PART D. CHAPTER 7: USDA FOOD PATTERNS FOR CHILDREN YOUNGER THAN AGE 24 MONTHS

INTRODUCTION

Establishing healthy dietary patterns in early childhood is crucial to support immediate needs for growth and development and to promote lifelong health by helping to reduce the risk of obesity and associated cardiometabolic disorders later in life. However, developing evidence-based dietary guidelines for infants and toddlers is not a simple task, in part because the scientific evidence for many questions is relatively scant, as shown in the preceding 3 chapters (***Part D. Chapter 4: Duration, Frequency, and Volume of Exclusive Human Milk and/or Infant Formula Feeding***, ***Part D. Chapter 5: Foods and Beverages Consumed During Infancy and Toddlerhood***, and ***Part D. Chapter 6: Nutrients from Dietary Supplements During Infancy and Toddlerhood***). This is the first time a Dietary Guidelines Advisory Committee has been charged with developing food patterns for infants and children younger than age 24 months.

As described in ***Part D. Chapter 14: USDA Food Patterns for Individuals Ages 2 Years and Older***, the USDA Food Patterns for ages 2 years and older are existing food patterns updated every 5 years. The USDA Food Patterns represent types and amounts of foods that aim to meet the Dietary Reference Intakes (DRI) and *Dietary Guidelines for Americans* recommendations, within energy needs, for each age-sex group. The foods in each of the food groups and subgroups are intended to be consumed in the indicated amounts, on average and over time, as an example of a healthy dietary pattern. Although some notable shifts are seen from ages 2 years to later into adulthood in consumption patterns of food groups and subgroups, as described in ***Part D. Chapter 14***, the majority of foods that comprise a healthy dietary pattern are fairly consistent from age 2 years onward.

The time period between birth and 24 months, however, is characterized by major changes in feeding patterns and dietary intake. Exclusive breastfeeding is recommended for about the first 6 months[1] (see ***Part D. Chapter 4***). For infants who are not fed human milk, or are mixed-fed (i.e., both human milk and infant formula), commercial infant formula is generally recommended until age 12 months.[1] The transition from sole consumption of human milk and/or infant formula to a varied diet that includes nutrient-dense complementary foods and beverages (CFB) is recommended around age 6 months.[1] Thus, the 2020 Dietary Guidelines Advisory Committee decided that USDA Food Patterns are not necessary for infants younger than age 6 months and began modeling exercises at age 6 months when CFB start to become an important part of the diet, even though they provide relatively limited energy at that age.[2,3]

The main purpose of food pattern modeling is to exemplify approaches to meet nutrient recommendations. For this age group, this work must take into account differences in the nutritional composition of milk sources for infants and toddlers. Human milk differs from infant formula in several ways, including its nutritional composition, bioavailability of nutrients, and presence of bioactive substances. Furthermore, the composition of human milk changes across time, and the concentrations of some nutrients and even flavors[4] are responsive to maternal diet (see ***Part D. Chapter 3: Food, Beverage, and Nutrient Consumption During Lactation***). As described in ***Part. D. Chapter 1: Current Intakes of Foods, Beverages, and Nutrients***, nutrient intakes from milk sources (and CFB) differ substantially between infants fed only human milk and those who are fed infant formula (which is fortified with many nutrients[5]) or those who are fed both (i.e., mixed-fed). However, it must be recognized that provision of key nutrients is only one of the ways in which human milk influences infant health and development, as substances other than traditional nutrients in human milk also play a role, and breastfeeding is associated with many health benefits for the mother as well as the child (see ***Part D. Chapter 3*** and ***Part D. Chapter 4***). Thus, the food pattern modeling exercises presented here should not be interpreted as an evaluation of the value of human milk compared to infant formula; they are exercises to demonstrate ways that nutritional goals can be met through CFB that *take into account* the milk source(s) in the child's diet.

For the period from ages 6 to 12 months, the Committee focused first on combinations of CFB aimed at meeting nutrient needs of infants whose milk source is human milk (i.e., no infant formula). The Committee then estimated nutrient intakes of infants fed infant formula if they consumed the same types and combinations of CFB that were developed for the infants fed human milk. The Committee considered the period from ages 12 to 24 months separately from ages 6 to 12 months for several reasons. First, ages 6 to 12 months is a time when infants are learning to eat new foods, so the variety, amounts, and textures of CFB increase and change substantially during those 6 months. Second, most of the DRI values between ages 6 and 12 months are Adequate Intake (AI) estimates, with Recommended Dietary Allowances (RDAs) established only for protein, iron, and zinc, whereas RDAs are established for most nutrients for ages 12 months and older.[6-13] Third, infant formula is not recommended after a child is older than 12 months, and most infants in the United States (66 percent) are no longer receiving human milk after age 12 months.[14] For that reason, the Committee focused on food patterns at ages 12 to less than 24 months that would meet nutrient needs of toddlers receiving neither human milk nor infant formula, although potential combinations of foods for toddlers receiving human milk at ages 12 to 24 months also were examined.

The complementary feeding period is important not only for providing essential nutrients, but also for introducing infants and toddlers to various types and textures of CFB that can be beneficial to health and development. For example, certain foods should be introduced before age 12 months to reduce the risk of food allergies (e.g., peanut, egg; see ***Part D. Chapter 5***). In addition, feeding experiences with foods provided in different textures and forms (such as "finger foods") help to develop manual dexterity, hand-eye coordination, and dexterity of the tongue and other mechanical features involved in chewing and swallowing. The timely introduction and progression of textures helps to support the development of appropriate feeding and eating behaviors during childhood.[15]

The complementary feeding period also is a time for implementation of responsive feeding practices that can have positive effects on child health and development.[16-18] Moreover, the interactions between the child and the caregivers and with the eating environment provide opportunities for modeling of healthy eating behaviors, bonding, and learning through food.[19] The food pattern modeling exercises presented in this chapter focus on nutrient intake during this developmental period and are not designed to address these other important aspects of complementary feeding.

Nutrient Intakes and Systematic Review Findings that Informed Food Pattern Modeling for Ages 6 to 24 Months

The energy and nutrients needed from CFB vary by infant milk source. As described in ***Part D. Chapter 1***, among infants ages 6 to 12 months, those who were fed infant formula or were mixed-fed typically met the Estimated Average Requirements (EAR) for iron, zinc, and protein (i.e., less than 7 percent had intakes less than the EAR). For infants fed human milk, the proportions with intakes less than the EAR were high for iron (77 percent), zinc (54 percent), and protein (27 percent). As described in ***Part D. Chapter 5***, strong evidence shows that iron-rich sources, such as meats or iron-fortified CFB, including infant cereals, can help maintain adequate iron status or prevent iron deficiency during the first year of life among infants with insufficient iron stores or among infants fed human milk who are not receiving adequate iron from another source. In addition, evidence, though limited, suggests that CFB that contain substantial amounts of zinc, such as meats or cereals fortified with zinc, can support zinc status during the first year of life, particularly among infants fed human milk who are not receiving adequate zinc from another source. For most of the other nutrients (for which the DRI is an AI), intakes appeared to be adequate regardless of milk source, with the exception of potassium, vitamin D, and choline (see ***Part D. Chapter 1***). As explained in ***Part D. Chapter 6***, vitamin D is a special case, and supplementation of infants is generally recommended unless their vitamin D intake from fortified products (including infant formula) is already sufficient.

After age 12 months, toddlers transition toward the typical foods and beverages consumed by most Americans ages 2 years and older, as described in ***Part D. Chapter 1***. Thus, the food components of public health concern observed in toddlerhood are similar to those identified among ages 2 years and older, with low intakes of vitamin D, calcium, dietary fiber, and potassium and higher than recommended intakes of sodium, saturated fat, and added sugars. As described in ***Part D. Chapter 1***, nutrients that pose special challenges among children between the ages of 12 and 24 months include choline and linoleic acid. As described in ***Part D. Chapter 5***, moderate evidence indicates that CFB with differing fatty acid profiles, particularly long-chain polyunsaturated fatty acids, can influence fatty acid status. Although iron intake at ages 12 to 24 months appears to be adequate, National Health and Nutrition Examination Survey (NHANES) 2003-2010 data indicated that 15 percent of toddlers ages 12 to 24 months had iron deficiency.[20]

Given the considerations above, achieving adequate iron and zinc intakes at ages 6 to 12 months for infants fed human milk was identified by the Committee as a major challenge and, hence, was a key focus of the Committee's work aimed at combinations of CFB during that age range. For both age intervals, the Committee was guided by the principle that CFB should be nutrient rich, particularly in nutrients for which potential risk of inadequacy exists, while also limiting exposures and intakes of other food components when they are of concern, such as added sugars.

LIST OF QUESTIONS

1. Can USDA Food Patterns be established based on the relationships identified in the systematic reviews? If so, how well do USDA Food Pattern variations meet nutrient recommendations for infants and toddlers? If nutrient needs are not met, is there evidence to support supplementation and/or consumption of fortified foods to meet nutrient adequacy?
   (See ***Part D. Chapters 3 through 6*** for systematic reviews.)

METHODOLOGY

USDA food pattern modeling methodology for answering these questions involved aiming to establish food patterns that incorporate goals for nutrient adequacy for energy, nutrients, and other food components compared to the DRIs and potential recommendations of the 2020 Committee. The analyses used here were informed by the process to establish and model food patterns for ages 2 years and older. More information on this approach is available in ***Part C. Methodology*** and in ***Part D. Chapter 14: USDA Food Patterns for Individuals Ages 2 Years and Older***. Nutrient profiles were developed from food groups and subgroups using data on foods consumed by infants and toddlers ages 6 to 24 months from NHANES, What We Eat in America (WWEIA) 2015-2016[21] and corresponding food composition data from the USDA Food and Nutrient Database for Dietary Studies,[22] USDA National Nutrient Database for Standard Reference,[23] and the USDA Food Patterns Equivalents Database.[24] Modifications of USDA Food Pattern elements were tested—for example, the proportions of intake from human milk or infant formula and the inclusion of fortified foods—where appropriate based on developmental age. The nutrient adequacy of variations of healthy eating patterns were then tested by comparing their nutrient content to the DRIs and potential recommendations of the 2020 Committee. The Committee then developed conclusion statements to summarize the answer to each food pattern modeling question and made research recommendations to inform future work on this topic.

Analytic Framework

The Committee developed a food pattern modeling protocol. The protocol included an analytic framework that described the scope of the food pattern modeling exercises. The analytic framework also described the population, data sources, and key terms used to answer this question. The patterns tested in these food pattern modeling exercises are intended to apply to the U.S. population ages 6 to 24 months old. The following are key definitions for the food pattern modeling exercises:

- **Essential Calories:** The energy associated with the foods and beverages ingested to meet nutritional goals through choices that align with the USDA Food Patterns in forms with the least amounts of saturated fat, added sugars, and sodium.
- **Food Groups and Subgroups:** USDA Food Patterns provide amounts from the 5 major food groups and subgroups, including:
    - Fruits

  - Vegetables: Dark green, red and orange, beans and peas, starchy, and other
  - Dairy, including calcium-fortified soy beverages
  - Grains: Whole grains and refined grains
  - Protein Foods: Meats, poultry, and eggs; seafood; nuts, seeds, and soy products

- **Food Pattern Components:** Oils, solid fats, added sugars.
- **Nutrient Profiles:** The anticipated nutrient content for each food group and subgroup that could be obtained by eating a variety of foods in each food group in nutrient-dense forms. The nutrient profiles are based on a weighted average of nutrient-dense forms of foods. The weighted average calculation considers a range of American food choices, but in nutrient-dense forms and results in a food pattern that can be tailored to fit an individual's preferences.
- **Nutrient-Dense Representative Foods:** For the purpose of USDA's Food Pattern modeling, nutrient-dense representative foods are those within each item cluster in forms with the least amounts of added sugars, sodium, and solid fats.
- **Added Sugars:** Sugars that are added during the processing of foods (such as sucrose or dextrose), foods packaged as sweeteners (such as table sugar), sugars from syrups and honey, and sugars from concentrated fruit or vegetable juices. They do not include naturally occurring sugars that are found in milk, fruits, and vegetables (see ***Part F. Appendix F-1: Glossary***).
- **Solid Fats:** The food category called "solid fat" includes a variety of fats, but predominantly saturated fat and to a small extent, *trans* fat. This category includes the saturated fats naturally found in animal products (e.g., meats, dairy) as well as vegetable sources with high saturated fat content, like tropical oils, e.g., coconut oil and hydrogenated vegetable shortenings.

