccurate. There is a potential for significant regional variability in selenium intake in North America; however, this has been largely buffered by the food distribution system in which extensive movement of food products protects individuals residing in areas with low-selenium soil from having low selenium intakes. Data from NHANES III show that serum levels of selenium in the U.S. population are quite adequate, with 99 percent of the population having levels at or above the cut point that is believed to represent maximum function in terms of selenium-dependent biochemical functions (LSRO, 1995a, 1995b; IOM, 2000).

products rather than in food (IOM, 1997, ATSDR, 2003b); vitamin B_{12}[12] is not considered a nutrient of concern at the ages of participants in the WIC program (IOM, 1998); fat substitutes were not considered relevant to the WIC population; and alcohol was not considered relevant to the WIC food packages.[13] Some isolated food components identified in the LSRO report were considered by the committee only as part of a larger category as follows: saturated fatty acids, monounsaturated fatty acids, polyunsaturated fatty acids, *trans* fatty acids, and cholesterol are considered as part of total fat; and some carotenes were considered as part of total vitamin A RAE (retinol activity equivalents).

Data Considerations

Several important issues need to be considered when interpreting the results presented on the nutrient adequacy of WIC-income-eligible subgroups. First, there are differences across subgroups in the accuracy of 24-hour dietary recalls. Many studies have documented the underestimation of food energy intakes among adult subgroups, especially among overweight adults (Mertz et al., 1991; Johansson et al., 1998; Schoeller and Schoeller, 2002). To the extent that lower reported food energy intakes are related to lower nutrient intake levels, the prevalence of inadequacy is overestimated for subgroups that exhibit underreporting. In contrast to studies documenting underreporting by adults, some studies suggest that food and nutrient intakes are over-reported for young children (Devaney et al., 2004). If this over-reporting of food energy intakes is associated with higher nutrient intakes, the prevalence of inadequacy for these subgroups would be underestimated. Thus intake data are biased to some extent by under-reporting in data for adults and over-reporting in data for children and conclusions must be tempered by these limitations.

A second data consideration concerns vitamin E. Fats and oils are major carriers of vitamin E, but they differ in their vitamin E content, and the amounts and types of fats and oils consumed are especially difficult to assess using diet recall methods (IOM, 2000b). A general data consideration in analyses of the dietary intake of any nutrient is that food composition databases contain mere estimates of the nutrient content of the foods actually consumed during dietary surveys. Because of the wide variations in the vitamin E content of fats and oils, additional concerns have been raised about the accuracy of the vitamin E values of foods in the food composition databases (IOM, 2000b). Thus, there are added reasons to question the accuracy of the reported vitamin E intakes in any data set utilized for the type of analyses described in this chapter. A third data consideration concerns folate. Folate intakes from the 1994-1996 and 1998 CSFII underestimate current folate intakes, since the data were collected prior to the mandatory folate fortification of the food supply. In addition, folate intakes from the

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[12] Dietary vitamin B_{12} is obtained primarily from foods that are of animal origin or that have been fortified (Herbert, 1988). Vitamin B_{12} deficiency can develop if the ability to absorb vitamin B_{12} is impaired; however, this problem is uncommon in individuals under 50 years of age (LSRO, 1995a). Thus vitamin B_{12} is not a concern except for individuals on primarily vegetarian diets (IOM, 1998; Herrmann et al., 2001; Obeid et al., 2002; Herrmann and Geisel, 2002; Hermann et al., 2003). The percentage of vegetarians in the general population is likely to be very low (ADA/Dietitians of Canada, 2003), 2.5 percent of the U.S. adult population in 2000 (VRG, 2000). The percentage of individuals following a vegan diet is lower (ADA/Dietitians of Canada, 2003), 0.9 percent of the U.S. adult population (VRG, 2000). Somewhat lower percentages of children (as young as six years of age) and adolescents have been reported to be vegetarian (VRG, 2001).

[13] A few micronutrients were not classified as current public health issues. These included: iodine, thiamin, riboflavin, and niacin (LSRO, 1995a).

CSFII are not available as Dietary Folate Equivalents, which is the form in which folate recommendations are expressed. As a result, folate was not examined in these analyses of nutrient intakes, but is considered in Chapter 5.

A final data consideration is vitamin D. The CSFII does not provide data on vitamin D intakes. As with folate, Chapter 5 presents evidence on vitamin D adequacy for the WIC target population.

RESULTS AND DISCUSSION

Infants Under One Year of Age

For infants, requirements for many nutrients are expressed in terms of the AI and methods for assessing nutrient adequacy are limited primarily to comparing mean intakes to the AI. For all nutrients in Table 3-3, mean usual intake exceeded the AI (see below for nutrients in Table 3-3 with EAR). These findings are in agreement with the 2002 Feeding Infants and Toddlers Study (FITS) that used a different data set and found that mean (or median) intakes exceeded the AI for infants 3 through 6 months and 7 through 11 months of age (breastfed and non-breastfed infants combined) for the nutrients listed in Table 3-3 with the exception of potassium and sodium, which were not analyzed in FITS (Devaney et al., 2004). In fact, in both Table 3-3 and FITS, the 10th percentile of the usual intake distribution was equal to or exceeded the AI for the vitamins and minerals examined, suggesting that infants have nutritionally adequate diets.

Three nutrients in Table 3-3—iron, zinc, and protein—have an EAR rather than an AI for infants 7 through 11 months. The estimated prevalence of inadequacy (percentage with usual intakes less than the EAR) for iron was 4.5 percent for low-income non-breastfeeding infants. The prevalence of inadequate zinc and protein intake among low-income non-breastfeeding infants was low, less than one percent. Again these findings are in agreement with the 2002 FITS that also found a low incidence of inadequate intakes for iron, zinc, and protein among infants 7 through 11 months (breastfed and non-breastfed infants combined) (Devaney et al., 2004).

TABLE 3-3 Usual Intake Distributions of Selected Micronutrients, Protein, Potassium, and Sodium: WIC-Income-Eligible Infants, Age Under One Year, Non-Breastfeeding

		Intake Distribution (percentiles and mean), 0 through 11 mos						AI		EAR	% < EAR
Nutrient	Units (per day)	10th	25th	Median	Mean	75th	90th	0-6 mos	7-11 mos	7-11 mos	7-11 mos
Calcium	g	0.40	0.50	0.63	0.67	0.80	1.01	0.32	0.34		
Iron	mg	8.6	11.3	14.7	15.7	18.8	23.9	0.3		6.9	4.5%
Zinc	mg	4.3	5.3	6.5	6.8	8.0	9.6	2.0		2.5	0.3%
Magnesium	mg	50	67	92	101	124	163	30	75		
Vitamin A	mcg as RAE	432	525	663	704	840	1,025	400	500		
Vitamin C	mg	58	76	100	110	134	175	40	50		
Vitamin E	mg	5.7	8.2	10.7	11.0	13.3	16.4	4.0	5.0		
Vitamin B_6	mg	0.36	0.46	0.60	0.65	0.77	0.99	0.10	0.30		
Protein[a]	g	12	15	20	22	27	35	9.1		9.9	0.6%
Potassium	g	0.61	0.79	1.04	1.12	1.36	1.72	0.40	0.70		
Sodium	g	0.16	0.22	0.34	0.50	0.61	1.05	0.12	0.37		

NOTE: AI = Adequate Intake, EAR = Estimated Average Requirement, RAE = retinol activity equivalents, % < EAR = percentage with intakes less than EAR. The % < EAR is an estimate of the percentage with inadequate intake. For iron, the % < EAR is estimated using the probability approach (NRC, 1986; IOM, 2001). For calcium, the AIs presented are for non-breastfed infants. All other AIs presented are based on mean intakes of healthy breastfed infants. AIs for non-breastfed infants have not been set for these nutrients, although the bioavailability of some nutrients, especially iron and zinc (Lönnerdal et al., 1981; Pabon and Lönnerdal, 2000), is known to be lower in infant formula than in breast milk.

[a] The DRIs for protein include an AI of 1.52 g/kg body weight/d for infants age 0 through 6 months and an EAR of 1.1 g/kg/d for infants age 7 through 11 months. The determination of the percent less than the EAR for infants age 7 through 11 months is based on this EAR value.

DATA SOURCE: Intake data are from 1994-1996 and 1998 CSFII (FSRG, 2000); data set does not include intake from dietary supplements (e.g., multivitamin and mineral preparations) or sodium intake from table salt. The analysis sample from the CSFII data set included only respondents living in households with income less than or equal to 185 percent of the federal poverty threshold. EAR and AI are from IOM (1997, 1998, 2000b, 2001, 2002a, 2004). Intake distributions were calculated using C-SIDE (ISU, 1997).

