

PART D. CHAPTER 5: FOODS AND BEVERAGES CONSUMED DURING INFANCY AND TODDLERHOOD

INTRODUCTION

The age interval for complementary feeding, generally defined as ages 6 to 24 months, is a critical period for growth and development and is characterized by high nutrient needs in relation to the amount of food consumed.¹ For the purposes of this report, complementary feeding is defined as “the process that starts when human milk or infant formula is complemented by other foods or beverages and typically continues to 24 months of age as the child transitions fully to family foods”.² The timing of introduction and the types and amounts of complementary foods and beverages (CFB) provided to infants and toddlers may influence nutritional status, growth and body composition, neurocognitive development, and various health outcomes, both short-term and long-term, including bone health and risk of food allergies and atopic diseases. This chapter describes the findings of the reviews conducted to examine these relationships.

Importance and Relevance of this Topic

For infants fed human milk, nutrient needs can generally be met from human milk alone for approximately the first 6 months.³ Iron is a potential exception: The iron content of human milk is low and breastfed infants generally rely on iron stores present at birth to meet iron needs in early life.⁴ As a result, iron deficiency may occur before age 6 months among infants whose iron stores at birth are low due to low birth weight or gestational age, maternal prenatal iron deficiency, or immediate clamping of the umbilical cord, which prevents full placental transfusion of blood to the newborn.⁵ Vitamin D is another nutrient of concern because human milk vitamin D concentrations may not be sufficient to meet the needs of young infants in populations with inadequate exposure to sunlight and/or inadequate maternal vitamin D intake.⁶ For these reasons, ***Part D. Chapter 6: Nutrients from Dietary Supplements During Infancy and Toddlerhood*** addresses questions related to the use of iron and vitamin D supplements. For some of the other nutrients, concentrations in human milk may be low if the mother’s intake or nutrient status is deficient (e.g., some of the B vitamins, iodine, selenium),⁷ but this can be addressed by improving the mother’s diet. Most of the minerals in human milk (e.g., iron, zinc, calcium) are not affected by maternal diet.⁷

After age 6 months, complementary foods are needed to ensure adequate nutrition and growth, and to expose infants to varied flavors, textures, and types of foods as they make the

transition to family diets. Because the amounts of CFB consumed are generally small, yet nutrient requirements (per unit of body weight) are high due to the rapid rate of growth, infants need nutrient-dense CFB. For example, the CFB nutrient densities (per 100 kcal of food) required for breastfed infants at ages 6 to 8 months are 9 times higher for iron and 4 times higher for zinc compared to the nutrient densities required for an adult male.⁸

Brain development is most rapid during the first 1,000 days, from conception to age 24 months, and adequate nutrition is critical for this process.^{9,10} Key nutrients include fat (particularly long-chain polyunsaturated fatty acids, which can come from the diet or from endogenous fatty acid metabolism), protein, iron, iodine, zinc, copper, choline, and the B vitamins. As a result, the adequacy of complementary foods to provide some or all of these nutrients may have important effects on child development.

Atopic diseases, including food allergy and allergic skin disease, are relatively common in the United States, with an estimated 5 to 8 percent of children experiencing confirmed food allergies¹¹ and approximately 30 percent of the U.S. population with atopic dermatitis.¹² These outcomes may be influenced by both the timing and the types of complementary foods provided to infants and toddlers.^{13,14} Recent evidence from randomized controlled trials (RCT) suggests that infancy may be a critical period for the development of tolerance to food antigens.¹⁵⁻¹⁷ Thus, this topic is of considerable public health importance.

Children establish food patterns and preferences early in life, which, if they persist, may have a significant impact on certain health outcomes in childhood as well as later in life, such as overweight or obesity and cardiovascular disease (CVD) risk factors (e.g., blood lipids, blood pressure). For this reason, relationships of added sugars and seafood consumption during the period from birth to age 24 months to risk of CVD later in life were examined. These questions are discussed in **Part D. Chapter 9: Dietary Fats and Seafood** and **Part D. Chapter 12: Added Sugars**, respectively.

Finally, it is important to recognize that how infants and toddlers are fed, not just what they are fed, can influence health outcomes. For example, responsive feeding practices that are sensitive to the child's hunger and satiety cues may influence the risk of overweight or obesity and the ability to maintain self-regulation of energy intake later in life.¹⁸ In addition, repeated exposure to healthy foods such as vegetables and fruits may promote acceptance of these foods later in childhood.¹⁹ Although these questions of "how to feed" were not among the topics selected for this 2020 Dietary Guidelines Advisory Committee to address, other resources are available that provide background, evidence, and guidance.^{20,21}

LIST OF QUESTIONS

1. What is the relationship between complementary feeding and growth, size, and body composition?
2. What is the relationship between complementary feeding and developmental milestones, including neurocognitive development?
3. What is the relationship between complementary feeding and nutrient status?
4. What is the relationship between complementary feeding and bone health?
5. What is the relationship between complementary feeding and food allergies and atopic allergic diseases?
6. What is the relationship between added sugars consumption during infancy and toddlerhood and risk of cardiovascular disease?
7. What is the relationship between types of dietary fats consumed during infancy and toddlerhood and risk of cardiovascular disease?
8. What is the relationship between seafood consumption during infancy and toddlerhood and risk of cardiovascular disease and neurocognitive development?

METHODOLOGY

All questions discussed in this chapter were answered using systematic reviews conducted with support from USDA's Nutrition Evidence Systematic Review (NESR) team. NESR's systematic review methodology provided a rigorous, consistent, and transparent process for the Committee to search for, evaluate, analyze, and synthesize evidence.