General Process for Developing and Updating the USDA Food Patterns

The overall food pattern modeling methodology used to develop and update the USDA Food Patterns includes: (1) identifying appropriate energy levels for the Patterns, (2) identifying nutritional goals for the Patterns, (3) establishing food groupings and food group amounts, (4) determining the amounts of nutrients that would be obtained by consuming various foods within each group, (5) evaluating nutrient levels in each Pattern against nutritional goals, and (6) adjusting and re-evaluating the Patterns to align with current or potential recommendations. The food pattern modeling exercises described in this chapter were informed by the process to establish and model food patterns for ages 2 years and older (see ***Part C. Methodology*** and ***Part D. Chapter 14: USDA Food Patterns for Individuals Ages 2 Years and Older)*** with modifications reflecting the unique feeding aspects of the population ages 6 to 24 months.

1. Establish Energy Levels

The DRIs use formulas to calculate Estimated Energy Requirements (EER) for infants and toddlers that account for energy deposition for the growing child.[10] Using these formulas, appropriate energy levels for each age-sex group for infants and toddlers were determined based on age in months, reference body lengths, median body weights, and sex of the child. Five energy levels from 600 to 1,000 kcal, at 100 kcal "step" intervals, were chosen to cover the energy needs for the majority of the population ages 6 to 24 months.

2. Establish Nutritional Goals

Specific nutritional goals for each modeling exercise were selected based on the age-sex group(s) being targeted. If more than one age-sex group was the target, the results were evaluated against the nutrient goals for all of those groups. Goals for energy, 3 macronutrients, 3 fatty acids, 12 vitamins, and 9 minerals were based on DRI reports released between 1997 and 2019.[6-13] Other goals could include potential recommendations of the 2020 Committee. Because food patterns in general are designed as plans for individuals to follow, the goals were the RDA amounts for nutrients having an RDA. The AI was used when an RDA was not available. RDA or AI values for 2 age ranges, infants 6 to 12 months and toddlers 12 to 24 months, were used.

3. Establish Food Groupings and Food Group Amounts

Existing food groups and subgroups in the USDA Food Patterns for ages 2 years and older published in the *2015-2020 Dietary Guidelines for Americans* informed this exercise.[25]

Before conducting food pattern modeling exercises, various options reflecting different proportions of energy coming from human milk or infant formula were created, so that the energy expected to come from CFB could be calculated. Infants and toddlers receiving human milk were the initial focus of the modeling exercises because the proportion of nutrients required from CFB is different for infants receiving infant formula, which is fortified. Energy from human milk was modeled at 3 levels (low, average, and high) (Table D7.1) and applied to each of 3 age intervals (6 to 9 months, 9 to 12 months, and 12 to 24 months). The average level was based on the mean percentage of total energy from human milk at those ages in published studies from high-income countries,[3] and the low and high levels were set at 15 percent lower and 15 percent higher than the mean, respectively, as shown in Table D7.1. For the modeling exercises for infants fed infant formula at ages 6 to 9 months and 9 to 12 months, the proportion of total energy expected to come from infant formula was the same as for human milk.

Table D7.1. Energy from human milk modeled at three levels (low, average, and high) applied to each of three age intervals (6 to 9, 9 to 12, and 12 to 24 months)[1] and the amount of energy available for complementary foods and beverages at 5 estimated energy needs from 600 to 1,000 kcal

Energy level (kcal)	600		700		800		900		1,000	
	CFB[2] kcal	HM[2] kcal	CFB kcal	HM kcal	CFB kcal	HM kcal	CFB kcal	HM kcal	CFB kcal	HM kcal
6 to 9 months										
HM level high (100% HM)	NA[2]	600	NA	700	NA	800				
HM level average (80% HM)	120	480	140	560	160	640				
HM level low (65% HM)	210	390	245	455	280	520				
9 to 12 months										
HM level high (70% HM)	180	420	210	490	240	560	270	630		
HM level average (55% HM)	270	330	315	385	360	440	405	495		
HM level low (40% HM)	360	240	420	280	480	320	540	360		
12 to 24 months										
HM level high (50% HM)			350	350	400	400	450	450	500	500
HM level average (35% HM)			455	245	520	280	585	315	650	350
HM level low (20% HM)			560	140	640	160	720	180	800	200

1: Energy from human milk was modeled at 3 levels (low, average, and high) applied to each of 3 age intervals (6 to 9 months, 9 to 12 months, and 12 to 24 months). The average level was based on the mean percentage of total energy from human milk at those ages in published studies from high-income countries.[3] and the low and high levels were set at 15 percent lower and 15 percent higher than the mean, respectively. For the modeling exercises for infants fed infant formula at ages 6 to 9 months and 9 to 12 months, the proportion of total energy expected to come from infant formula was the same as for human milk.
2: CFB=complementary foods and beverages; HM=human milk; NA=not applicable

The food group amounts for the 1,000 kcal Pattern established in the Healthy U.S.-Style Food Patterns in the *2015-2020 Dietary Guidelines for Americans*[25] were used in the first step in modeling the contributions to nutrient intakes from combinations of CFB for ages younger than 24 months. When the energy expected to come from CFB was less than 1,000 kcal, amounts of each food group were decreased such that the food group density (i.e., food group or subgroup amounts per 100 kcal) in the pattern remained similar to the food group density of the 1,000 kcal Pattern. Food group amounts were then compared to mean food group intakes in each age group. As part of the process to test the feasibility of combinations of CFB and human milk or infant formula for infants and patterns for toddlers, amounts from each food group could be modified to reach all or most of the specified goals.

4. Determine the Amounts of Nutrients that Would be Obtained by Consuming Various Foods Within Each Group

A "composite" system was used to determine the anticipated nutrient content, or nutrient profile, of each food group. To create nutrient profiles, all foods reported for individuals ages 6 to 24 months as part of WWEIA, NHANES 2015-2016 were disaggregated into their ingredients. Similar ingredients were aggregated into food item clusters. A nutrient-dense form of the food specific to the life stage was selected as the representative food for each cluster. Unique considerations for this life stage were identified where relevant, such as the importance of adequate fat intake. Differences in the representative foods used, compared to those used for Food Patterns for children older than age 2 years, were the following:

- Whole milk was used instead of fat-free milk.
- Reduced-fat plain yogurt was used instead of fat-free yogurts (plain or flavored with non-caloric sweeteners).
- Reduced-fat cheeses were used as representative foods for *all* cheese item clusters, instead of using skim or fat-free cheese options when available.

A detailed list of the item clusters, the nutrient-dense representative foods, and the proportions of consumption is available as part of the online supplemental materials (available at https://www.dietaryguidelines.gov/2020-advisory-committee-report/food-pattern-modeling/FPM-under-2).

The proportional intake of each item cluster within each food group or subgroup was calculated from dietary intake data for this age group (i.e., infants and children younger than age 24 months) and used to compute a weighted average of nutrient-dense forms of foods representing each food item cluster. Using the nutrients in each representative food and the item cluster's proportional intake, a nutrient profile was calculated for each food group or subgroup. Nutrient profiles also were calculated for oils and solid fats using food supply data to estimate proportional intakes. The nutrient amounts used for human milk were the mean concentrations of each nutrient published in the respective reports for the development of the DRIs for infants.[6-13] (For the nutrient profile for human milk, see the online food pattern modeling report, available at https://www.dietaryguidelines.gov/2020-advisory-committee-report/food-pattern-modeling/FPM-under-2). The nutrient profile for infant formula comes from FNDDS 15-16, code 11710000 Infant Formula, NFS.[22]

5. Evaluate Nutrient Level in Each Modeling Exercise Against Nutritional Goals

Using the updated nutrient profiles that apply to ages 6 to 24 months, the nutrients provided in each modeling exercise were compared to the goals, which in most cases aimed to meet at least 90 percent of the RDA or AI.

6. Adjust and Re-Evaluate to Align with Goals

After identifying any nutrient goals that were not met in the modeling exercises, the Committee used a step-wise iterative approach to make additional adjustments. Four modifiable elements were considered: (1) food group amounts could be increased or decreased, (2) goals and constraints could be adjusted, (3) food group nutrient profiles could be adjusted through selection of different representative foods or categorization of item clusters, and (4) certain foods could be included or excluded. Nutrient adequacy was reassessed after these modifications.

After all iterations were complete, energy contributions from all food groups and oils, termed "essential calories," were summed and any remaining energy up to the kcal limit for each energy level was calculated. The uses for remaining energy were discussed, such as in relation to limits on added sugars.

REVIEW OF THE SCIENCE

Question 1. Can USDA Food Patterns be established based on the relationships identified in the systematic reviews? If so, how well do USDA Food Pattern variations meet nutrient recommendations for infants and toddlers? If nutrient needs are not met, is there evidence to support supplementation and/or consumption of fortified foods to meet nutrient adequacy?

Approach to Answering Question: Food Pattern Modeling

Conclusion Statements

Ages 6 to 12 Months

The Committee was not able to establish a recommended food pattern for infants ages 6 to 12 months because of uncertainty about nutrient requirements for this age range and challenges in meeting the Recommended Dietary Allowance for iron through complementary foods and beverages. However, examples of potential combinations of complementary foods and beverages that come close to meeting almost all nutrient recommendations are described for a variety of scenarios differing in the proportion of energy coming from human milk or infant formula versus complementary foods and beverages at ages 6 to 9 months and 9 to 12 months.

The example combinations of complementary foods and beverages described by the Committee support consumption of fortified infant foods to meet nutrient adequacy for infants whose milk source is human milk (i.e., no infant formula).

Infants fed infant formula who also consume iron-fortified infant cereals may consume up to 2 times the Recommended Dietary Allowance for iron (22 milligrams per day) at ages 6 to 12 months, although iron intakes are not likely to exceed the Tolerable Upper Intake Level of 40 milligrams per day.

Further work is needed to determine the feasibility of meeting all nutrient recommendations for infants fed human milk at ages 6 to 12 months from diets that do not include any fortified foods (e.g., fortified infant cereal, infant formula).

With the exception of vitamin D, supplementation should not be necessary if fortified foods with appropriate levels of fortification are included in the diet of infants whose milk source is human milk. Vitamin D supplementation guidance from the American Academy of Pediatrics is provided in ***Part D. Chapter 6: Nutrients from Dietary Supplements During Infancy and Toddlerhood***.

Ages 12 to 24 Months

For toddlers fed neither human milk nor infant formula, the Committee developed a Food Pattern for ages 12 to 24 months that is consistent with the proportions of food groups and subgroups recommended for children ages 2 years and older. This Food Pattern requires careful choices of foods and beverages but does not require inclusion of fortified products specifically formulated for infants or toddlers to meet nutrient recommendations.

For toddlers who receive at least 20 percent of total energy from human milk at ages 12 to 24 months, the Committee was not able to establish a recommended food pattern because of uncertainty about nutrient requirements for this age range and challenges in meeting the Recommended Dietary Allowances. However, examples of potential combinations of complementary foods and beverages that come close to meeting almost all nutrient recommendations are described for a variety of scenarios differing in the proportions of energy coming from human milk and from complementary foods and beverages at ages 12 to 24 months.

For toddlers fed a lacto-ovo vegetarian diet and fed neither human milk nor infant formula at ages 12 to 24 months, the Committee developed a Healthy Vegetarian Pattern that includes regular consumption of eggs, dairy products, soy products, and nuts or seeds, in addition to fruits, vegetables, grains, and oils. This Food Pattern requires careful choices of foods and beverages but does not require inclusion of fortified products specifically formulated for infants or toddlers to meet nutrient recommendations.

Additional Considerations for Ages 6 to 24 Months Regarding Added Sugars

The combinations of foods needed to achieve recommended intakes of key nutrients for ages 6 to 24 months leave virtually no remaining dietary energy for added sugars, apart from the very small amounts (less than 3 grams per day) already inherent in the foods used in modeling.