TABLE 3-4 Usual Food Energy Intakes and Estimated Energy Requirements: WIC-Income-Eligible Infants, Under One Year of Age, Non-Breastfeeding

	Intake Distribution (percentiles and mean), 0-11 mos					
	10th	25th	Median	Mean	75th	90th
Usual food energy intakes (kcal/d)	526	652	821	859	1,024	1,241
EER (kcal/d) [a]	443	539	637	659	759	903

NOTE: EER = Estimated Energy Requirement.

[a] EER was calculated for each infant using body weight and the age-appropriate Energy Deposition coefficient (IOM, 2002a).

Data Source: Intake data are from 1994-1996 and 1998 CSFII (FSRG, 2000). The analysis sample from the CSFII data set included only respondents living in households with income less than or equal to 185 percent of the federal poverty threshold. EER are from IOM (2002a). Intake distributions were calculated using C-SIDE (ISU, 1997).

Both the mean and median usual intakes of food energy, as well as the estimated percentiles of the usual energy intake distribution, exceeded the comparable percentiles of the EER distributions (Table 3-4). For low-income infants under one year of age (excluding breastfeeding infants), mean food energy intake (859 kcal) exceeded mean EER (659 kcal) by 200 kcal per day, or by about 30 percent.

Three possible reasons may explain this excess of food energy intake over requirements: (1) over-consumption of food energy; (2) over-reporting of foods consumed; and (3) underestimation of EERs. Although the increasing prevalence of overweight and obesity among children is consistent with an excess consumption of food energy, the magnitude of the difference between mean intake and mean EER suggests that parents or caregivers over-report food intakes of children. This finding also has been observed in other studies (Eck, 1989; Devaney et al., 2004). To the extent that caregivers do over-report the food intakes of infants and children, the estimated rates of inadequate nutrient intakes in this report (and other analyses of similar data) are underestimates. An interesting proposition to consider is the extent to which over-reporting of food intakes because of its social desirability may also then be correlated with overfeeding of foods to children.

The third possible reason for the excess of food energy intakes over EERs—underestimation of EERs—could occur if parents do not report their infant's weight correctly. Assuming that weight is assessed at well-baby visits to a doctor or clinic, it is probable that most infants would have gained weight between the time they were last measured and the date of the CSFII interview. Using higher weights in the EER calculations would have resulted in higher values for the EER, and therefore a smaller difference between the EER and reported intake. For example, a difference in weight of 1 kg (2.2 pounds) would increase the EER by 89 kcal (IOM, 2002a).

Children 1 Through 4 Years of Age

With the exception of vitamin E, the prevalence of inadequate micronutrient intake for low-income children 1 through 4 years of age was low, in most cases around 1 percent or less, and estimates of protein inadequacy were zero (Table 3-5). For calcium, mean intake exceeded the AI, also suggesting adequate intake levels for WIC-income-eligible children. In contrast,

vitamin E had a high prevalence of inadequacy; more than half of low-income children had inadequate estimated usual intakes. For both fiber and potassium, mean intakes were below the AI. In fact, the 90th percentile of usual fiber and potassium intakes were below the AI, suggesting that intakes of these two dietary components may be inadequate.

As with infants, reported food energy intakes of children 1 through 4 years of age exceeded the EER (Table 3-6). The magnitude of the difference depended on the assumed physical activity level; at low-active levels, mean reported food energy intake exceeded the mean EER by about 300 kcal per day, and at active levels by about 200 kcal per day.

Results on the percentage of food energy from fat, protein, total carbohydrate, and added sugars suggest that many children had usual fat intakes outside the AMDR (Table 3-7). Regarding the percent of food energy from fat, more individuals were below the lower boundary of the AMDR of 30 percent of food energy from fat than were above the upper boundary of 40 percent (16 .8 versus 12.2 percent). From this analysis, total fat may be excessive in diets of some children, however, since more children have usual fat intakes that are lower than recommended as a percentage of food energy, reducing total fat intake in children is not a priority. The added sugars recommendation applies only to children two years of age and older. Estimates of the percentage of low-income children with added sugars intakes exceeding 25 percent of food energy for the 2 through 4 year olds were under 5 percent.

TABLE 3-5 Usual Intake Distributions of Selected Micronutrients, Protein, Potassium, and Fiber: WIC-Income-Eligible Children, Ages 1 Through 4 Years

		Intake Distribution (percentiles and mean), 1 through 4 years						AI		EAR [a]		% < EAR [a]
Nutrient	Units (per day)	10th	25th	Median	Mean	75th	90th	1-3 y	4 y	1-3 y	4 y	1-4 y
Calcium	g	0.50	0.64	0.81	0.84	1.00	1.21	0.50	0.80			
Iron	mg	7.4	9.2	11.6	12.2	14.6	17.9			3.0	4.1	1.0%
Zinc	mg	5.6	6.7	8.2	8.6	10.0	12.0			2.5	4	0.1%
Magnesium	mg	132	158	191	197	230	269			65	110	0.7%
Vitamin A	mcg as RAE	369	458	578	625	733	929			210	275	0.7%
Vitamin C	mg	50	70	97	105	132	169			13	22	0.2%
Vitamin E	mg	3.2	4.0	5.0	5.4	6.4	8.0			5.0	6.0	55.4 %
Vitamin B_6	mg	0.92	1.11	1.38	1.43	1.69	2.02			0.40	0.50	0.0%
Protein [b]	g	37	44	53	55	64	75			11	15	0.0%
Potassium	g	1.4	1.7	2.0	2.1	2.4	2.9	3.0	3.8			
Total Fiber	g	6	7	10	10	12	15	19	25			

NOTE: AI = Adequate Intake, EAR = Estimated Average Requirement, RAE = retinol activity equivalents, % < EAR = percentage with intakes less than EAR. The % < EAR is an estimate of the percentage with inadequate intake. For iron, the % < EAR is estimated using the probability approach (NRC, 1986; IOM, 2001).

[a] To calculate the % < EAR the intake of each individual was compared to the applicable EAR according to age.

[b] The EAR for protein is 0.88 g/kg body weight/d for children ages 1 through 3 years and 0.76 g/kg/d for children ages 4 through 8 years. The determination of the percent less than the EAR was based on these values.

DATA SOURCE: Intake data are from 1994-1996 and 1998 CSFII (FSRG, 2000); data set does not include intake from dietary supplements (e.g., multivitamin and mineral preparations). The analysis sample from the CSFII data set included only respondents living in households with income less than or equal to 185 percent of the federal poverty threshold. EAR and AI values are from IOM (1997, 1998, 2000b, 2001, 2002a, 2004). Intake distributions were calculated using C-SIDE (ISU, 1997). Breastfeeding children are excluded from this analysis.

TABLE 3-6 Usual Food Energy Intakes and Estimated Energy Requirements: WIC-Income-Eligible Children, 1 Through 4 Years, Non-Breastfeeding

	Intake Distribution (percentiles and mean)					
	10th	25th	Median	Mean	75th	90th
Usual food energy intakes (kcal/d)	1,049	1,240	1,476	1,516	1,750	2,037
EER-Low active (kcal/d) [a]	883	1,041	1,229	1,216	1,380	1,511
EER-Active (kcal/d) [a]	889	1,053	1,323	1,301	1,523	1,676

NOTE: EER = Estimated Energy Requirement.

[a] For children ages 1 through 2 years an EER was calculated for each individual using body weight and the age-appropriate Energy Deposition factor (IOM, 2002a). For children ages 3 through 4 years an EER was calculated for each individual using age, body weight, height, the age-appropriate Energy Deposition factor, and the sex- and age-appropriate PA coefficient (Physical Activity coefficient) for the indicated PAL (Physical Activity Level; Low Active or Active) (IOM, 2002a).

DATA SOURCE: Intake data are from 1994-1996 and 1998 CSFII (FSRG, 2000). The analysis sample from the CSFII data set included only respondents living in households with income less than or equal to 185 percent of the federal poverty threshold. EER are from IOM (2002a). Intake distributions were calculated using C-SIDE (ISU, 1997).

TABLE 3-7 Macronutrients and Added Sugars: WIC-Income-Eligible Children, 1 Through 4 Years [a]

Percent of Food Energy Intake						
Fat		Protein		Total Carbohydrate		Added Sugars [a]
< 30%	> 40%	< 5%	> 20%	< 45%	> 65%	> 25%
16.8%	12.2%	0.6%	2.0%	5.0%	1.7%	4.3%

[a] For added sugars, data were available only for children 2 through 4 years of age. The recommendation to limit added sugars to less than 25% of food energy intake is to be applied only to children 2 through 4 years of age.

DATA SOURCE: Intake data used in calculations are from 1994-1996 and 1998 CSFII (FSRG, 2000). The analysis sample from the CSFII data set included only respondents living in households with income less than or equal to 185 percent of the federal poverty threshold. Recommendations are from IOM (2002a).

Females of Reproductive Age

The diets of women of reproductive age had high levels of inadequacy (Table 3-8). The micronutrients with the highest prevalence of inadequacy were magnesium and vitamin E, where more than 75 percent of non-pregnant and non-lactating women had usual intakes less than the EAR. For vitamin E, the estimated prevalence of inadequacy for adolescent females was 100 percent. Vitamins A, C, and B_6 had estimates of the prevalence of inadequacy between 25 and 53 percent for women 19 through 44 years of age. Two remaining micronutrients—iron and zinc—had more moderate estimates of the prevalence of inadequacy. For females 14 through 18 years of age, only 10 to 11 percent have inadequate intakes of these two nutrients, while for women 19 through 44 years of age, 21 to 22 percent had inadequate intakes. It is noteworthy that inadequacy of iron intakes could not be evaluated for pregnant and lactating women due to technical considerations.[14] For pregnant and lactating women, vitamin E had the greatest proportion of individuals whose diets were classified as inadequate. Magnesium and vitamin A had prevalences of inadequacy in the range of 50 to 60 percent, and vitamin C and vitamin B_6 had lower prevalences in the range of 30 to 40 percent.

Estimates of protein inadequacy were lower than for the other nutrients in Table 3-8. Less than 5 percent of low-income adolescent women had inadequate protein intakes. For low-income women 19 through 44 years of age and for pregnant and lactating women, the prevalence was somewhat higher but still moderate (17.4 percent for low-income women 19 through 44 years of age and 10.8 percent for pregnant/lactating women). For all subgroups, mean intakes of calcium, potassium, and fiber were far less than the AI, suggesting inadequate intakes. Although mean intakes below the AI do not necessarily imply nutrient inadequacy, when mean intakes are far below the AI, concerns about nutrient adequacy may arise. For calcium, potassium, and fiber, mean usual intakes are far below the AI. In fact, for low-income adolescent and adult women 19 through 44 years, even the 90th percentiles of usual intakes of these nutrients are below the AI, suggesting inadequate intakes.

Reported intakes of food energy were less than the EER for women of reproductive ages, especially for low-income adult women (Table 3-9). For low-income adult women 19 through 44 years of age, mean reported food energy intake was more than 400 kcal less than the mean EER. The magnitude of this difference would imply a weight loss that has not been observed among low-income women, suggesting underreporting of food energy intakes by adult women.

Results on the percentage of food energy from fat, protein, carbohydrate, and added sugars suggested that many adolescent females and almost a third of women 19 through 44 years of age had usual fat intakes outside the AMDR and had intakes of added sugars above 25 percent

[14] As noted earlier in this chapter, due to limitations in the data set required for analysis of inadequacy of iron intakes using the probability approach, the percentage of inadequacy of iron intakes was not estimated for pregnant and lactating women.

TABLE 3-8 Usual Intake Distributions of Selected Micronutrients, Protein, Potassium, and Fiber: WIC-Income-Eligible Women

Nutrient (units per day)	Subgroup	Intake Distribution (percentiles and mean), 14-44 y						AI		EAR[a]			% < EAR[a]
		10th	25th	Median	Mean	75th	90th	14-18 y	19-44 y	14-18 y	19-30 y	31-44 y	14-44 y
Calcium (g)	14-18 y	0.50	0.59	0.71	0.73	0.84	0.98	1.30					
	19-44 y	0.33	0.44	0.58	0.62	0.76	0.95		1.00				
	Pregnant[b]	0.57	0.71	0.87	0.91	1.07	1.29	1.30	1.00				
	Lactating[b]							1.30	1.00				
Iron (mg)	14-18 y	8.7	10.5	12.8	13.4	15.7	18.9			7.9			11.1%
	19-44 y	7.4	9.2	11.8	12.6	15.0	18.7				8.1	8.1	20.9%
Zinc (mg)	14-18 y	7.3	8.5	9.9	10.1	11.5	13.2			7.3			10.0%
	19-44 y	5.7	7.0	8.8	9.4	11.0	13.7				6.8	6.8	21.9%
	Pregnant[b]	10.0	11.0	12.3	12.4	13.7	15.1			10.5	9.5	9.5	5.8%[b]
	Lactating[b]									10.9	10.4	10.4	
Magnesium (mg)	14-18 y	166	187	213	216	241	270			300			96.7%
	19-44 y	132	165	208	217	259	314				255	265	75.5%
	Pregnant[b]	175	215	265	272	322	378			335	290	300	57.4%[b]
	Lactating[b]									300	255	265	
Vitamin A (mcg as RAE)	14-18 y	338	420	529	557	664	812			485			39.9%
	19-44 y	254	345	482	569	689	976				500	500	52.8%
	Pregnant[b]	419	504	616	641	751	896			530	550	550	56.0%[b]
	Lactating[b]									880	900	900	
Vitamin C (mg)	14-18 y	45	61	83	89	110	140			56			19.8%
	19-44 y	35	51	76	85	110	148				60	60	44.1%
	Pregnant[b]	49	78	124	146	190	271			66	70	70	30.9%[b]
	Lactating[b]									96	100	100	
Vitamin E (mg)	14-18 y	5.9	6.3	6.7	6.7	7.2	7.6			12.0			100%
	19-44 y	4.0	5.0	6.3	6.6	7.9	9.6				12.0	12.0	97.5%
	Pregnant[b]	4.5	5.5	7.0	7.6	8.9	11.3			12.0	12.0	12.0	95.2%[b]
	Lactating[b]									16.0	16.0	16.0	

Vitamin B_6	14-18 y		0.99	1.20	1.45	1.49	1.74	2.03			1.00				10.5%
(mg)	19-44 y		0.87	1.09	1.38	1.44	1.72	2.08				1.10	1.10		25.6%
	Pregnant [b]		1.26	1.50	1.80	1.84	2.13	2.46			1.60	1.60	1.60		36.1% [b]
	Lactating [b]										1.70	1.70	1.70		
Protein [c]	14-18 y		51	58	67	68	76	86			38				4.4%
(g)	19-44 y		42	51	62	64	75	88				38	38		17.4%
	Pregnant [b]		64	71	79	79	87	94			†	†	†		10.8% [b]
	Lactating [b]										†	†	†		
Potassium	14-18 y		1.7	1.9	2.2	2.2	2.5	2.9	4.7						
(g)	19-44 y		1.4	1.7	2.1	2.2	2.6	3.1		4.7					
	Pregnant [b]		1.9	2.3	2.8	2.8	3.3	3.8	4.7	4.7					
	Lactating [b]								5.1	5.1					
Total Fiber	14-18 y		9	11	12	12	14	15	26						
(g)	19-44 y		7	9	12	12	15	19		25					
	Pregnant [b]		9	11	14	15	18	22	28	28					
	Lactating [b]								29	29					

NOTE: AI = Adequate Intake, EAR = Estimated Average Requirement, RAE = retinol activity equivalents, % < EAR = percentage with intakes less than EAR. The % < EAR is an estimate of the percentage with inadequate intake. For iron, the % < EAR was estimated using the probability approach (NRC, 1986; IOM, 2001). For women of reproductive age, estimated percentiles of the distribution of iron requirements for a mixed adult population were used (IOM, 2001). The distributions of iron requirements were not reported for pregnant or lactating women (IOM, 2001) and therefore the percentage of inadequacy of iron intakes was not estimated for these women.

† The EAR for protein is 0.88 g/kg body weight plus 21 g for pregnant women of all age groups and 1.05 g/kg body weight plus 21.2 g for lactating women of all age groups.

[a] To calculate the % < EAR the intake of each individual was compared to the applicable EAR according to age and life stage.

[b] Because of small sample sizes, data for pregnant and lactating women were combined.

[c] The EARs for protein for non-pregnant, non-lactating women are 0.71 g/kg body weight/d for adolescents ages 14 through 18 years and 0.66 g/kg/d for adults ages 19 through 44 years. The determination of the percent less than the EAR was based on these values.

DATA SOURCE: Intake data are from 1994-1996 CSFII (FSRG, 2000); data set does not include intake from dietary supplements (e.g., multivitamin and mineral preparations). The analysis sample from the CSFII data set included only respondents living in households with income less than or equal to 185 percent of the federal poverty threshold. EAR and AI are from IOM (1997, 1998, 2000b, 2001, 2002a, 2004). Intake distributions were calculated using C-SIDE (ISU, 1997).