Results of Food Pattern Modeling Exercises

Nutrient Profiles

The nutrient profiles for the foods included in the modeling exercises are shown in the online food pattern modeling report (available at https://www.dietaryguidelines.gov/2020-advisory-committee-report/food-pattern-modeling). These include energy and nutrients per cup equivalent (cup eq) or ounce equivalent (oz eq) of each food group or subgroup. In Table D7.2, the most nutrient-rich foods are listed with respect to the amounts of calcium, iron, potassium, and choline per 100 kcal.

Table D7.2. Nutrient-rich food sources of calcium, iron, potassium, and choline[1]

Nutrient	Criteria for Selection	Food items	
Calcium	Calcium density ≥ 200 mg/100 kcal, except for fruits and vegetables for which 100 kcal is a large volume (i.e., energy/cup < 50 kcal); in those cases, food is selected if calcium content is ≥ 200 mg/cup.	*Dairy* Cheese Milk Yogurt *Fruits and Vegetables* Cooked turnip greens/ spinach	*Other* Tofu
Iron[2]	Iron density ≥ 2 mg/100 kcal, except for fruits and vegetables for which 100 kcal is a large volume (i.e., energy/cup < 50 kcal); in those cases, food is selected if iron content is ≥ 2 mg/cup.	*Meats and Seafood* Octopus/squid Oysters/mussels/snails Liver Game meat Anchovy Ground beef *Other* Tofu	*Fruits and Vegetables* Bok choy Cauliflower Okra Asparagus Mushrooms Tomatoes (cooked) Edible-pod green peas Green peppers (cooked) Avocado
Potassium[3]	Potassium density ≥ 400 mg/100 kcal, except for fruits and vegetables for which 100 kcal is a large volume (i.e., energy/cup < 50 kcal); in those cases, food is selected if potassium content is ≥ 400 mg/cup eq.	*Fruits and Vegetables* Bok choy Tomatoes Green pepper Cauliflower Mushrooms Asparagus Summer squash Okra Red pepper Eggplant Tomatoes (cooked) Carrots Edible-pod green peas Broccoli (cooked) Melon (cantaloupe/ honeydew) Apricot	Beets Pumpkin/ winter squash Kiwifruit Nectarines/ peaches Grapefruit Papaya Banana *Dairy* Milk Yogurt *Seafood* Fish Snails, clams
Choline[4]	Choline density ≥ 50 mg/100 kcal, except for fruits and vegetables for which 100 kcal is a large volume (i.e., energy/cup < 50 kcal); in those cases, food is selected if choline content is ≥ 50 mg/cup.	*Protein foods* Liver Eggs Shrimp/scallops/crab/ lobster Fish Soy milk Beef/pork/lamb Turkey	*Fruits and Vegetables* Bok choy Mushrooms Cooked okra Edible-pod green peas

1: Excludes foods fortified with these nutrients
2: Excludes processed soy, tomatillos, spring onions and scallions, and cooked or canned fruits. Note that the bioavailability of iron from different sources is not taken into account in the ranking of these foods.
3: Excludes cooked and canned fruit, tomatillos, spring onions and scallions, cooked celery, and cooked onions
4: Excludes cooked celery and tomatillos

Modeling Exercises for Ages 6 to 12 Months

Infants Fed Human Milk

Based on energy allowances for human milk and CFB as shown in Table D7.1 (described in Methodology), the first step was to set up a model that included food group amounts in proportion to the amounts in the 1,000 kcal Pattern for ages 2 years and older. Numerous nutrient gaps were evident in this model for both ages 6 to 9 and 9 to 12 months. Gaps existed for iron and zinc, as expected, but also for magnesium, phosphorus, potassium, sodium, choline, niacin, and vitamins A, B_6, C, D, and E at ages 6 to 9 months, and magnesium, potassium, sodium, choline, and vitamins A, C, D and E at ages 9 to 12 months. Carbohydrate was also low at the lower energy levels. The iron content of this first model was only about 1 to 2 milligrams (mg) at ages 6 to 9 months and 1 to 4 mg at ages 9 to 12 months (far below the RDA of 11 mg) and zinc content was 1.4 to 2.5 mg at ages 6 to 9 months (below the RDA of 3 mg) and 2 to 4 mg at 9 to 12 months (closer to the RDA of 3 mg).

Therefore, the second step was to examine how replacing 56 kcal of grains with 56 kcal of fortified infant cereal (0.5 oz eq) would change iron and zinc intakes (see Table D7.3). For iron, this second model included about 8 to 9 mg at 6 to 9 months and about 8 to 11 mg at 9 to 12 months. These amounts were closer to the RDA, but still below it for most energy levels and human milk proportion options. For zinc, this second model included 3 to 5 mg, which was adequate.

Table D7.3. Summary of iron and zinc estimates in combinations of complementary foods and beverages without and with 0.5 ounce equivalents of fortified infant cereal for infants fed human milk at ages 6 to 9 months and 9 to 12 months

Energy and HM[1] proportion[2]	Iron (mg) 6 to 9 months		Iron (mg) 9 to 12 months		Zinc (mg) 6 to 9 months		Zinc (mg) 9 to 12 months	
	No IC	IC[1]	No IC	IC[1]	No IC	IC[1]	No IC	IC[1]
600 H[1, 3]	---	---	1.4	8.4	---	---	1.7	2.9
600 A[1]	0.9	8.2	2.1	9.0	1.4	2.7	2.2	3.3
600 L[1]	1.6	8.5	2.8	9.7	1.9	3.0	2.7	3.8
700 H[3]	---	---	1.6	8.4	---	---	2.0	3.1
700 A	1.1	8.2	2.5	9.4	1.6	2.9	2.6	3.7
700 L	1.9	8.8	3.3	10.2	2.2	3.3	3.1	4.3
800 H[3]	---	---	1.9	8.8	---	---	2.3	3.4
800 A	1.3	8.3	2.8	9.7	1.9	3.1	2.9	4.0
800 L	2.2	9.1	3.7	10.6	2.5	3.6	3.6	4.7
900 H[4]	---	---	2.1	9.0	---	---	2.6	3.7
900 A[4]	---	---	3.2	10.1	---	---	3.3	4.4
900 L[4]	---	---	4.2	11.1	---	---	4.0	5.1

1: H=high; A=average; L=low; HM=human milk; IC=fortified infant cereal; CFB=complementary foods and beverages

2: Energy from human milk was modeled at 3 levels (low, average, and high) applied to each of 3 age intervals. The average level was based on the mean percentage of total energy from human milk at those ages in published studies from high-income countries,[3] and the low and high levels were set at 15 percent lower and 15 percent higher than the mean, respectively.

3: No combinations of CFB were developed at “high” human milk intakes for ages 6 to 9 months because all energy is allotted to HM.

4: No combinations of CFB were developed for 6 to 9 months at 900 kcal because it is above estimated energy needs.

The third step was to examine how much energy remained available for other CFB, after including 56 kcal (0.5 oz eq) of fortified infant cereal. Table D7.4. shows that the remaining energy for CFB was 0 to 224 kcal at 6 to 9 months and 124 to 484 kcal at 9 to 12 months. The lower amounts in these ranges correspond to options with high levels of human milk intake. At any given proportion of human milk, lower amounts were available at 600 to 700 kcal energy levels than at higher energy levels. This illustrates the energy constraints for CFB, particularly at the younger ages (6 to 9 months).

Table D7.4. Energy (kcal) provided by human milk or infant formula plus 0.5 ounce equivalents of fortified infant cereal and remaining energy available for other complementary foods and beverages for infants, by age and 3 levels of human milk or infant formula intake[1]

Energy level (kcal)		600			700			800			900			1,000		
Age (months)	Energy Source	H[2]	A[2]	L[2]	H	A	L	H	A	L	H	A	L	H	A	L
6 to 9	HM[2] (or IF[2])	600	480	390	700	560	455	800	640	520						
	Total CFB[2]	0	120	210	0	140	245	0	160	280						
	Infant Cereal	0	56	56	0	56	56	0	56	56						
	Remaining CFB	0	64	154	0	84	189	0	104	224						
9 to 12	HM (or IF)	420	330	240	490	385	280	560	440	320	630	495	360			
	Total CFB	180	270	360	210	315	420	240	360	480	270	405	540			
	Infant Cereal	56	56	56	56	56	56	56	56	56	56	56	56			
	Remaining CFB	124	214	304	154	259	364	184	304	424	214	349	484			
12 to 24	HM (or IF)				350	245	140	400	280	160	450	315	180	500	350	200
	Total CFB				350	455	560	400	520	640	450	585	720	500	650	800
	Infant Cereal				56	56	56	56	56	56	56	56	56	56	56	56
	Remaining CFB				294	399	504	344	464	584	394	529	664	444	594	744

1: Energy from human milk was modeled at 3 levels (low, average, and high) applied to each of 3 age intervals (6 to 9 months, 9 to 12 months, and 12 to 24 months). The average level was based on the mean percentage of total energy from human milk at those ages in published studies from high-income countries,[3] and the low and high levels were set at 15 percent lower and 15 percent higher than the mean, respectively. For the modeling exercises for infants fed infant formula at ages 6 to 9 months and 9 to 12 months, the proportion of total energy expected to come from infant formula was the same as for human milk. This table represents a third step to examine how much energy remained available for other CFB, after including 56 kcal (0.5 oz eq) of fortified infant cereal.
2: H=high; A=average; L=low; HM=human milk; IF=infant formula; CFB=complementary foods and beverages

The fourth step was to examine how the remaining energy for CFB could be allocated across food groups and subgroups to move closer to nutrient adequacy for iron, zinc, potassium, and choline (the nutrients with the most critical gaps). Although gaps also existed for vitamins A and C, it should be noted that the AI values at ages 7 to12 months (500 retinol activity equivalents [RAE] and 50 mg, respectively) are higher than the RDA values at ages 1 to 3 years (300 RAE and 15 mg, respectively), so the AI values may be overestimates. The recommended intakes issued by European Food Standards Authority[26] are 250 RAE of vitamin A and 20 mg of vitamin C during both of these age intervals. During this fourth step, the food combinations were set up so as to include a minimum amount of seafood, eggs, and nuts (weekly amounts of 3 oz eq, 1 oz eq, and 0.5 oz eq, respectively, by ages 9 to 12 months), in accordance with recommendations to introduce these foods during infancy. In addition, a maximum for Dairy (no more than 0.5 cup eq per day) was set, given that infants at this age are receiving human milk or infant formula. Remaining nutrient gaps were filled to the extent possible by prioritizing Protein Foods, particularly meat, because of the relatively high content and bioavailability of iron and zinc in red meats in particular. The approximate amounts of each of the food groups of CFB in the final models are shown in Table D7.5. When a range is shown, the lower amounts generally correspond to the lower energy levels and/or a higher proportion of energy from human milk, and the higher amounts correspond to the higher energy levels and/or a lower proportion of energy from human milk.

Table D7.5. Approximate amounts of food groups and subgroups in example combinations of complementary foods and beverages for ages 6 to 12 months[1]

	6 to 9 months		9 to 12 months	
Food Groups	Daily amounts	Weekly amounts	Daily amounts	Weekly amounts
Total Fruits (cup eq)	⅛ to ¼	---	⅛ to ½	---
Total Vegetables (cup eq)	⅛ to ¼	---	⅛ to ½	---
Red and orange	---	¼ to ⅔	---	½ to 1½
Starchy	---	¼ to ½	---	⅓ to 1
Dark green	---	Small amounts[2]	---	¼
Legumes	---	Small amounts[2]	---	¼
Other	---	¼ to ½	---	¼ to ¾
Total Grains (oz eq)[2]	½ to ¾	---	½ to 1	---
Fortified infant cereals	½	---	½	---
Other grains including whole and refined	0 to ¼	---	0 to 1[3]	---
Total Protein Foods (oz eq)[4]	¾ to 2⅔	---	2 to 3	---
Meats	---	4⅔ to 16	---	8½ to 15½
Poultry	---	½ to 1¼	---	1
Seafood	---	Modest amounts[5]	---	$\geq$3
Eggs	---	Modest amounts[5]	---	$\geq$1
Nuts and seeds	---	Modest amounts[5]	---	$\geq$½
Total Dairy (cup eq)	¼	---	½	---
Total added oils/fats (g)	0	---	0 to 7¾	---

1: The amounts shown represent the quantities of food items (cup or oz eq) that infants ages 6 to 12 months could consume as complementary foods and beverages from different food groups and subgroups to approach nutrient adequacy for iron, zinc, potassium, and choline (the nutrients with the most critical gaps) within the energy allocation for complementary foods and beverages for this age group (0 to 224 kcal at 6 to 9 months and 124 to 484 kcal at 9 to 12 months).
2: "Small amounts" refer to less than ⅛ cup equivalent per week.
3: At least half of other grains as whole grains
4: Total protein foods includes a majority from meats rather than poultry because meat has higher iron content than poultry. The weekly amounts of seafood, eggs, and nuts and seeds represent minimum amounts; greater quantities from these subgroups may be accommodated within the quantities allocated to total protein foods and the energy allocation for complementary foods and beverages for this age group.
5: "Modest amounts" refer to less than 1 ounce equivalent per week.