TABLE 3-9 Usual Food Energy Intakes and Estimated Energy Requirements: WIC-Income-Eligible Women

	Intake Distribution (percentiles and mean)					
	10th	25th	Median	Mean	75th	90th
Adolescents, 14 through 18 y						
Usual food energy intakes (kcal/d)	1,450	1,651	1,922	1,984	2,268	2,617
EER-Low Active (kcal/d) [a]	1,896	1,993	2,109	2,118	2,233	2,353
Adults, 19 through 44 y						
Usual food energy intakes (kcal/d)	1,162	1,408	1,710	1,756	2,053	2,407
EER-Low Active (kcal/d) [b]	1,970	2,048	2,148	2,185	2,280	2,447

NOTE: EER = Estimated Energy Requirement.

[a] For adolescent women (14 through 18 years of age) an EER was calculated for each individual using age, body weight, height, the age-appropriate Energy Deposition coefficient, and the sex- and age-appropriate PA coefficient for the indicated PAL (Physical Activity Level: Low Active) (IOM, 2002a).

[b] For adult women (19 through 44 years of age) an EER was calculated for each individual using age, body weight, height, and the sex- and age-appropriate PA (Physical Activity) coefficient for the indicated PAL (Physical Activity Level: Low Active) (IOM, 2002a).

DATA SOURCE: Intake data are from 1994-1996 and 1998 CSFII (FSRG, 2000). The analysis sample from the CSFII data set included only respondents living in households with income less than or equal to 185 percent of the federal poverty threshold. EER are from IOM (2002a). Intake distributions were calculated using C-SIDE (ISU, 1997).

TABLE 3-10 Macronutrients and Added Sugars: WIC-Income-Eligible Women

	Percent of Food Energy Intake						
	Fat		Protein		Total Carbohydrate		Added Sugars
	< 20%	> 35%	< 10%	> 35%	< 45%	> 65%	> 25%
Adolescents, 14 through 18 y	0.2%	27.7%	3.0%	0.0%	2.4%	0.8%	25.0%
Adults, 19 through 44 y	1.4%	33.6%	1.9%	0.0%	14.4%	4.5%	19.2%
Pregnant or lactating	0.0%	20.1%	0.4%	0.0%	1.5%	0.0%	2.2%

DATA SOURCE: Intake data are from 1994-1996 and 1998 CSFII (FSRG, 2000). The analysis sample from the CSFII data set included only respondents living in households with income less than or equal to 185 percent of the federal poverty threshold. Recommendations are from IOM (2002a).

of food energy (Table 3-10). Only a small proportion had usual fat intakes less than the lower boundary of the AMDR for fat (20 percent), but more than a quarter of adolescent women and almost one-third of women 14 through 44 years had usual fat intakes exceeding the upper boundary. One-quarter of low-income adolescent women had intakes of added sugars that were greater than 25 percent of food energy.

Excessive Nutrient Intake

Table 3-11 presents estimates of the prevalence of usual intakes above the UL. In general, the risk of excessive intakes was low, less than 1 percent for most WIC-income-eligible subgroups. Some notable exceptions were:

- Intakes of sodium appeared excessive. The percentages with usual sodium intakes above the UL were more than 80 percent of low-income children, more than 90 percent of low-income adolescent females and pregnant/lactating women, and nearly three-quarters of low-income adult women. It is noteworthy that the data set used for these analyses did not include dietary sodium added in the form of table salt.
- High proportions of non-breastfed infants and small proportions of children ages 1 through 4 years had estimated usual intakes exceeding the UL for zinc and preformed vitamin A. The percentages with usual zinc intakes above the UL were almost 90 percent of low-income, non-breastfed infants and 15 percent of low-income children. The percentages with usual preformed vitamin A intakes above the UL were almost 40 percent of low-income, non-breastfed infants and 16 percent of low-income children. It is noteworthy that the data set used for these analyses did not include intake from dietary supplements.

TABLE 3-11 Percentage of WIC-Income-Eligible Individuals with Usual Intake Above the UL.

	Infants < 1 y, non-breastfed	Children 1 through 4 y	Women		
			14 through 18 y	19 through 44 y	Pregnant or Lactating (14 through 50 y)
Calcium					
UL (g/d)	2.5	2.5	2.5	2.5	2.5
% > UL	< 1%	< 1%	< 1%	< 1%	< 1%
Iron					
UL (mg/d)	40	40	45	45	45
% > UL	< 1%	< 1%	< 1%	< 1%	< 1%
Zinc					
UL (mg/d)	4	7	34	40	40
% > UL	88.8%	14.9%	< 1%	< 1%	< 1%
Vitamin A, preformed					
UL (mcg/d)	600	600	2,800	3,000	2,800
% > UL	39.1%	16.4%	< 1%	< 1%	< 1%
Vitamin C					
UL (mg/d)	ND	400	1,800	2,000	2,000
% > UL		< 1%	< 1%	< 1%	< 1%
Vitamin B_6					
UL (mg/d)	ND	30	80	100	100
% > UL		< 1%	< 1%	< 1%	< 1%
Sodium					
UL (g/d)	ND	1.5	2.3	2.3	2.3
% > UL		86.3%	93.1%	72.4%	98.9%

NOTE: ND = not determined; UL = Tolerable Upper Intake Level (for infants, UL values listed in the table are for infants ages 0 through 6 months; for children, UL values listed in the table are for children ages 1 through 3 years).

DATA SOURCE: Intake data are from 1994-1996 and 1998 CSFII (FSRG, 2000); data set does not include intake from dietary supplements (e.g., multivitamin and mineral preparations) or sodium intake from table salt. The analysis sample from the CSFII data set included only respondents living in households with income less than or equal to 185 percent of the federal poverty threshold. UL are from IOM (1997, 1998, 2000b, 2001, 2004).

SUMMARY

The results above provide a comprehensive analyses of the nutrient adequacy of WIC-income-eligible subgroups, focusing on the prevalence of inadequate nutrient intake, risk of excessive intake, and dietary imbalances. The results indicate inadequate intakes of key micronutrients; reported food energy intakes that differ from EERs; too high a percentage of food energy from fat; a low percentage of food energy from carbohydrate; inadequate intakes of potassium and fiber; and excessive intakes of sodium. Low-income infants and young children

had diets that are more nutritionally adequate than low-income adolescent and adult women of reproductive age.

In interpreting these results, several analytic issues should be noted. First, CSFII data do not include nutrients from dietary supplements, which may reduce the prevalence of inadequacy estimated from dietary data alone, as reported in this chapter. Second, the difference between mean EER and mean food energy intakes for adolescents and adults suggested that some individuals were underreporting intakes. If food energy intakes were less than actual energy expenditures for specific subgroups, then individuals could not maintain their weight and these subgroups would then experience weight loss. Given the increase in the prevalence of overweight and obesity, however, underreporting of food intakes is the likely explanation for the difference between mean EER and mean food energy intakes.

Given the likely underreporting of food energy intakes by adolescents and adults in general (Mertz et al., 1991; Johansson et al., 1998; Schoeller and Schoeller, 2002), an important question is the extent to which the prevalence of inadequacy for micronutrients was overestimated in these analyses for adolescent and adult women in the WIC population. The answer depends on the extent of underreporting and the correlation between food energy and micronutrient intakes. Nonetheless, given the very high prevalence of inadequacy for some micronutrients—vitamin E and magnesium in particular—and the low intakes of calcium, it is unlikely that underreporting of food intakes could explain fully the apparent inadequacies in the intakes of these nutrients (IOM, 2000b).

For children, mean food energy intakes were considerably larger than mean EER for low-income children 1 through 4 years of age. Although the increasing prevalence of overweight and obesity among children was consistent with an excess of food energy intakes over requirements, the magnitude of the difference between mean intake and mean EER suggested that parents or caregivers over-report food intakes of children. To the extent that caregivers over-report the food intakes of children, the rates of inadequate nutrient intakes in this report are underestimates (Devaney et al., 2004).