These combinations come close to meeting almost all nutrient recommendations for a variety of scenarios differing in the proportion of energy coming from human milk and CFB at ages 6 to 9 months and 9 to12 months. Projected iron intakes would range from 8.5 to 12 mg and projected zinc intakes from 3.1 to 6.5 mg per day for ages 6 to 12 months. However, projected potassium intakes fall short of 90 percent of the AI at several energy levels, which suggests the need to choose potassium-rich fruits and vegetables (see Table D7.2), as well as whole-grain products, which are generally higher in both potassium and iron than are refined grains. The amounts of dairy products that could be accommodated at ages 6 to 9 months were very small. In all of these models, no energy remained for added sugars (other than added sugars inherent from some of the foods in the nutrient profile) after aiming to achieve nutrient adequacy. In addition, little energy was available for oils or solid fats, but given that human milk is rich in fat, no added oils or fats are needed. The percentage of energy from fat in these models was 41 to 44 percent at ages 6 to 9 months and 35 to 42 percent at 9 to 12 months. The percentage of energy from protein was 11 to 16 percent at ages 6 to 9 months and 16 to 19 percent at ages 9 to 12 months.

Infants Fed Infant Formula

For infants fed infant formula at ages 6 to 12 months, the models developed above for infants fed human milk were modified to replace human milk with infant formula. Because these models included fortified infant cereal as well as infant formula, they had few shortfall nutrients, except for vitamin D and omega-3 fatty acids at some energy levels. However, the potential for excess intakes of certain nutrients exists. Table D7.6 shows the projected iron and zinc intakes when 0.5 oz eq of fortified infant cereal is included at ages 6 to 9 months and 9 to 12 months and at each energy level for infants fed infant formula. Iron reaches 142 to 181 percent (15.6 to 19.9 mg, respectively) of the RDA at 6 to 9 months and 123 to 176 percent (13.6 to 19.3 mg, respectively) of the RDA at 9 to 12 months, though none of these estimates exceeded the Tolerable Upper Intake Level (UL) for iron (40 mg). Zinc reaches 226 to 267 percent (7 to 8 mg, respectively) of the RDA at ages 6 to 9 months and 183 to 276 percent (5.5 to 8 mg, respectively) of the RDA at ages 9 to 12 months. These estimates all exceed the UL for zinc (5 mg), though this UL has been challenged as being too low.[27] In any case, infants fed infant formula do not need the extra iron and zinc contributed by fortified infant cereal if formula intake is greater than 760 milliliters (mL) at ages 6 to 9 months or 690 mL at ages 9 to 12 months. Thus, flexibility exists within the grains food group to substitute other grain products (preferably whole grain) for the 0.5 oz eq of fortified infant cereal shown in the example food group amounts described for infants fed human milk (Table D7.5). The percentage of energy from fat in these models was 44 to 46 percent at ages 6 to 9 months and 42 to 47 percent at ages 9 to 12 months. The percentage of energy from protein was 11 to 15 percent at ages 6 to 9 months and 15 to 19 percent at ages 9 to 12 months.

Table D7.6. Summary of iron and zinc estimates in combinations of complementary foods and beverages without and with 0.5 ounce equivalents of fortified infant cereal for infants fed infant formula at ages 6 to 9 months and 9 to 12 months

Energy and IF[1] proportion[2]	Iron (mg) 6 to 9 months		Iron (mg) 9 to 12 months		Zinc (mg) 6 to 9 months		Zinc (mg) 9 to 12 months	
	No IC	IC[1]	No IC	IC[1]	No IC	IC[1]	No IC	IC[1]
600 H[1, 3]	---	---	9.0	15.2	---	---	5.0	5.7
600 A[1]	9.6	16.9	8.1	14.4	5.1	6.4	4.7	5.6
600 L[1]	8.7	15.6	7.1	13.6	4.9	6.0	4.5	5.5
700 H[3]	---	---	10.5	16.5	---	---	5.8	6.4
700 A	11.2	18.3	9.4	15.7	5.9	7.2	5.5	6.3
700 L	10.1	17.0	8.3	14.8	5.7	6.8	5.3	6.2
800 H[3]	---	---	12.0	17.9	---	---	6.6	7.3
800 A	12.8	19.9	10.7	16.9	6.8	8.0	6.3	7.1
800 L	11.6	18.5	9.5	15.9	6.5	7.6	6.1	6.9
900 H[4]	---	---	13.5	19.3	---	---	7.4	8.0
900 A[4]	---	---	12.1	18.2	---	---	7.1	7.8
900 L[4]	---	---	10.7	17.0	---	---	6.8	7.6

1: H=high; A=average; L=low; IF=infant formula; IC=fortified infant cereal; CFB=complementary foods and beverages

2: For the modeling exercises, the proportion of total energy was the same for infant formula as for human milk. Energy from human milk was modeled at 3 levels (low, average, and high) applied to each of 3 age intervals. The average level was based on the mean percentage of total energy from human milk at those ages in published studies from high-income countries,[3] and the low and high levels were set at 15 percent lower and 15 percent higher than the mean, respectively.

3: No combinations of CFB were developed at “high” human milk intakes for ages 6 to 9 months because all energy is allotted to HM.

4: No combinations of CFB were developed for 6 to 9 months at 900 kcal because it is above estimated energy needs.

Modeling Exercises for Ages 12 to 24 Months

Toddlers Fed Neither Human Milk Nor Infant Formula

These food pattern modeling exercises were conducted to identify a pattern of food groups and subgroups that resembles the Pattern established for ages 2 years and older. The first step was to set up a model that included food group amounts in proportion to the amounts in the 1,000 kcal Pattern for ages 2 years and older. Nutrients less than 90 percent of the RDA or AI were flagged. Carbohydrates were below the RDA, but above the EAR of 100 g and within the Acceptable Macronutrient Distribution Range (AMDR) for each energy level. Vitamins E and D were well below the RDA, as is true of the Healthy U.S.-Style Patterns applied to ages 2 years and older. Choline was at least 90 percent of the AI for all kcal levels. Potassium was less than 90 percent of the AI. In addition, calcium and iron were less than 90 percent of the RDA for the 800 and 700 kcal levels.

The next step was designed to increase iron and calcium to 90 percent of the RDA for the 700 and 800 kcal levels, through meats for iron and dairy for calcium. Seafood was adjusted such that 3 oz eq per week was included for all energy levels, as was done for the exercises for ages 9 to 12 months. Whole grains, a source of potassium, were set at 2 oz eq per day, with the remaining portion of grains allocated to refined grains (0.25 to 1 oz eq), with the exception of the 700 kcal level in which grains were adjusted such that 1.5 oz eq per day was provided through whole grains and 0.5 oz eq per day through refined grains. For all other food groups and subgroups, amounts were rounded to the nearest quarter measure (cup or oz eq) in daily or weekly amounts, where appropriate. These adjustments increased energy for the 700 kcal level to 736 kcal and iron at that level to 96 percent of the RDA, so the allocation to meats was reduced from 2.5 oz eq to 1.75 oz eq per day.

Omega-3 and omega-6 fatty acids were well below the AI in these models, which included negligible amounts of oils. To address this, fruit was reduced by a quarter cup eq at the 700 kcal level and refined grains were reduced by a quarter oz eq for the 700 and 800 kcal levels, with the remaining energy reallocated to oils. After these adjustments, iron was 87 percent of the RDA for the 700 kcal level.

In the final Patterns, total Protein Foods are approximately 2 oz eq in all kcal levels. The final Pattern amounts are summarized in Table D7.7.

Table D7.7. Amount from each food group or subgroup in the Healthy U.S.-Style Pattern developed for ages 12 to 24 months without any human milk or infant formula

ENERGY LEVEL (kcal)	**1,000**	**900**	**800**	**700**
FRUITS (cup eq[1]/d[1])	1.00	1.00	0.75	0.50
VEGETABLES				
Total Vegetables (cup eq/d)	1.00	1.00	0.75	0.65
subgroup amounts in cup eq per week				
Dark green (cup eq/wk[1])	0.50	0.50	0.33	1.0
Red Orange (cup eq/wk)	2.50	2.50	1.75	1.00
Legumes (cup eq/wk)	0.50	0.50	0.33	0.75
Starchy (cup eq/wk)	2.00	2.00	1.50	1.00
Other (cup eq/wk)	1.50	1.50	1.25	0.75
GRAINS				
Total Grains (oz[1] eq/d)	3.00	2.50	2.25	1.75
Whole grains (oz eq/d)	2.00	2.00	2.00	1.50
Refined grains (oz eq/d)	1.00	0.50	0.25	0.25
PROTEIN FOODS				
Total Protein Foods (oz eq/d)	2.00	2.00	2.00	2.00
subgroup amounts in oz eq per week				
Meats and Poultry (oz eq/wk)	7.70	7.00	7.00	8.75
Eggs (oz eq/wk)	2.25	2.25	2.75	2.00
Seafood (oz eq/wk)	3.00	3.00	3.00	3.00
Nuts, Seeds and Soy (oz eq/wk)	1.25	1.25	1.00	1.00
DAIRY (cup eq/d)	2.00	2.00	1.75	1.66
OILS (g[1]/d)	13	8	9	9

1: eq=equivalents; d=day; wk=week; oz=ounce; g=gram

The macronutrient distribution for these Patterns is approximately 44 to 50 percent carbohydrate, 31 to 36 percent fat, and 17 to 20 percent protein (Table D7.8). Projected omega-6 fatty acid intake is 90 percent or more of the AI for the 800 to 1,000 kcal Patterns and 87 percent of the AI at the 700 kcal Pattern. Omega-3 fatty acid intake is at least 100 percent of the AI for all Patterns. Other nutrients that fall below 90 percent of the RDA or AI include iron at the 700 kcal level (88 percent of the RDA), potassium at the 700 to 900 kcal levels (ranging from 65 to 89 percent of the AI), vitamin E at all energy levels (ranging from 60 to 81 percent of the RDA), choline at 700 kcal level (87 percent of the AI), and vitamin D at all energy levels (approximately 40 percent of the RDA). To fill some of these gaps, caregivers could choose some of the nutrient-rich foods shown in Table D7.2. Apart from those exceptions, these Patterns achieve 90 percent of the RDA or AI for all other nutrients. In these Patterns, any energy remaining after meeting nutrient goals was allocated to oils, leaving no additional energy for added sugars apart from the 2 to 3 g of added sugars inherent in the Patterns from some of the foods in the nutrient profile (mostly refined grains).

Table D7.8. Summary of energy, macronutrient distributions, and select nutrient amounts and percent of RDA or AI for the Healthy U.S.-Style Pattern intended for infants ages 12 to 24 months without any human milk or infant formula

		Energy Level			
		1,000	**900**	**800**	**700**
Energy	kcal	1,001	907	804	704
Protein	% of kcal	17%	18%	19%	21%
Fat	% of kcal	33%	31%	34%	36%
Carbohydrate	% of kcal	50%	51%	48%	44%
Calcium	mg	782	772	675	612
	% RDA[1]	112%	110%	96%	87%
Iron	mg	8.4	7.9	7.2	6.2
	% RDA	120%	113%	102%	88%
Potassium	mg	1,797	1,772	1,488	1,299
	% AI[1]	90%	89%	74%	65%
Zinc	mg	7	7	7	6
	% RDA	243%	236%	220%	198%
Vitamin E	mg AT[1]	4.9	4.1	3.8	3.6
	% RDA	81%	69%	63%	60%
Vitamin D	IU[1]	260	258	235	214
	% RDA	43%	43%	39%	36%
Choline	mg	199	195	188	169
	% AI	100%	98%	94%	84%
Omega-3	g	1.2	0.9	0.9	0.9
	% AI	178%	135%	133%	130%
Omega-6	g	8.6	6.4	6.5	6.1
	% AI	123%	91%	93%	87%

1: RDA=Recommended Dietary Allowance; AI=Adequate Intake; AT=alpha tocopherol; IU=international units

As was true for ages 6 to 12 months, careful choices of CFB are required at ages 12 to 24 months, such as selecting potassium-rich fruits and vegetables (see Table D7.2), prioritizing seafood, prioritizing whole grains over refined grains, and choosing oils over solid fats.