Dietary intakes of vitamin E were inadequate for large proportions of the population in the data sample. For example, among low-income adolescent women, the prevalence of vitamin E inadequacy was 100 percent; vitamin E was the only nutrient with a high prevalence of inadequacy among young children (over 50 percent). Other recent studies also reported inadequate dietary intakes of vitamin E in infants (Devaney et al., 2004), children (Devaney et al., 2004), school age children (Suitor and Gleason, 2002), adolescents (Suitor and Gleason, 2002), and adults (Maras et al., 2004). Vitamin E intakes were inadequate even when dietary supplements were included in the analysis (Devaney et al., 2004). Although clinical vitamin E deficiency is rare, low dietary intake of vitamin E may increase the long-term risk of chronic disease.[15] Despite the data limitations regarding food composition and dietary intakes of vitamin E (discussed earlier in this chapter under Data Considerations) the committee cannot

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[15] Low *dietary* intake of vitamin E was correlated with an increase in the long-term risk of fatal coronary heart disease in adult populations as shown in a large 14-year longitudinal study in Finland (Knekt et al., 1994) and a large 7-year longitudinal study in Iowa (Kushi et al., 1996). However, *dietary* intake of vitamin E was not protective against myocardial infarction in a large 4-year longitudinal study in the Netherlands (Klipstein-Grobusch et al., 1999). Low intake of *dietary* vitamin E was correlated with an increased incidence of cardiovascular disease in two observational studies that also correlated the protective effect of *dietary* vitamin E with the *plasma* level of vitamin E adjusted for plasma lipid levels (Ford et al., 2003; Iannuzzi et al, 2002). That vitamin E in excess of recommended dietary guidelines does not have a protective effect was illustrated in a meta analysis of seven clinical trials utilizing *supplemental* vitamin E (Eidelman et al., 2004).

ignore the findings from the analysis of the dietary intake data—especially in light of the evidence of the beneficial effects of dietary vitamin E in reducing cardiovascular disease (Knekt et al., 1994; Kushi et al., 1996; Iannuzzi et al, 2002; Ford et al., 2003) and the possibility that vitamin E may serve an important antioxidant role during pregnancy (discussed under Nutrients and Improved Birth Outcomes in Chapter 5).

For magnesium, the proportion with inadequate intake was high for low-income adolescent and adult women of reproductive age. Almost all adolescent women, more than three-quarters of low-income adult women in their childbearing years, and more than half of pregnant and lactating women were estimated to have inadequate magnesium intakes. Suitor and Gleason (2002) also found a high prevalence of inadequacy for magnesium among school-age children.

Substantial proportions of low-income non-breastfed infants and some children had estimated usual intakes above the UL for zinc (89 and 15 percent, respectively) and preformed vitamin A (39 and 16 percent, respectively) indicating a possible risk of adverse effects. The methods used to set the UL in infants and young children for these two nutrients resulted in a narrow margin between the RDA and the UL (less than two times the RDA in the case of zinc). There has been no evidence of adverse effects from ingestion of zinc as naturally occurring in food (IOM, 2001). However, zinc is added to infant formula and also is used as a fortificant in foods that are commonly consumed by children (e.g., breakfast cereal). While certain animal-derived food sources can contribute to hypervitaminosis A, toxicity is rare without a supplemental source of retinol. Preformed vitamin A is used in infant formula and is also used as a fortificant in foods that are commonly consumed by children (e.g., milk).The finding that a considerable proportion of low-income non-breastfed infants and children had reported zinc and preformed vitamin A intakes that exceeded the UL reinforces the need to avoid unwarranted fortification and supplementation. Therefore, the Committee will consider the source of the nutrient (i.e., naturally-occurring versus fortificant) when proposing foods for the WIC food packages. This approach is in agreement with recommendations by the International Zinc Nutrition Consultative Group (Hotz and Brown, 2004).

Finally, although the WIC-income-eligible subgroups had usual iron intakes with lower prevalences of inadequacy than most nutrients examined, it is important to recognize the large body of literature suggesting positive effects of WIC participation on iron intakes (Miller et al., 1985; Brown and Tieman, 1986; Rush et al., 1988a, 1988b; Sherry et al., 1997; Rose et al., 1998; Batten et al., 1990; Pehrsson et al., 2001). Thus, the absence of evidence of substantial iron inadequacy may reflect the success of the WIC program in improving iron intakes.

While the discussion and caveats above clearly suggest caution in interpreting the results presented in this report, concerns persist about dietary inadequacies and excesses. Based on the detailed analyses results, the following nutrients are considered high priority.

- *Low-income infants under one year of age, non-breastfed:* No nutrients were identified with a high risk of inadequacy; the prevalence of inadequacy was highest for iron, at 4.5 percent. Priority nutrients related to risk of excessive intakes in non-breastfed infants are zinc, preformed vitamin A, and food energy.
- *Low-income children 1 through 4 years of age:* Priority nutrients identified as lacking in the diets of young children are vitamin E, fiber, and potassium. Nutrients that may be excessive in the diets of young children are zinc, preformed vitamin A, sodium, and food energy.
- *Low-income women of reproductive age:* Priority nutrients identified as lacking in the diets of women 14 through 44 years of age are calcium, magnesium, vitamin E, potassium, and fiber. Nutrients with more moderate, but still high, levels of inadequacy are vitamins A, C, and B_6.

Nutrients with lower levels of inadequacy are iron, zinc, and protein. Sodium intakes and fat intakes as a percentage of food energy intakes are excessive in the diets of low-income women of reproductive age.

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4

Food Intake of WIC-Eligible Populations

INTRODUCTION

An assessment method that relates food intake to the *Dietary Guidelines for Americans* (USDA/DHHS, 2000) could be very useful in determining needed changes in the WIC food package. The *Dietary Guidelines* provide science-based advice to promote health and to reduce risk for major chronic diseases through diet and physical activity. According to Public Law No. 101-445 (U.S. Congress, 1990) the *Dietary Guidelines* form the basis of federal food, nutrition education, and information programs, including the WIC program. However, since *Dietary Guidelines* are targeted to healthy people two years and older, other guidance needs to be considered for addressing the younger age groups. This chapter covers selected aspects of *Dietary Guidelines* for children ages 2 through 4 years and for women, related food intake data, and widely accepted guidance from professional groups pertaining to infants and children younger than two years. Food safety considerations, which are a part both of *Dietary Guidelines* and guidance from professional groups, are addressed separately in Chapter 2.

DIETARY INTAKES OF CHILDREN AGES 2 THROUGH 4 YEARS AND OF WOMEN

Methods of Assessing Intake

Comparison of Intakes with Food Guide Pyramid Servings

The most widely used methods to compare food intake with the *Dietary Guidelines for Americans* (Box 4-1) (USDA/DHHS, 2000) have relied on the USDA food patterns that accompany the Food Guide Pyramid (Figure 4-1) developed in 1992 (USDA/DHHS, 1992; Welsh et al., 1993)—before the release of the Dietary Reference Intakes, which were discussed in Chapter 3 (IOM, 1997, 1998, 2000b, 2001, 2002a, 2004). This Pyramid is part of a food guidance system that is based upon earlier editions of the *Dietary Guidelines* and upon recommended nutrient intakes (Recommended Dietary Allowances [RDAs]) from the National Research Council (1989b) and the Institute of Medicine (IOM, 1997). The Food Guide Pyramid was designed to feature foods commonly eaten by Americans and to address the diet as a whole,

BOX 4-1 Summary of the *Dietary Guidelines for Americans* 2000

For good health...

- *Aim for Fitness*
  - Aim for a healthy weight.
  - Be physically active each day.
- *Build a Healthy Base*
  - Let the Pyramid guide your food choices.
  - Choose a variety of grains daily, especially whole grains.
  - Choose a variety of fruits and vegetables daily.
  - Keep food safe to eat.
- *Choose Sensibly*
  - Choose a diet that is low in saturated fat and cholesterol and moderate in total fat.
  - Choose beverages and foods to moderate your intake of sugars.
  - Choose and prepare foods with less salt.
  - If you drink alcoholic beverages, do so in moderation.

SOURCE: USDA/DHHS, 2000

providing for proportionality and moderation as well as for nutrient adequacy (Dixon et al., 2001). The Pyramid, shown in Figure 4-1, features the five major food groups and suggests "healthy food choices" within each food group. Accompanying tables specify the number of servings needed from each group for different life stages and food energy intakes. Accompanying text promotes the selection of a variety of foods from the five major food groups.

A person who consumes foods from each of the major food groups in the amounts recommended based on his or her food energy intake is expected to achieve recommended nutrient intake levels without requiring highly fortified food. That person also would meet the 2000 *Dietary Guidelines* related to the intake of grains and fruits and vegetables. Attention to the "healthy food choices" and the tip of the Pyramid addresses the two guidelines related to fats and sugars, but only added sugars (as described in Chapter 3) are covered in this chapter. The *Dietary Guidelines* recommend a diet that is low in saturated fat and cholesterol and moderate in total fat for all individuals over the age of two years (IOM, 2002a). The WIC Program, in general, and WIC food packages, specifically, should encourage participants to follow these general recommendations. Data on fat intake are excluded because the analyses in Chapter 3 provide more accurate estimates of the intakes of interest than do the data sources used in this chapter.

With the upcoming release of *Dietary Guidelines* 2005, the standards for whole grains and vegetables are likely to become higher than those of the 1992 Pyramid system (Dietary Guidelines Advisory Committee, 2004; public information). Thus, the related findings in this chapter may be conservative estimates.