Toddlers Fed Human Milk

Based on energy allowances for human milk and CFB as shown in Table D.7.1 (described in Methodology), the first step was to set up a model that included food group amounts in proportion to the amounts in the 1,000 kcal Pattern for ages 12 to 24 months with no human milk. Numerous nutrient gaps were evident in this model. Nutrients that fell short of the RDA or

AI for 1 to 3 year old children included calcium, iron, potassium, vitamin E, vitamin D, choline, omega-6 polyunsaturated fatty acids, and in some instances B vitamins.

Therefore, the second step was to examine how adjustments similar to those made for infants fed human milk at ages 9 to 12 months would increase the amount of iron and calcium in the combinations. Additionally, the nutrient profile for calcium in human milk was adjusted to account for the higher bioavailability of calcium in human milk (approximately 60 percent) when compared to cow milk (approximately 30 percent), by applying a factor of 2 to the human milk calcium concentration. Adjustments included the following: meat was increased (while keeping total Protein Foods at about 3 oz eq per day); poultry was set at no more than 1 oz eq per week; eggs were set at 1 oz eq per week (except for the 700 kcal level with an average proportion of human milk, in which eggs were set at 2 oz eq per week to achieve choline needs); nuts were set at 0.5 oz eq per week; and grains were adjusted to emphasize whole grains. These models generally met at least 90 percent of the RDA for iron (except for the 700, 800, and 900 kcal combinations with a high proportion of human milk), but projected calcium intakes were lower than the target for most of the combinations, and projected intake of omega-6 polyunsaturated fatty acids was also well below the AI.

The final step was to examine how further adjustments could increase omega-6 polyunsaturated fatty acids while maintaining iron and calcium to the extent possible, aiming for at least 450 mg of calcium (the amount recommended by the European Food Standards Authority.[26] Adjustments were made to vegetable subgroups to emphasize good sources of calcium and/or iron, including increases in dark green vegetables, legumes, red and orange vegetables, and other vegetables and a corresponding decrease in starchy vegetables. Refined grains were reduced to ¼ cup eq per day (except for the 1,000 and 900 kcal levels with a low proportion of human milk). To shift some energy to oils where needed, dairy was reduced in the combinations for which this would not reduce calcium to lower than 450 mg. Energy was then re-allocated to oils (2 to 11 grams per day) whenever possible to increase fatty acid adequacy.

The approximate amounts of each of the food groups of CFB in the final models are shown in Table D7.9. When a range is shown, the lower amounts generally correspond to the lower energy levels and/or a higher proportion of energy from human milk, and the higher amounts correspond to the higher energy levels and/or a lower proportion of energy from human milk.

Table D7.9. Approximate amounts of food groups and subgroups in example combinations of complementary foods and beverages for toddlers ages 12 to 24 months fed human milk[1]

	12 to 24 months	
Food Groups	Daily amounts	Weekly amounts
Total Fruits (cup eq)	⅓ to ¾	---
Total Vegetables (cup eq)	⅔	---
Red and orange	---	1½
Starchy	---	½ to ¾
Dark green	---	1 to 1½
Legumes	---	½
Other	---	¾
Total Grains (oz eq)[2]	1 ¼ to 2 ¼	---
Total Protein Foods (oz eq)[3]	2 ¼ to 3	---
Meats	---	9 ¼ to 15 ¾
Poultry	---	1 to 3
Seafood	---	≥3
Eggs	---	≥1
Nuts and seeds	---	≥½
Total Dairy (cup eq)[4]	¼ to 1¾	---
Total added oils/fats (g)[5]	2 to 11	---

1: The amounts shown represent the quantities of food items (cup or oz eq) that toddlers ages 12 to 24 months fed human milk could consume as complementary foods and beverages from different food groups and sub-groups to approach most nutrient recommendations for this age group for a variety of scenarios differing in the proportion of energy coming from human milk and complementary foods and beverages.
2: Emphasis on whole grains ranging from 1 to 2 oz eq
3: Total protein foods includes a majority from meats rather than poultry because meat has higher iron content than poultry. The weekly amounts of seafood, eggs, and nuts and seeds represent minimum amounts; greater quantities from these subgroups may be accommodated within the quantities allocated to total protein foods and the energy allocation for complementary foods and beverages for this age group.
4: Dairy is zero in combinations where the human milk proportion is high and energy for complementary foods and beverages is small.
5: Grams of oils are lower when proportions of human milk are high and energy for complementary foods and beverages is small.

The macronutrient distribution for these combinations is 44 to 48 percent carbohydrate, 35 to 40 percent fat, and 15 to 20 percent protein. These combinations come close to meeting most nutrient recommendations for a variety of scenarios differing in the proportion of energy coming from human milk and CFB. Projected omega-6 fatty acid intake is close to or greater than 90 percent of the AI for nearly all of the 800, 900, and 1,000 kcal level scenarios, and 66 to 89 percent at the 700 kcal level. Projected omega-3 fatty acid intake is greater than 100 percent of the AI for all of the scenarios at the 800 to 1,000 kcal levels and the 700 kcal level with a "low" proportion of human milk, but 81 to 83 percent of the AI for the "high" and "average" human milk intake scenarios at the 700 kcal level. Other nutrients that fall below 90 percent of the RDA or AI include calcium at most energy levels (mostly above 70 percent of the RDA except at the 700 kcal level), iron at most energy levels (though nearly all had at least 80 percent of the RDA), potassium at all energy levels (50 percent to 82 percent of the AI), vitamin E at most energy levels (generally 60 to 83 percent of the RDA), and vitamin D at all energy levels (9 to 39 percent of the RDA). To fill some of these gaps, caregivers could choose some of the nutrient-rich foods shown in Table D7.2.

Toddlers Fed a Lacto-Ovo Vegetarian Diet, and Fed Neither Human Milk Nor Infant Formula

Descriptions of vegetarian dietary patterns in the literature often focus on foods that are not consumed, rather than on the foods that represent the pattern. The USDA Healthy Vegetarian Pattern intended for ages 2 and older was developed as part of the 2015 Committee's work and described in detail in their report.[28] In brief, the Healthy Vegetarian Style Pattern was informed by reported dietary intakes of self-identified vegetarians using data from NHANES 2007-2010. Information on self-identified vegetarian status was not collected in more recent NHANES survey years, so this analysis was not undertaken by the Committee. In previous analysis, more than 90 percent of self-identified vegetarians consumed dairy products on the day of the NHANES survey, and 65 percent consumed eggs.[29] Thus, the Healthy Vegetarian Style Pattern was modeled as a lacto-ovo vegetarian pattern. Nutrient adequacy of the Healthy Vegetarian Patterns is calculated using the same nutrient standards as used for the Healthy U.S.-Style Patterns. The Healthy Vegetarian Style Pattern for ages 2 years and older is described in ***Part D. Chapter 14: USDA Food Patterns for Individuals Ages 2 Years and Older***.

To adapt the Healthy Vegetarian Style Pattern for toddlers ages 12 to 24 months, the following steps were followed. First, the nutrient profiles based on proportions of foods reported for infants and toddlers were applied at the 1,000 kcal Pattern. This Pattern was evaluated against the nutrient goals for ages 12 to 24 months. Nutrients that did not align with the RDA or AI included choline, potassium, vitamin E, vitamin D, and omega-3 and omega-6 fatty acids.

Second, the 1,000 kcal pattern was adjusted to include 0.43 oz eq per day (3 eggs per week) to achieve more choline. Grains were shifted to emphasize whole grains as was done in the Patterns for non-vegetarians for ages 12 to 24 months. Of the 3 oz eq, 2 were applied to whole grains and 1 to refined grains. Then the proportions of energy from each food group were extrapolated down for the 900, 800, and 700 kcal levels.

Third, the following additional adjustments were made, mainly to achieve consistency. Amounts from Fruits were adjusted to correspond to the amounts in the Healthy U.S.-Style Pattern for ages 12 to 24 months, amounts from Vegetables in the 1,000 kcal level were carried across all levels, amounts from grains in the Healthy U.S.-Style for 12 to 24 months were adopted with emphasis on whole grains, amounts of Protein Foods in the 1,000 kcal level were carried across all levels with one adjustment to eggs across all energy levels (increased from 0.43 per day to 0.5 oz eq per day), and amounts from Dairy were adjusted to at least 1.75 cup eq per day to achieve the calcium goal.

In the final Patterns, total Protein Foods are approximately 1 oz eq per day for all energy levels. The final Pattern amounts are summarized in Table D7.10.

Table D7.10. Amount from each food group or subgroup in the Healthy Vegetarian Style Pattern developed for ages 12 to 24 months without any human milk or infant formula

Energy level (kcal)	1,000	900	800	700
FRUITS (cup eq[1]/d[1])	1	1	0.75	0.5
VEGETABLES				
Total Vegetables (cup eq/d)	1	1	1	1
subgroup amounts in cup eq per week				
Dark green (cup eq/wk[1])	0.5	0.5	0.5	0.5
Red Orange (cup eq/wk)	2.5	2.5	2.5	2.5
Legumes (cup eq/wk)	0.75	0.75	0.75	0.75
Starchy (cup eq/wk)	2	2	2	2
Other (cup eq/wk)	1.5	1.5	1.5	1.5
GRAINS				
Total Grains (oz[1] eq/d)	3	2.75	2.25	1.75
Whole grains (oz eq/d)	2	2	1.75	1.25
Refined grains (oz eq/d)	1	0.75	0.5	0.5
PROTEIN FOODS				
Total Protein Foods (oz eq/d)	1	1	1	1
subgroup amounts in oz eq per week				
Eggs (oz eq/wk)	3.5	3.5	3.5	3.5
Nuts, Seeds, and Soy (oz eq/wk)	4	4	4	4
DAIRY (cup eq/d)	2	1.75	1.75	1.5
OILS (g[1]/d)	15	10	8.5	9

1: eq=equivalents; d=day; wk=week; oz=ounce; g=gram

The macronutrient distribution for these patterns is about 48 to 53 percent carbohydrate, 32 to 36 percent fat, and 16 to 17 percent protein (Table D7.11). Projected omega-3 and omega-6 fatty acid intakes are greater than 90 percent of the AI for all energy patterns. Nutrients that fall below 90 percent of the RDA or AI include iron at the 700 kcal level (89 percent of the RDA), potassium at all energy levels (66 to 87 percent of the AI), vitamin E at the 700 to 900 kcal levels (71 to 80 percent of the RDA), vitamin D at all energy levels (approximately 30 to 40 percent of the RDA), choline at the 700 kcal Pattern (88 percent of the AI), and calcium at the 700 kcal Pattern (86 percent of the RDA). To fill some of these gaps, caregivers could choose some of the nutrient-rich foods shown in Table D7.2. Apart from those exceptions, these Patterns achieve 90 percent of the RDA or AI for all other nutrients. However, it should be noted that most of the iron in this Pattern comes from whole grains, soy products, nuts/seeds and legumes, and that bioavailability of iron (and zinc) from these types of foods is low due to relatively high levels of phytate.[9] If the RDA for iron is increased by a factor of 1.8 for vegetarian diets,[9] these Patterns meet only 50 to 71 percent of the RDA for iron.

Table D7.11. Summary of energy, macronutrient distributions, and select nutrient amounts and percent of RDA or AI for the Healthy Vegetarian Pattern intended for infants ages 12 to 24 months without any human milk or infant formula

Energy level (kcal)		1,000	900	800	700
Energy	kcal	999	898	810	703
Protein	% of kcal	16%	16%	17%	17%
Fat	% of kcal	35%	32%	33%	36%
Carbohydrate	% of kcal	51%	53%	51%	48%
Calcium	mg	805	726	707	609
	% RDA[1]	115%	104%	101%	87%
Iron	mg	9.0	9.0	7.6	6.3
	% RDA[2]	126% (71%)	122% (71%)	108% (60%)	89% (50%)
Potassium	mg	1732	1649	1537	1330
	% AI[1]	87%	82%	77%	66%
Zinc	mg	6.7	6.4	5.9	4.9
	% RDA	224%	213%	198%	163%
Vitamin E	mg AT[1]	5.6	4.8	4.5	4.3
	% RDA	93%	80%	74%	71%
Vitamin D	IU[1]	239	214	211	183
	% RDA	40%	36%	35%	31%
Choline	mg	204	195	190	175
	% AI	102%	98%	95%	88%
Omega-3	g	1.4	1.0	0.9	0.9
	% AI	196%	148%	133%	129%
Omega-6	g	9.6	7.3	6.5	6.3
	% AI	137%	105%	92%	90%

1: RDA=Recommended Dietary Allowance; AI=Adequate Intake; AT=alpha tocopherol; IU=international units

2: Taking into account the reduced bioavailability of iron in vegetarian diets (i.e., 10% rather than 18% for non-vegetarian diets), the requirement for iron is 1.8 times higher for individuals consuming vegetarian diets (i.e., 7 x 1.8 = 12.6 mg iron per day)[9]; percent of this requirement is shown in parentheses.

In these Patterns, any energy remaining after meeting nutrient goals was allocated to oils, leaving no additional energy for added sugars apart from the 2 to 3 g of added sugars inherent in the Patterns from some of the foods in the nutrient profile (mostly refined grains). Careful choices of foods and beverages within vegetarian diets are very important to meet nutrient needs.

For additional details on this body of evidence, visit:
https://www.dietaryguidelines.gov/2020-advisory-committee-report/food-pattern-modeling/FPM-under-2

DISCUSSION

Overview of Approach and Summary of Shortfall or Excess Nutrients

Developing recommended food patterns for infants and toddlers ages 6 to 24 months is challenging because nutrient needs are high relative to energy requirements at this age, and the amounts of CFB that can be consumed are relatively low, especially at the younger ages. The Committee opted to start with modeling the contributions of food groups in proportion to the amounts in the 1,000 kcal Pattern for ages 2 years and older, with adaptations as needed to correspond to estimated energy intakes and nutritional goals for infants and toddlers ages 6 to 24 months. This approach has the advantage of developing Patterns that are feasible with respect to the types of foods consumed in the United States, and that become consistent with the Patterns recommended for older age groups by age 24 months. However, the results do not necessarily represent the optimal combinations of foods and beverages for meeting nutritional goals, which requires a different modeling approach.

One strength of the approach taken herein was to model various scenarios with respect to the potential contribution from human milk or infant formula, as well as several options reflecting total energy needs at ages 6 to 12 months and 12 to 24 months. One key limitation of this approach is uncertainty regarding the nutrient composition of human milk. The models generally used the mean concentrations of each nutrient in human milk cited in the descriptions of the DRIs for infants as the nutrient profile (see the nutrient profile for human milk available at https://www.dietaryguidelines.gov/ 2020-advisory-committee-report/data-analysis), but in many cases these values are based on relatively few samples and/or outdated methods. Currently, no suitable approach or database is available that represents the variability of human milk composition in the United States. Several nutrients in human milk vary due to maternal nutritional status, diet and/or supplement intake, and other factors,[30] including total fat, fatty acids, most vitamins, choline, iodine, and selenium (see ***Part D. Chapter 3: Food, Beverage, and Nutrient Consumption During Lactation***). This has implications for the modeling exercises. For example, because the 2011 DRI report for vitamin D[12] states that human milk is not a meaningful source of vitamin D, the nutrient profile for human milk used in modeling included no vitamin D. However, it is known that milk vitamin D levels can increase substantially in response to maternal vitamin D supplementation and sun exposure[30,31]; thus, infants are expected to get some vitamin D through human milk.

Another limitation is that the nutritional goals for the modeling exercises for ages 6 to 12 months were based mainly on AI values, because RDAs are available only for protein, iron, and zinc. The primary approach for setting the AIs for older infants was to sum the estimated mean content coming from reported CFB intakes and from 600 mL of human milk. However, when the value was judged to be unreasonable, the AI was set by extrapolating up from the AI for ages 0 to 6 months (for vitamins K, E, and B_{12}, selenium, and iodine), down from estimates of adult requirements (for thiamin and niacin), or a combination of the two (for riboflavin, vitamin B_6, folate, and choline). No DRI has been established for dietary fiber for older infants. The lack of RDAs made it difficult to evaluate risk of inadequacy for potential shortfall nutrients, such as potassium and choline, for which the AI may or may not represent the correct target. In addition, the potential for overconsumption was assessed in the models (particularly those with infant formula) based on ULs for older infants (and toddlers), but some ULs have been criticized as having been established with too little available data and are considered to be too low for certain nutrients,[27] specifically zinc and retinol. For both age intervals (6 to 12 months and 12 to 24 months), published nutrient reference values vary considerably across authoritative bodies,[32] which suggests some uncertainty about nutrient requirements.

It also should be noted that these modeling exercises were based on energy requirements, but reported intakes among infants fed infant formula in this age group tend to exceed energy requirements (see ***Part D. Chapter 1: Current Intakes of Foods, Beverages, and Nutrients***). In the various modeling scenarios presented, the volume of human milk or formula was calculated based on a given proportion of total energy requirements. The volumes of infant formula in these models may be an underestimate of actual intakes among infants fed infant formula. These modeling exercises did not attempt to model mixed-feeding scenarios, in which infants receive both human milk and infant formula. However, the example combinations that meet most nutrient recommendations for infants fed human milk also are likely to be nutritionally adequate for mixed-fed infants.

The first set of models for infants fed human milk at ages 6 to 12 months, in which the amounts of the various food groups and subgroups were proportional to the amounts in Patterns for children ages 2 years and older, there were numerous shortfall nutrients (i.e., those that did not meet at least 90 percent of the DRI value). Several of these food components were also reported as underconsumed in ***Part D. Chapter 1***, including iron and zinc among infants fed human milk, and vitamin D, potassium, and choline among all infants at ages 6 to 12 months.

Although the intake data suggested that 27 percent of infants fed human milk at this age had protein intakes that were low enough to be at risk of inadequacy, protein was not a limiting nutrient in the modeling exercises in any of the scenarios, as a focus on iron naturally led to the inclusion of iron-rich foods, like meat, that also have a high protein content. Indeed, the percentage of energy from protein at ages 9 to 12 months (16 to 19 percent) was on the high side, and evidence suggests that protein intakes exceeding 15 percent of energy in early life may increase the risk of excess weight gain.[33] However, this is an area of active research and it is not clear which types of protein (e.g., dairy vs meat) may or may not be contributing to this association.

The modeling exercises for ages 6 to 12 months confirmed the challenges of meeting iron and zinc needs for infants fed human milk. For this reason, the second step for this age interval was to include 0.5 oz eq/d of fortified infant cereals. Fortified infant cereal helped to close some of the gap between the amount provided in the example combination of foods and the RDA for both iron and zinc. However, these models still had shortfalls for some nutrients, including iron, potassium, magnesium, and choline. In the final step of the modeling exercises, most of these gaps were filled by prioritizing protein foods, particularly meat. For infants fed infant formula at ages 6 to 12 months, the final step included fortified infant cereal as well as infant formula, so the final combinations of CFB had few shortfall nutrients except for vitamin D and omega-3 fatty acids at some energy levels.

For ages 12 to 24 months, the shortfall nutrients (for some or all of the energy levels) in the first set of models for toddlers fed neither human milk nor infant formula were calcium, iron, potassium, vitamin E, vitamin D, choline, and omega-3 and omega-6 fatty acids. Some of these food components also were reported as underconsumed at this age in ***Part D. Chapter 1***, including potassium and vitamin D. Choline and linoleic acid were categorized as “special challenges.” Small increases in Protein Foods and Dairy and an emphasis on whole grains rather than refined grains closed some of these gaps, but potassium, vitamin E, and vitamin D were still consistently below the goals. As was the case at ages 9 to 12 months, the percentage of energy from protein was on the high side (17 to 21 percent), which warrants further consideration.

For toddlers fed human milk at ages 12 to 24 months, the modeling exercises revealed challenges in meeting nutrient goals for both calcium and iron simultaneously, given that: a) human milk has considerably less calcium than cow milk (though calcium absorption from human milk is high, approximately 60 percent,[12] and b) inclusion of sufficient amounts of dairy products to meet calcium needs meant that iron became a shortfall nutrient, because dairy products contain very little iron. It should be noted that the RDA for calcium at ages 1 to 3 years (700 mg) is much higher than the AI for calcium at ages 7 to 12 months (270 mg), and that the recommended calcium intake for ages 1 to 3 years published by the European Food Standards Authority is only 450 mg.[26] As was true for toddlers fed neither human milk nor infant formula, other shortfall nutrients included potassium, vitamin E, and vitamin D. Further modeling work is needed that incorporates estimates of mineral absorption under various circumstances. Using tools such as linear programming would be helpful in addressing multiple nutritional constraints and food sources of nutrients simultaneously, to identify combinations of foods and beverages that meet all nutritional goals.

For toddlers fed lacto-ovo vegetarian diets, and fed neither human milk nor infant formula at ages 12 to 24 months, a pattern was developed, but most of the iron in this Vegetarian Style Pattern comes from whole grains, soy products, nuts and seeds, and legumes, from which bioavailability of iron is likely to be low due to relatively high levels of phytate and absence of heme iron.[9] The projected percentage of the iron RDA provided in that Pattern is likely an overestimate of the amount that is physiologically available. If one assumes that iron requirements are 1.8 times higher for vegetarian diets than for non-vegetarian diets,[9] the Vegetarian Style Pattern for toddlers would meet only 50 to 71 percent of the RDA for iron. Further work is needed to take this into account.

The percentage of energy from fat in these models was 41 to 44 percent at ages 6 to 9 months, 35 to 42 percent at 9 to 12 months, and 29 to 40 percent at ages 12 to 24 months, within recommended ranges capable of meeting the AI for infants and AMDR for toddlers. The AI is 30 g/d of fat at ages 7 to 12 months, which represents about 30 to 45 percent of energy for total energy intakes of 600 to 900 kcal/d. Projected intakes of omega-6 fatty acids in these models were more than adequate at ages 6 to 12 months but lower than the AI of 7 g/d for linoleic acid at ages 12 to 24 months for several scenarios. For omega-3 fatty acids, projected intakes in these models were greater than 90 percent of the AI for most energy levels (except the lowest, 600 kcal level) for the infants fed human milk or infant formula at ages 6 to 12 months. At ages 12 to 24 months they also were generally greater than 90 percent of the AI.

Iron as a Key Nutrient at Ages 6 to 12 Months

As expected, the most limiting nutrient for infants fed human milk at ages 6 to 12 months was iron. It was not possible to meet the RDA without the inclusion of iron-fortified infant foods. Because the iron concentration of human milk is low (approximately 0.3 mg/L after 5 months of lactation), the food pattern modeling exercises assumed zero iron coming from that source.

Absorption of iron from human milk is variable,[34] but even if 100 percent is absorbed, the amount of iron that an infant would receive from 600 mL would be less than 0.2 mg, a trivial amount relative to the RDA of 11 mg/d. This discrepancy may seem counter-intuitive, but it is likely that the iron content of complementary foods fed to infants during most of human evolution, when humans relied completely on hunting and gathering before the invention of agriculture, was much higher than it is today, and that iron deficiency was rare.[35] The estimated iron density of the pre-agricultural diet was 2.9 mg/100 kcal at age 9 months, whereas typical modern-day (unfortified) complementary food diets have an iron density of only 0.4 to 1.3 mg/100 kcal.