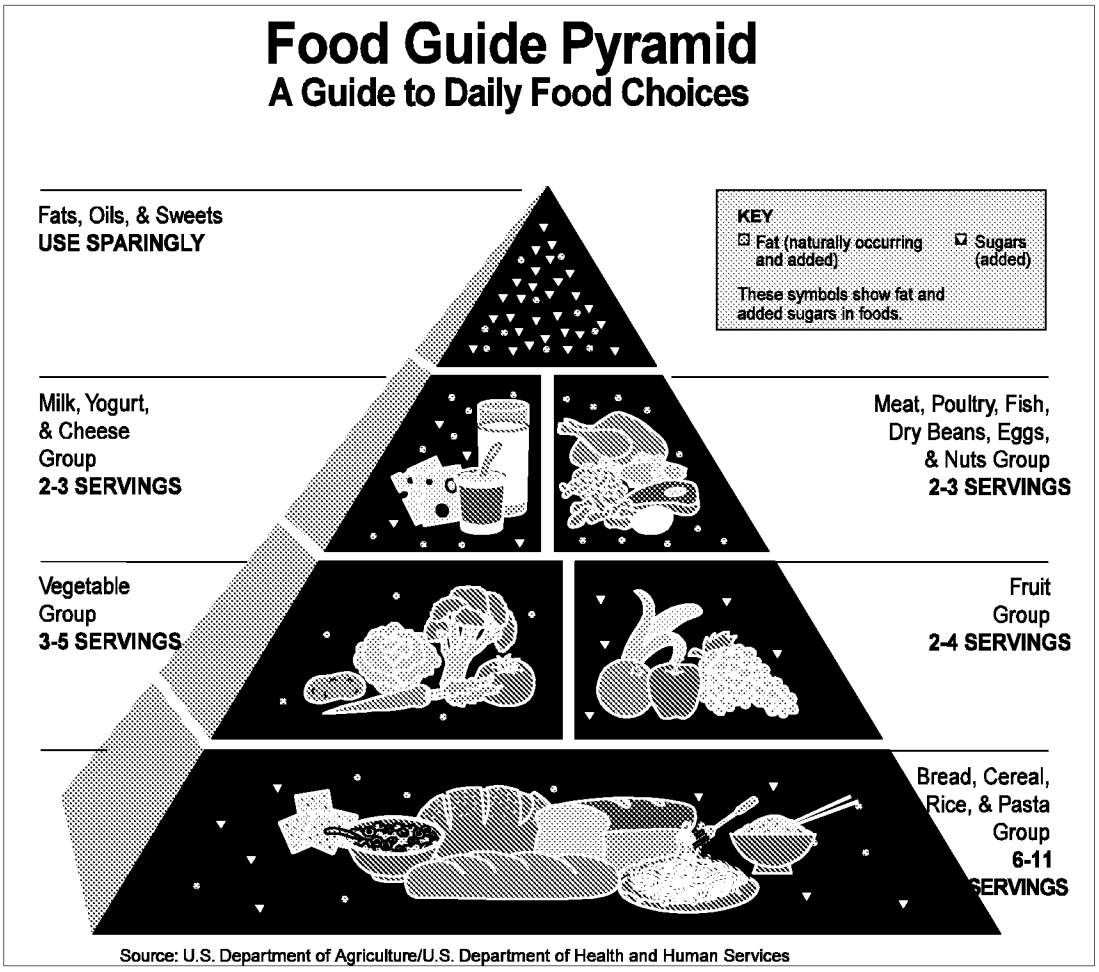

FIGURE 4-1 Food Guide Pyramid.
SOURCE: USDA/DHHS, 1992.

In 1997, Cleveland and co-workers (1997) developed a method to determine the number of Pyramid servings accurately for comparison with Pyramid recommendations. This method disaggregates food mixtures into their component parts so that each ingredient can be credited to a food group in the correct amount. For example, the ingredients in pizza are credited to the grains, milk, vegetable, and (if meat is present) to the meat and meat alternatives groups. If the meat is not lean, part of the weight is credited to the meat group and part to the discretionary fat group. The grain in a sweetened ready-to-eat cereal would be credited to the grains group and the sugar to added sugars in the Pyramid tip. The weight in grams of each food or ingredient is divided by a predetermined weight per serving to obtain the number of servings consumed.

To compare the dietary intake of a population group with Pyramid recommendations, investigators have applied the method described above (Cleveland et al., 1997) to food intake data obtained from diet recalls or diet records. The resulting analyses produce data on the percentages of persons consuming a specified number of servings from one or more food groups.

To compare dietary intake of a population group with the *Dietary Guidelines* as a whole, one also must examine the intakes of fat, cholesterol, salt (i.e., sodium), and sugars. Total fat, sodium, and added sugars are discussed in Chapter 3; added sugars are addressed in different ways in the Chapters 3 and 4. The *Dietary Guidelines* contain some overall guidance about

specific components of food. For example, *trans* fatty acids tend to raise blood cholesterol, and intakes of foods high in hydrogenated fats should be limited (USDA/DHHS, 2000). It should be noted that in the various ways of comparing dietary intake with the *Dietary Guidelines*, the published estimates are made with the unadjusted daily intake data. Unlike the nutrient analyses in the previous chapter, the food group assessments have not been adjusted to remove the effect of day-to-day variations in intakes.

Use of Indexes that Address Overall Diet Quality

The Center for Nutrition Policy and Promotion of USDA developed the Healthy Eating Index (HEI) (CNPP, 1995; Kennedy et al., 1995, 1999; Bowman et al., 1998; Ballew et al., 2000; Basiotis et al., 2002) to make an overall comparison of food intake with the *Dietary Guidelines*. This index represents the sum of equally weighted scores for each of 10 components derived from the *Dietary Guidelines*. The Diet Quality Index Revised (DQI-R) is a similar scoring method for population groups (Haines et al., 1999), but it differs from the HEI in some of its 10 components.

Because the HEI and the DQI-R are summary measures, they do not provide information useful to developing recommendations for the contents of the WIC food packages. However, the Committee examined articles that reported these summary measures to look for scores for the individual components for the relevant population groups. The Committee found no data more recent than that used below.

FINDINGS FOR YOUNG CHILDREN AND WOMEN

The scientific literature includes analyses of Pyramid servings data, by selected age groups and gender (Krebs-Smith et al., 1990, 1996, 1997a, 1997b; Welsh et al., 1994; Munoz et al., 1997, 1998; Crane et al., 1999; Cleveland et al., 2000; Smiciklas-Wright, 2002). None of these sources addressed intakes for all the five basic food groups for all the relevant age groups served by the WIC program. However, using the Food Guide Pyramid servings methods described above (and in more detail by Cleveland and colleagues, 1997), the Food Surveys Research Group, ARS, USDA, has published *Pyramid Servings Data* (FSRG, 1999a, 1999b) using data from the 1994–1996 Continuing Survey of Food Intakes by Individuals (see Chapter 3 for a description of this survey). To examine the food intake of young children and women, the Committee relied on the information in *Pyramid Serving Data* (FSRG, 1999b), which reports results by gender, age group, and three income levels but not by WIC participation. This chapter presents data on the subjects having incomes under 131 percent of the federal poverty level, the group closest to that served by the WIC program. Separate data are not available for pregnant and lactating women. The data presented in this chapter cover the age groups most relevant to the WIC program—boys and girls ages 2 to 5 years and for females ages 12 to 19 years and 20 to 39 years.

The data represent 2-day averages, but they have not been adjusted for within-person variation. Thus, as discussed in Chapter 3, the food intake data are subject to greater error than are the nutrient data presented in that chapter. In addition, the food intake data on children are subject to over-reporting bias, and the data on women are subject to under-reporting bias, as identified in Chapter 3. Table 4-1 shows *mean* servings of foods from the five basic food groups and for selected food subgroups. It also gives the mean number of teaspoons of added sugars consumed. Table 4-2 shows the percentages of individuals consuming the *minimum* number of Pyramid servings recommended. The Committee chose this as a conservative estimate of the

TABLE 4-1 Mean Numbers of Servings from the Five Basic Food Groups with Selected Subgroups, and Mean Teaspoons of Added Sugars, Consumed by Selected Age Groups, Income Under 131 Percent of Federal Poverty Level