Fortified infant foods are not necessarily the only way for infants fed human milk to achieve the RDA, however. For example, certain animal-source foods (e.g., red meat) are good sources of iron, particularly when taking into account the fact that heme iron (as found in meat) is much better absorbed than non-heme iron (as found in plant-based foods). Assuming that infants at ages 6 to 12 months need 1.1 mg of absorbed iron (back-calculated from the RDA of 11 mg, which assumes 10 percent absorption), and 25 percent absorption of heme iron, infants would need 4.4 mg of iron from animal-source foods. Obtaining that amount solely from beef, which has about 1 mg of iron per 100 g (81 kcal of baby food beef), would require consuming 440 g of beef (356 kcal), which is not feasible. Organ meats such as liver have far more iron. For example, the iron content of chicken liver is about 11.5 mg per 100 g (166 kcal), so infants would need only 38 g (64 kcal) to meet the target of 4.4 mg. However, feeding liver to infants is not common in the United States. Other foods that are rich in iron are listed in Table D7.2. Further work is needed to estimate the quantities of iron-rich foods that would be needed by infants fed human milk, in the absence of fortified infant foods, to support adequate iron status between ages 6 and 12 months, recognizing that: a) the RDA is set to meet the needs of 97.5 percent of infants, and many infants require less than the RDA, b) iron absorption is up-regulated when iron stores begin to become depleted, and c) the Recommended Nutrient Intake for iron at this age set by WHO/FAO (i.e., 9.3 mg)[36] is lower than the RDA (i.e., 11 mg), both of which assume 10 percent absorption. In the meantime, it should be noted that iron-fortified infant foods have been an important strategy for reducing iron deficiency among infants in the United States for several decades.[37]

On the other hand, infants fed infant formula have the potential for excess intakes of iron (and other nutrients), as the iron content of formulas most commonly used in the United States is relatively high (approximately 1.8 mg/100 kcal), about 40 times the iron content of human milk. In the food pattern modeling exercises for infants fed infant formula, inclusion of iron-fortified infant cereal in addition to infant formula would result in total iron intakes that are 123 to 181 percent of the RDA, although it should be noted that the bioavailability of iron in fortified infant cereals is highly variable, depending on the type of cereal and form of iron that is added. As described in ***Part D. Chapter 6: Nutrients from Dietary Supplements During Infancy and Toddlerhood***, iron is a "double-edged sword," in that both deficient and excess intakes can be harmful. Although the estimated iron intakes in these scenarios did not exceed the UL of 40 mg, it is clear that iron-fortified infant foods are not necessary if infant formula intake is greater than 760 mL at ages 6 to 9 months or 690 mL at ages 9 to 12 months.

Potassium, Sodium, and Iodine

It was challenging to meet the AI for potassium (860 mg at ages 7 to 12 months; 2,000 mg at ages 1 to 3 years) in all of the modeling exercises. At ages 6 to 12 months, the predicted intakes were often less than 90 percent of the AI, especially at lower energy levels; at 12 to 24 months, predicted intakes were only 65 to 90 percent of the AI. Similarly, the Healthy U.S.-Style Pattern for the 1,000 kcal level intended for children ages 2 years or older does not achieve 90 percent of the AI. The AI for ages 7 to 12 months is based on 260 mg from human milk plus 600 mg from CFB, and it is possible that the latter is an overestimate of actual intakes. After 12 months, the AI is based on the highest median intakes at ages 1 to 3 years, and this may overestimate needs at ages 12 to 24 months. The recommended potassium intakes published by the European Food Standards Authority are lower than the AI values: 750 mg at ages 7 to 11 months and 800 mg at ages 1 to 3 years.[38] This suggests some uncertainty regarding potassium requirements for infants and children younger than age 24 months. Nonetheless, choosing potassium-rich foods is important at these ages (see Table D7.2 for a list of such foods).

The modeling exercises at ages 6 to 9 months provided relatively little sodium (179 to 400 mg), although by ages 9 to 12 months the estimates were adequate (384 to 566 mg in the models for infants fed human milk). The AI for sodium for infants ages 7 to 12 months is based on estimated sodium intake from human milk (70 mg, from 600 mL of human milk) plus CFB (300 mg/d), for a total of 370 mg/d. Physiological requirements for sodium during infancy[39,40] correspond to an intake of about 300 to 460 mg/d at ages 6 to 12 months. Projected intakes at ages 6 to 9 months for "average" human milk intake models were less than 300 mg/d. Infant feeding guidance usually recommends not to add salt to foods for infants. This has implications not only for adequacy of sodium intake, but also adequacy of iodine intake, as iodized salt is a key contributor to the latter. If infants are fed some prepared foods to which salt has been added, sodium intakes may not be low, but if the recommendation to avoid added salt were fully implemented, underconsumption may be a concern. The estimated sodium provided by the Patterns for 12 to 24 months (with no human milk or infant formula) was 613 to 729 mg, which is well below the AI of 800 (which is based on extrapolation down from adult values).

Iodine intakes could not be predicted because food composition data are not available for iodine. The AI for iodine at ages 6 to 12 months is 130 micrograms per day (mcg/d), extrapolated up from the AI of 110 mcg/d for ages 0 to 6 months. Estimated iodine intake at ages 6 to 12 months is about 141 mcg/d, based on Total Diet Study estimates of iodine in the U.S. food supply and predicted intakes based on food consumption data reported in WWEIA 2007-2008, 2009-2010, and 2011-2012.[41] However, this estimate is based on 59 percent (83 mcg) from "baby food," which includes infant formula, and 33 percent (46 mcg) from dairy products. It is not clear what the estimated intake would be among infants fed human milk. Infant formula generally has 15 mcg/100 kcal, which would provide the AI if energy intake from formula is 866 kcal or more, although the minimum content required is only 5 mcg of iodine per 100 kcal.[5] The average estimated iodine concentration of human milk is similar, but maternal diet influences milk iodine concentration, and wide variability in iodine intakes of women who are lactating is likely. In situations in which neither the mother nor the infant consumes iodized salt or obtains adequate iodine from other sources (e.g., dairy products), iodine intakes of infants could be deficient. Only 53 percent of table salt sold at retail level in the United States in 2009 was iodized,[42] and the iodine content of cow milk in the United States is highly variable.[43] Underconsumption of iodine during infancy has important potential consequences for brain development, especially if maternal intake was also low during pregnancy.[44]

Added Sugars

In general, public health concern about sugars tends to focus on "added" sugars, rather than naturally occurring sugars that are intrinsic to fruits, vegetables, and milk.[45] The example combinations of foods developed for older infants contain a negligible amount of added sugars, with a range of 0.5 to 1.1 grams across all energy levels and models differing in proportions of energy from human milk. Similarly, low amounts of added sugars were estimated in the Patterns for toddlers (ages 12 to 24 months) with a range of approximately 2 to 3 grams, representing 1 percent of total energy intakes. This low amount of added sugars is logical given that the foods selected for the Patterns were in the most nutrient-dense forms, and would thus, by definition, be low in added sugars. For example, the food combinations and Patterns include only plain yogurt, whereas other types of yogurts with added sugars are more frequently consumed by this age group. The observed intake patterns among infants and toddlers suggest that much higher amounts of added sugars are currently being consumed then the proposed combinations of foods in these modeling exercises. For older infants fed human milk, milk and dairy (28 percent of total added sugars), grains (17 percent), and fruits (16 percent) were the top 3 contributing sources of added sugars, whereas among infants fed infant formula or mixed-fed, the primary contributors were snacks and sweets (25 percent), baby foods (20 percent), and milk and dairy (19 percent). Nevertheless, the mean amounts of added sugars were quite similar despite different food sources, with both groups consuming about 1 tsp eq per day. The intake of added sugars precipitously increases in ages 12 to 24 months, with an average of about 6.2 tsp eq consumed on a given day. It should be noted that 100% fruit juice does not contribute toward added sugars, but rather toward fruit intakes. Fruit drinks and juice blends that are not 100% fruit juice do, however, contribute to intakes of added sugars. The Patterns developed for this age group consider only the nutrient contributions from 100% juice and fluid milk as beverages that contribute to the Fruits and Dairy groups, respectively. Most other beverages, such as fruit drinks, are not represented in those food groups. The modeling exercises described in this chapter illustrate that aiming to achieve recommended intakes of key nutrients for ages 6 to 24 months, including iron, leaves virtually no remaining energy for added sugars. Shifts in the dietary intakes of infants and toddlers are needed to ensure that nutrient-dense foods are provided.

SUMMARY

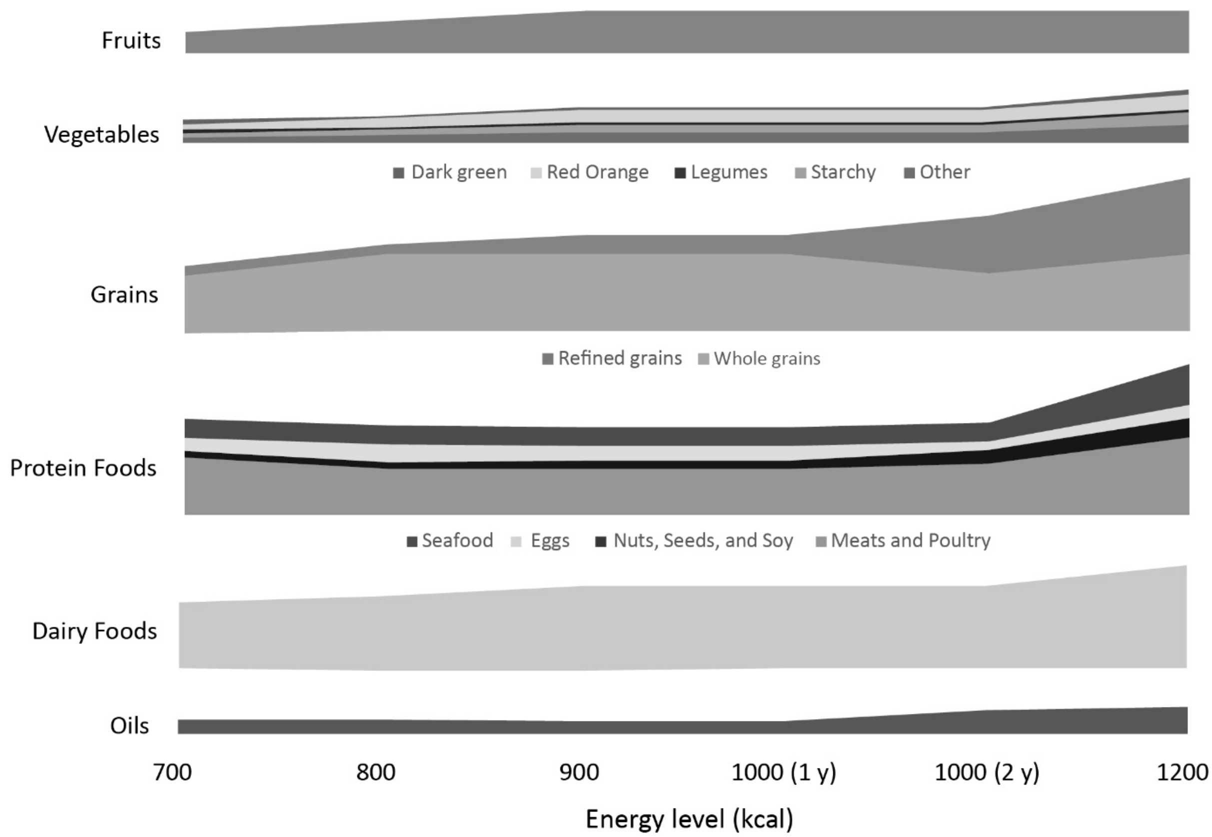
The results of modeling exercises for infants and children ages 6 to 24 months illustrate that simply extrapolating down from the patterns for children older than age 2 years is not sufficient to meet the unique nutrient needs during this life stage. During the complementary feeding period, human milk or other milk sources (such as infant formula until age 12 months, other milks thereafter) make up a substantial proportion of total energy intake such that the energy to be contributed by CFB is limited, especially at ages 6 to 12 months. At the same time, CFB need to provide nearly all of the iron and zinc and a substantial proportion of the amounts of several other key nutrients required by infants fed human milk at these ages, so the nutrient density of CFB has to be quite high. The nutrient gaps identified in ***Part D. Chapter 1: Current Intakes of Foods, Beverages, and Nutrients*** reflect this situation and confirm the need to provide sources high in these nutrients during the transition to the family diet.

For infants ages 6 to 12 months, the Committee was not able to establish a recommended food pattern. Further work is needed to explore various options for meeting all nutrient recommendations during that age range, using tools such as linear programming and taking into account differences in iron bioavailability from different sources. In the meantime, the modeling exercises revealed the importance of prioritizing certain food groups and making careful food choices within food groups. For example, certain animal-source foods are important sources of key “shortfall” nutrients at this age, including iron, zinc, choline, and long-chain polyunsaturated fatty acids. Fortified infant cereals can contribute a substantial amount of some of these nutrients, particularly iron and zinc, but prioritizing consumption of meat, egg, and seafood is an important strategy for providing all of these crucial nutrients. By contrast, dairy products (such as yogurt and cheese) are less crucial than other types of animal-source foods at ages 6 to 12 months because infants are still receiving human milk or infant formula, and dairy products tend to have low amounts of iron. Prioritizing fruits and vegetables, particularly those that are rich in potassium, vitamin A, and vitamin C, is another key element of healthy complementary food diets at ages 6 to 12 months, not only to provide adequate nutrition but also to foster acceptance of these healthy foods. In addition, introduction of peanut products and egg in the first year of life is advised, to build tolerance to food antigens (i.e., help prevent food allergies) and to provide good sources of fatty acids and choline. Finally, the modeling exercises illustrated that CFB diets at this age include no remaining energy for added sugars and little energy for added oils or added solid fats.

For ages 12 to 24 months, the Committee was able to establish a recommended Food Pattern for toddlers fed neither human milk nor infant formula that resembles the Pattern established for ages 2 and older. The Pattern allows for a variety of nutrient-rich animal-source foods, including meat, poultry, seafood, eggs, and dairy products, as well as nuts and seeds, fruits, vegetables, and grain products. Key aspects to emphasize include choosing potassium-rich fruits and vegetables, prioritizing seafood, making whole grains the predominant type of grains offered, and choosing oils over solid fats. In these Patterns, energy allocated to oils is minimal (8 to 13 g/d) and no energy remains for added sugars not already inherent in the Patterns. For toddlers fed human milk at ages 12 to 24 months, the Committee was not able to establish a recommended food pattern but provides examples of potential combinations of CFB that come close to meeting almost all nutrient recommendations. Further work is needed to examine predicted nutrient intakes of toddlers fed human milk that take into account mineral bioavailability under various conditions. For toddlers fed lacto-ovo vegetarian diets and fed neither human milk nor infant formula at ages 12 to 24 months, a Pattern was established that includes regular consumption of eggs, dairy products, soy products, and nuts or seeds, in addition to fruits, vegetables, grains, and oils. Because of concerns about iron bioavailability in the vegetarian pattern, the Committee recommends further modeling work that takes this into account. Careful choices of CFB within vegetarian diets are very important to meet nutrient needs. It should be noted that the Healthy Vegetarian Eating Pattern developed is not a vegan diet, as the former includes substantial amounts of animal-source foods (egg and dairy). Without supplements and/or fortified products, it is not possible to meet all nutrient goals with a vegan diet at this age.[46] In all of the Patterns for toddlers ages 12 to 24 months, any energy remaining after meeting nutrient goals was allocated to oils, leaving no additional energy for added sugars apart from the 2 to 3 g of added sugars inherent in the patterns from some of the foods in the nutrient profile (mostly refined grains).

These findings are not intended to provide a combination of CFB or food pattern that is right for every infant or toddler, because children develop at different rates, and many different circumstances influence feeding needs and decisions. In the Patterns developed for toddlers ages 12 to 24 months, the lowest energy level (700 kcal) presented challenges for meeting certain nutritional goals (e.g., iron and fatty acids). Toddlers with relatively low energy intakes may benefit from food combinations that resemble those for infants ages 6 to 12 months, with a gradual shift to the patterns presented for ages 12 to 24 months. A general principle is to view the period from ages 6 to 24 months as a continuous transition from diets appropriate for infants to diets that resemble family food patterns. Figure D7.1 illustrates this transition. For most of the food groups, amounts to be consumed gradually rise as energy from CFB increases, which is correlated with age. However, the energy from Protein Foods is relatively constant, and is a substantial proportion of total energy from CFB, at all energy levels between 700 and 1,000 kcal. This is a reflection of the need for nutrient-rich foods for children younger than age 24 months. Another important feature of Figure D7.1 is the high proportion of whole grains, relative to total Grains, until age 2 years.

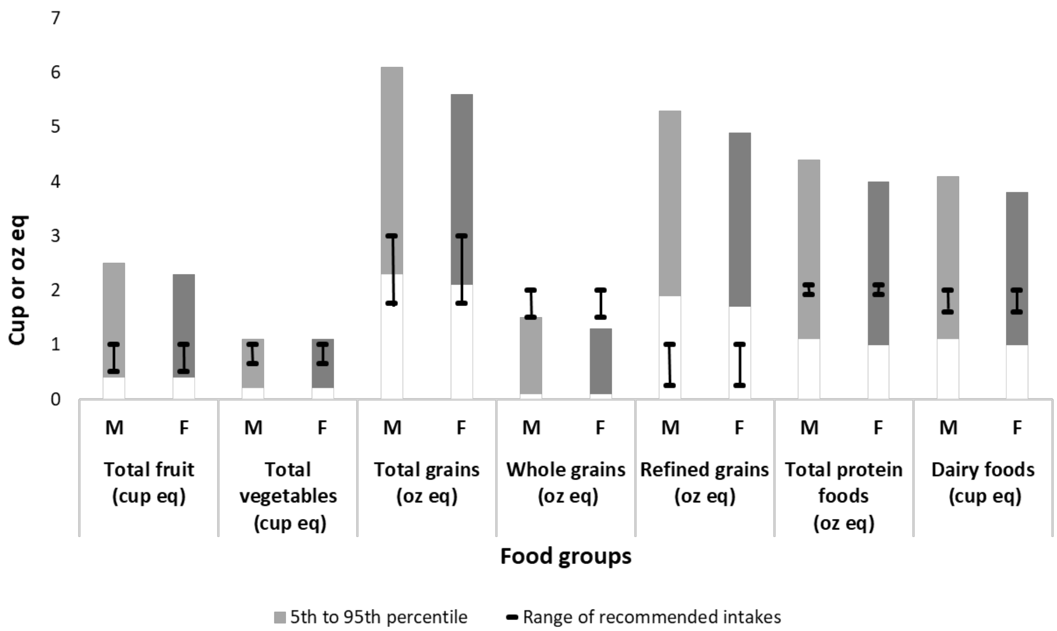
Figure D7.1. Relative amounts of food groups and subgroups in Healthy U.S.-Style Patterns across energy levels for toddlers and young children[1]: transition from diets appropriate for infants to diets that resemble family food patterns[2]



1: Inclusive of complementary foods and beverages (CFB) and not human milk or infant formula; modeled complementary food includes fluid milk, calcium fortified soy beverage, and 100% fruit and vegetable juice
2: For most of the food groups, amounts to be consumed gradually rise as energy from CFB increases, which is correlated with age. However, the energy from Protein Foods is relatively constant, and is a substantial proportion of total energy from CFB, at all energy levels between 700 and 1,000 kcal, and whole grains are a high proportion of total grains until age 2 years. These features reflect the need for nutrient-rich foods for children younger than age 24 months.

As described in ***Part D. Chapter 14: USDA Food Patterns for Individuals Ages 2 Years and Older***, a strength of the USDA Food Patterns is that they provide examples of amounts of food groups and subgroups that could be consumed, but do not dictate the specific types of foods to be consumed, providing a large amount of flexibility for foods to be tailored to an individual's needs and preferences. This flexibility is very important during the CFB period, as it accommodates cultural preferences and cost considerations, and permits multiple approaches for the introduction of a wide variety of foods, flavors, and textures important in shaping healthy eating patterns. Figure D7.2 illustrates that the Healthy U.S.-Style Pattern for toddlers ages 12 to 24 months is an achievable pattern, with a few shifts from current consumption patterns needed. The range of recommended intakes in the Pattern is well within the range (5th to 95th percentile) of current intakes of Fruits, Vegetables, total Protein Foods, and Dairy in this age group, though a shift toward greater intake of Vegetables is needed. By contrast, the recommended intakes of whole grains are well above current intakes, whereas the recommended intakes of refined grains are far below current intakes. Thus, a shift toward a higher proportion of total Grains as whole grains and a reduction in refined grains is needed.

Figure D7.2. Range of recommended food group amounts in the Healthy U.S.-Style Food Pattern compared to the 5th to 95th percentiles of intakes in the population for children ages 12 to 24 months not fed human milk[1]



1: Illustrates that the Healthy U.S.-Style Pattern for toddlers ages 12 to 24 months (not fed human milk) is an achievable pattern, with a few shifts from current consumption patterns needed. The range of recommended intakes in the Pattern is well within the range (5th to 95th percentile) of current intakes of Fruits, Vegetables, total Protein Foods, and Dairy in this age group, though a shift toward greater intake of Vegetables is needed. By contrast, the recommended intakes of whole grains are well above current intakes, whereas the recommended intakes of refined grains are far below current intakes.
Source: Food Group Intake Distributions, WWEIA NHANES 2013-2016, ages 12 to 24 months. Prepared by NCI, 2019

Although longitudinal studies tracking eating habits within the same individual across time are lacking, early dietary patterns may shape dietary choices later in life, as illustrated by the cross-sectional data spanning the NHANES data by age group in this report (see ***Part D. Chapter 1***). Thus, establishing healthy eating habits during the first 2 years of life is critical. Although the individual experience shapes food preferences (e.g., taste), the collective modeling of food choices in young childhood through direct observation of food intake by peers and adults also is paramount.[47]

Recommendations for Advice to Caregivers

- Provide a variety of animal-source foods (meat, poultry, seafood, eggs, and dairy), fruits, and vegetables, nuts and seeds, and whole grain products, beginning at ages 6 to 12 months and continuing thereafter, to provide key nutrients, foster acceptance of a variety of nutritious foods, and build healthy dietary habits.
- For infants fed human milk at ages 6 to 12 months, consider providing iron-fortified infant cereals or similar products to ensure adequate iron intake.
- Provide good sources of omega-3 and omega-6 fatty acids, such as seafood, beginning at ages 6 to 12 months. To limit exposure to methylmercury for groups at risk, the U.S. Food and Drug Administration and the U.S. Environmental Protection Agency have issued joint guidance regarding the types of seafood to choose.[48]
- Introduce peanut products and egg between ages 6 and 12 months. Be careful to choose forms of peanut that do not present a choking risk. Evidence regarding benefits of introducing other potentially allergenic foods (e.g., tree nuts, shellfish, fish) in the first year of life is limited, but there is no reason to avoid them (see ***Part D. Chapter 5: Foods and Beverages Consumed During Infancy and Toddlerhood***).
- For toddlers ages 12 to 24 months whose diets do not include meat, poultry, or seafood, provide eggs and dairy products on a regular basis, along with soy products and nuts or seeds, fruits, vegetables, grains, and oils.
- Avoid foods and beverages with added sugars during the first 2 years of life. The energy in such products is likely to displace energy from nutrient-dense foods, increasing the risk of nutrient inadequacies. Moreover, consumption of sugar-sweetened beverages is linked with increased risk of overweight or obesity. Because food preferences and patterns are beginning to form during this developmental stage, and taste and flavor preferences appear to be more malleable in this life stage than in older children,[49] it is important that caregivers limit consumption of foods that contain added sugars, while encouraging consumption of nutrient-dense foods.

Recommendations for Federal Agencies

- Develop communication and dissemination strategies that effectively address common misconceptions about diets for infants and children younger than age 24 months. The importance of carefully choosing CFB may not be fully appreciated by the public. For example, the rhyme that "food before one is just for fun" implies that the only goal during infancy is fostering pleasant eating experiences, and that the nutritional contribution of CFB is not critical. A more appropriate message is that "every bite counts," emphasizing the nutrients of concern for potential inadequacy and excess, while also conveying the need to make eating enjoyable and the importance of responsive feeding practices.
- Consider strategies for assisting caregivers and program managers to use the information about the CFB combinations and patterns described in this chapter. In particular, guidance will be needed on how to operationalize providing the recommended amounts of food groups and subgroups shown in the Healthy U.S.-Style Pattern and Healthy Vegetarian Pattern for ages 12 to 24 months. This information is provided by energy level, but the energy intake of an infant or toddler is generally unknown by caregivers.

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