Sex:	Recommended	Male	Female		
Age:	Minimum Number of Servings [a]	2–5 y	2–5 y	12–19 y	20-39 y
		Mean Number of Servings [a] Consumed			
Grains, total	**6**	6.3	6.0	6.3	5.4
Whole grain		0.8	0.8	0.9	0.8
Vegetables, total	**3**	2.3	2.3	2.8	2.8
Dark green leafy		†	0.1	0.1	0.1
Deep yellow		0.1	0.1	0.1	0.1
Cooked dry beans and peas		0.2	0.2	0.2	0.2
White potatoes		1.0	1.0	1.2	0.7
Other starchy		0.2	0.2	0.1	0.2
Tomatoes		0.4	0.3	0.5	0.4
Other vegetables		0.4	0.4	0.7	1.0
Fruit, total	**2**	1.9	1.8	1.1	1.2
Citrus, melons, berries		0.7	0.8	0.6	0.6
Dairy, total [b]	**2**	1.8	1.8	—	1.1
Ages 9-18 y	**3‡**	—	—	1.4‡	—
Milk		1.5	1.5	0.9	0.7
Yogurt		†	†	†	†
Cheese		0.3	0.3	0.4	0.4
Meat and meat alternatives [c] (oz)					
Total	**5**	3.2‡	3.0‡	4.3	4.3
Ages 2-3 y	**3‡**				
Meat		1.1	1.1	1.9	1.7
Poultry		0.8	0.7	0.9	1.1
Fish		0.1	0.2	0.2	0.4
Organ Meat		†*	†*	†*	†*
Frankfurter and lunch meat		0.7	0.6	0.8	0.6
Eggs		0.4	0.3	0.4	0.4
Soybean products		†*	†*	†*	†*
Nuts and seeds		0.1	0.1	0.1	0.1
		Mean Number of Teaspoons Consumed			
Added Sugars	**N/A**	14.9	14.9	19.4	17.4

Note: † = value less than 0.05 but greater than 0, ‡ = recommended minimum number of servings is different for specific age groups,* = statistical reliability is reduced due to small cell size, N/A = not applicable.

[a] Servings from each food group: fruits and vegetables, ½ cup or equivalent; grains, 1 oz dry or ½ cup cooked; dairy, 1 cup milk or equivalent; meat and meat alternatives, equivalent to 1 oz of lean meat.

[b] Intakes include small amounts of miscellaneous dairy products, such as whey and nonfat sour cream, that are not included in the subgroups milk, yogurt, and cheese.

[c] Intakes exclude cooked dry beans and peas that were tabulated as vegetables.

Data Source: Intake date are from 1996-1996 CSFII and are 2-day average intakes based on daily intakes (FSRG, 1999b). The recommended number of servings are from the Food Guide Pyramid (USDA/DHHS, 1992).

TABLE 4-2 Percentages of Individuals Consuming the Minimum Number of Recommended Servings per Day as Specified by USDA's Food Guide Pyramid, Selected Age Groups, Income Under 131 Percent of Poverty

Sex:	Recommended Minimum	Male	Female		
Age:	Number of Servings	2-5 y	2-5 y	12-19 y	20-39 y
Grains	6	52	45	46	32
Vegetables	3	29	28	40	35
Fruit	2	38	40	20	20
Dairy	2-3	35	38	21	14
Meat	5 oz	N/A	N/A	35	30

Note: N/A = not applicable from available data.

Data Source: Intake date are from 1996-1996 CSFII and are 2-day average intakes based on daily intakes (FSRG, 1999b). The recommended number of servings are from the Food Guide Pyramid (USDA/DHHS, 1992).

percentages of individuals with food patterns consistent with the food group recommendations because no adjustment for daily variation in food group intakes was made. Like the DRIs, the Pyramid system does not include a target minimum for added sugars intake. It does, however, specify a suggested maximum amount of added sugars for each of the calorie levels. The maximum reflects an amount of added sugars that can be consumed that is consistent with meeting nutrient goals for a specified number of calories. For children ages 2 to 6 years of age, this amount is about 6 teaspoons (USDA, 1999; Davis et al, 1999). For women, the suggested maximum ranges from about 8 to 12 teaspoons, depending on food energy intakes (USDA/DHHS, 1992) and food energy requirements (NRC, 1989b).

Children Ages 2 through 4 Years

Mean Servings Compared with Minimum Pyramid Servings Recommendations

For young children, Table 4-1 shows that the mean number of servings reported is smaller than the recommended minimum number of servings for the vegetable, fruit, dairy, and meat and meat alternatives groups. Using these mean numbers, the deficit in the intakes of children compared to the recommended minimum number of servings is largest for the vegetable group, 0.7 servings. In contrast, the mean number of servings of grains is slightly higher than the recommended minimum. From this analysis of the data available for intake of the major food groups (Table 4-1), the *vegetable group* appears to be the major inadequacy in the diets of children ages 2 to 5 years.

The mean servings for the food group subcategories provide useful information because of differences in the average nutrient content of the foods in the subgroups (e.g., citrus, berries, and melon provide more vitamin C and certain other micronutrients than do other fruits) and because of differences in the average cost of foods in some of the subgroups (e.g., potatoes are less costly than most other vegetables). As shown, mean intake of potatoes is much greater than of any of the other vegetables, and mean intake of frankfurters and lunch meat is relatively high. On the

other hand, mean intakes of dark green leafy vegetables, deep yellow vegetables, and legumes are very low. These subgroups are rich in a number of the nutrients of concern identified in Chapter 3. Similarly, whole grains are a better source of fiber and certain other nutrients than are refined grains, but mean intake of the whole grains is less than one serving in a day. From this analysis of the data available for intake of foods in subgroups (Table 4-1), the *vegetable group* again appears to be the major inadequacy in the diets of children ages 2 to 5 years.

Data on the mean intake of added sugars, expressed as teaspoons of sugar, can be used for assessment purposes only indirectly. The 15-teaspoon mean intake by children is equivalent to just under 1/3 cup of added sugars, whereas their suggested maximum is 5 to 6 teaspoons—one third as much. These sugars may improve the perceived palatability of the food; and, in some cases, added sugars may lead to increased intake of foods (e.g., milk, breakfast cereal) that are excellent nutrient sources (Frary et al., 2004). However, 1/3 cup of added sugars provides no essential nutrients while providing about 240 kcal.

Percentages Meeting Minimum Pyramid Servings Recommendations

As shown in Table 4-2, approximately 30 percent meet the minimum for the vegetable group, approximately 40 percent meet the minimum for the dairy and fruit groups, and approximately half of the children meet the minimum for grains. Available data on meat are misleading for the children since the data source used 5 oz as the minimum recommendation whereas 3.5 oz is the actual minimum recommendation for children 2 through 3 years old and 5 oz, for children four years old (CNPP, 1999). For this reason, the Committee could not determine the percentage of boys and girls who meet at least the minimum number of recommended servings for the meat and meat alternatives group and omitted the original data in Table 4-2. From this analysis of the of the percentage of children consuming the minimum pyramid servings recommended (Table 4-1), the *vegetable* group again appears to be the major inadequacy in the diets of children ages 2 to 5 years.

The results in Table 4-2 are similar to those reported by Krebs-Smith et al. (1996) and Munoz et al. (1997, 1998) for earlier periods. However, a comparison of recent findings with results from the earlier surveys (data not shown) indicates that in the 1994-1996 CSFII

- higher percentages of children consumed at least one serving of fruit and at least one serving of vegetables than in the 1989-1991 Continuing Survey of Food Intakes by Individuals (Krebs-Smith et al., 1996) ,
- substantially lower percentages of children consumed the number of dairy group servings recommended based on calorie intake in 1996 than in the 1989-1991 Continuing Survey of Food Intakes by Individuals (Munoz et al., 1997, 1998).

Data are not available to determine the extent of change occurring between the 1994-1996 survey and the present.

Women in the Childbearing Years

Mean Servings Compared with Minimum Pyramid Servings Recommendations

For women, Table 4-1 shows that the mean number of servings reported is smaller than the recommended minimum number of servings for all five food groups. For the 12- through 19-year-old females, reported mean intake of grains is slightly higher than the recommended minimum. The mean servings of fruit reported by the women are only slightly more than half of the minimum recommendation, but about half of the fruit is in the nutrient-rich citrus, melons,

and berries subgroup. Reported intakes from the dairy group also are quite low. The mean of 1.4 servings reported by the teens is especially notable since their recommended minimum is 3 servings. Of their total meat and meat alternatives intake, the women reported higher intake of red meat than of the other choices. From this analysis of the data available for mean intakes of the food groups (Table 4-1), the *fruit group* (with a deficit of 0.8 servings) and *dairy groups* (with a deficit of 0.9 to 1.6 servings) appear to be the major inadequacies in the diets of low-income women ages 12 to 39 years.

Mean intake of added sugars by the teens (20 tsp) is somewhat greater than that of the women (17 tsp), but both means exceed the suggested maximum, which ranges from 8 to 12 teaspoons.

Percentages Meeting Minimum Pyramid Servings Recommendations

Once again, the data need to be examined with respect to the percentages of women meeting Food Guide Pyramid recommendations. Using the least stringent definition of recommended servings—the minimum number recommended, the data show that fewer than 50 percent of the women meet the recommendation for grains, 40 percent or fewer meet the minimum recommendations for vegetable and meats, and fewer than 25 percent meet the minimums for fruit and dairy products. Less than 10 percent of the teens meet the higher 3-cup recommendation for dairy products.

In summary, the percentages of individuals consuming the minimum recommended number of servings are low for each of the five food groups. The percentages meeting the minimum recommended Pyramid servings differ for the three different age groups in Table 4-2. The major concerns are definitely the *fruit and dairy groups* women and the *vegetable group* for children. Overall, however, the percentages of individuals consuming the minimum recommended number of servings is low for each of the five food groups. The extent of the identified shortfalls may be overestimated for the women because of underreporting of intakes and the limitations of data that have not been corrected for day-to-day variation in intake. For the children, the direction of the bias is less certain.

DIETARY INTAKES OF INFANTS AND CHILDREN YOUNGER THAN TWO YEARS

Widely Accepted Guidance from Professional Groups

One possible way to identify food-related priorities for infants and children younger than two years of age is to obtain descriptive information about their intakes and examine it in relation to widely accepted recommendations from professional organizations, summarized in Table 4-3.

Breastfeeding Rates

In 2002, reported breastfeeding rates for WIC participants were about 59 percent in the hospital and 22 percent at six months (Abbott Laboratories, 2003). While these rates represent significant short- and long-term increases (Abbott Laboratories, 2002, 2003), these rates are about 10 percentage points lower than the rates for all postpartum women and 20 percent lower

TABLE 4-3 Dietary Guidance for Infants and Children Under the Age of Two Years

Dietary Guidance	Source
Breastfeeding is the preferred method of infant feeding because of the nutritional value and health benefits of human milk	AAP, 2004
Increase breastfeeding rates; targets in U.S. general population are 75% breastfeeding in early postpartum, 50% at 6 months, 25% at 12 months	DHHS, 2000b
Encourage breastfeeding with exclusion of other foods for first 4 to 6 months	AAP, 2004
Continue breastfeeding for first year of life	AAP, 2004
Continue breastfeeding into second year of life if mutually desired by the mother and child	AAP, 1997; Kleinman, 2000; AAP, 2001b; AAP, 2004
For infants who are not currently breastfeeding, use infant formula throughout the first year of life	Kleinman, 2000; AAP, 2004
Infant formula used during the first year of life should be iron-fortified	AAP, 1997; AAP, 2001b; AAP, 2004
Infants with specific medical conditions may require medical formula and this should be readily available through programs such as the WIC program	AAP, 2001b
Introduce solid foods at 4 to 6 months of age	AAP, 2004
Fruit juice may be introduced at 6 months of age; avoid introducing juice before 6 months of age	Kleinman, 2000; AAP, 2001a; AAP, 2004
Limit intake of fruit juice to 8 oz per day for children ages 6 to 12 months	AAP, 1997; Kleinman, 2000; AAP, 2001a
Introduce single-ingredient complementary foods, one at a time for a several day trial	AAP, 2004
Introduce iron-rich solid foods at 6 to 12 months of age	AAP, 2004
Delay introduction of cow's milk until the second year of life	AAP, 1992; AAP, 2004
Cow's milk fed during the second year of like should be whole milk	AAP, 1992
Avoid feeding of hard, small particulate foods during first 2 to 3 years of life due to choking hazard	Kleinman, 2000; AAP, 2004
Limit intake of fruit juice to 4 to 6 oz per day for children ages 1 to 6 years	AAP, 2001a; AAP, 2004
Encourage children to eat whole fruits to meet their recommended daily fruit intake	AAP, 2001a; AAP, 2004
WIC food prescriptions should be nutritionally and culturally appropriate	AAP, 2001b; AAP, 2004
Provide children with repeated exposure to new foods to optimize acceptance and encourage development of eating habits that promote selection of a varied diet	ADA, 1999; AAP, 2004
Promotion of healthy eating should begin early in life	ADA, 1999; AAP, 2004

than the rates for low-income non-WIC participants. The rates of breastfeeding among WIC participants also are substantially lower than the public health goals for the U.S. (see Table 4-3) (DHHS, 2000b). These low breastfeeding rates are of concern because of the many short- and long-term health benefits of breastfeeding.[1] Breastfeeding promotion efforts in the WIC setting have been able to increase initiation rates, but sustained effects on the duration of breastfeeding—particularly exclusive breastfeeding in the first six months—have been much more difficult to achieve (Ahluwalia et al., 2000).

Findings Related to Adherence to Dietary Guidance

Introduction of Complementary Foods

Based on data from the Feeding Infants and Toddler Study, Briefel and colleagues (2004) reported that infants were introduced to complementary foods at very young ages. Almost 30 percent of infants were fed complementary foods prior to four months of age, and 17 percent of infants consumed juice prior to six months of age. An earlier study of WIC participants had similar findings (Bayder et al., 1997).

Furthermore, some infants are fed cow's milk too early. Almost one-quarter of infants 9 through 11 months were fed cow's milk on a daily basis, although cow's milk is not recommended for infants under one year of age (Briefel et al., 2004). An earlier study of WIC participants had similar findings (Bayder et al., 1997).

Beverage and Fruit/Vegetable Consumption

The Feeding Infants and Toddlers Study also found that milk may be displaced in toddler diets by other beverages. The calcium density of toddler diets decreased with increasing consumption of 100 percent juice, fruit drinks, and carbonated beverages (Skinner et al., 2004). For children who consumed 100% fruit juice (more than half of the sample), mean reported intake by those ages 15 through 18 months was 8.8 oz per day; and by those ages 19 through 24 months, it was 9.5 oz per day (Skinner et al., 2004). Both mean values exceed the recommended maximum of 4 to 6 oz per day for children ages 1 to 6 years (AAP, 2004). Almost all toddlers consumed milk, however, and calcium intakes of infants and toddlers were adequate (Devaney et al., 2004).

In addition, non-juice fruit and vegetable consumption was low. About 20 percent of toddlers did not consume any vegetable on a given day and about one-third of older toddlers did not consume any fruit (excluding juice). The most common vegetable consumed by toddlers 15 months and older was fried potatoes (Fox et al., 2004).

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[1] Benefits to infants from breastfeeding include reduced illness from gastrointestinal (Beaudry et al., 1995; WHO, 2000), respiratory (Wilson et al., 1998; WHO, 2000), and ear (Scariati et al., 1997) infections; reduced risk of atopic illness (adverse conditions resulting from allergic/immune responses) such as food allergy (Saarinen and Kajosaari, 1995), atopic eczema (Saarinen and Kajosaari, 1995), and asthma (Saarinen and Kajosaari, 1995; Oddy et al., 1999); reduced risk of sudden infant death syndrome (Ford et al., 1993); higher scores on cognitive development tests for breastfed infants (Anderson et al., 1999); protective effects on later blood pressure (Wilson et al., 1998); and a somewhat reduced risk of childhood obesity (Dewey, 2003). Additional benefits of breastfeeding include reduced maternal risk of subsequent breast cancer (Collaborative Group on Hormonal Factors in Breast Cancer, 2002), less maternal postpartum weight retention (Dewey et al., 1993), and less maternal absenteeism from work due to the infants' better health compared to formula-fed infants (Cohen et al., 1995).

Development of Long-Term Eating Patterns

The early eating environment is very important in the development of long-term eating patterns. Young children need frequent exposure to new foods, including tasting, to learn to like a variety of foods (Birch et al., 1984, 1987). However, the Feeding Infants and Toddlers Study found that most caregivers offered a new food no more than 3 to 5 times before deciding that their infant or toddler disliked it (Carruth et al., 2004). In older children, studies indicate that acceptance of a new food is enhanced by offering it 8 to 15 times (Sullivan and Birch, 1990; Birch et al., 1995). Thus, mechanisms that promote acceptance of a variety of foods in children appear to be lacking. Food preferences, as well as household food availability, are correlated with food intake in children (Harvey-Berino et al., 1997; Cullen et al., 2003).

SUMMARY

The Committee's findings show that low-income women and young children have mean intakes of servings from each of the five food groups that are less than the minimum Pyramid recommendations—with the exception of the grain group for the children and teens. In general, fewer than half of the individuals had intakes that met any one of the minimum Pyramid recommendations. In comparison with recommendations, dairy and fruit intakes were lowest for the women and vegetable intake was lowest for the children. Intakes of added sugars were higher than those suggested by the Pyramid. The Committee may need to consider both the added sugars content and the fat content of the food packages (based on the findings from Chapter 3) to assist participants in maintaining energy balance.

Data show that the dietary practices of most concern for the infants and toddlers less than two years of age include the short duration of breastfeeding, excessive consumption of fruit juice, early introduction of solid food and cow's milk, low consumption of fruits (other than juice) and vegetables, and infrequent exposure to new foods.

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