Questions 1 through 5 in this chapter were answered using existing systematic reviews that were previously conducted by USDA's Nutrition Evidence Systematic Review (NESR) team as part of the Pregnancy and Birth to 24 Months Project, which was completed in 2019. The conclusion statements that answer these questions were taken directly from the existing systematic reviews and the wording reflects the findings of those reviews, which included articles published between 1980 and 2016 or 2017 depending on the review. A description of the process the Committee used to determine that these existing systematic reviews were relevant to their questions and timely enough to not require updating is provided in **Part C. Methodology**. In addition, detailed information about the methodology used to complete these systematic reviews can be found at the following website: nesr.usda.gov/project-specific-overview-pb-24-0.

Methodology specific to Question 6 is in **Part D. Chapter 12: Added Sugars** and methodology specific to Questions 7 and 8 is in **Part D. Chapter 9: Dietary Fats and Seafood**. These questions intended to examine the consumption of added sugars, dietary fats, and seafood in infants and toddlers as well as other age groups.

REVIEW OF THE SCIENCE

Question 1. What is the relationship between complementary feeding and growth, size, and body composition?

Approach to Answering Question: Existing NESR systematic reviews

Conclusion Statements and Grade

Timing of Introduction of Complementary Foods or Beverages

Moderate evidence suggests that first introduction of any complementary food or beverage between the ages of 4 and 5 months compared to approximately 6 months of age is not associated with weight status, body composition, body circumferences, weight, or length among generally healthy, full-term infants. Grade: Moderate

Limited evidence suggests that introducing complementary foods or beverages before age 4 months of age may be associated with higher odds of overweight or obesity. Grade: Limited

There is not enough evidence to determine the relationship between introduction of complementary foods or beverages at 7 months of age or older on growth, size, or body composition. Grade: Grade Not Assignable

Types and Amounts of Complementary Foods or Beverages

Moderate evidence indicates that higher vs lower meat intake or meat vs iron-fortified cereal intake over a short duration (about 3 months) during the complementary feeding period does not favorably or unfavorably influence growth, size, and/or body composition [Grade: Moderate].

There is insufficient evidence to determine a relationship between meat intake and prevalence/incidence of overweight or obesity.

Limited evidence suggests that type or amount of cereal given does not favorably or unfavorably influence growth, size, body composition, and/or prevalence/incidence of overweight or obesity. Grade: Grade Not Assignable¹

Moderate evidence suggests that consumption of complementary foods with different fats and/or fatty acid composition does not favorably or unfavorably influence growth, size, or body composition [Grade: Moderate]. There is not enough evidence to determine a relationship between consumption of complementary foods with different fats and/or fatty acid composition and prevalence/incidence of overweight or obesity.

Limited evidence suggests that sugar-sweetened beverage consumption during the complementary feeding period is associated with increased risk of obesity in childhood, but is not associated with other measures of growth, size, and body composition. Grade: Limited

Limited evidence showed a positive association between juice intake and infant weight-for-length and child body mass index z-scores. Grade: Limited

No conclusion could be made about the relationship between other complementary foods (vegetables, fruit, dairy products and/or cow milk, cereal-based products, milk-cereal drink, and/or categories such as “ready-made foods”) and growth, size, body composition, and/or prevalence/incidence of overweight or obesity. Grade: Grade Not Assignable

No conclusion could be made about the relationship between distinct dietary patterns during the complementary feeding period and growth, size, body composition, and/or prevalence/incidence of malnutrition, overweight or obesity. Grade: Grade Not Assignable

Summary of the Evidence

Timing of Introduction of Complementary Foods or Beverages

- This review included 81 articles that examined the association between timing of introduction of CFB and growth, size, and/or body composition across the lifespan.²²

¹ Grade not assigned due to inconsistency in types of cereal examined.

- Timing of CFB introduction is the age at which any or specific types of CFB were first consumed and was examined as early as age 1 month and as late as age 12 months.
- Timing of CFB introduction was not associated with growth, size, body composition, and/or weight status in the majority of included studies. A limited number of observational studies suggested that CFB introduction before age 4 months was associated with higher odds of overweight or obesity.
- Given the normal variation in healthy child growth patterns, caution should be used when interpreting results between timing, types, and/or amounts of CFB and outcomes for individuals based on findings at the population level.

For additional details on this body of evidence, visit: [nesr.usda.gov/what-relationship-between-timing-introduction-complementary-foods-and-beverages-and-growth-size-and#full-review](https://www.nesr.usda.gov/what-relationship-between-timing-introduction-complementary-foods-and-beverages-and-growth-size-and#full-review)

Types and Amounts of Complementary Foods or Beverages

- This review included 49 articles from 18 RCTs, 1 non-randomized controlled trial (non-RCT), and 30 prospective cohort studies (PCSs).²
- The studies varied in terms of the types and/or amounts of CFB examined. Studies examined meat, cereal, foods with different fatty acid composition, sugar-sweetened beverages (SSB), juice or 100% juice, and other individual CFB, as well as distinct dietary patterns consumed during the complementary feeding period.
- Gaps and limitations in the evidence included the need for RCTs and studies that examine a wider range of specific types and amounts of complementary foods and beverages, account for the rationale for type or amount of complementary foods and beverages given (e.g., reverse causality), and adjust for potential confounders (e.g., human milk and/or formula-feeding and baseline growth status).

For additional details on this body of evidence, visit: [nesr.usda.gov/what-relationship-between-types-and-amounts-complementary-foods-and-beverages-and-growth-size-and#full-review](https://www.nesr.usda.gov/what-relationship-between-types-and-amounts-complementary-foods-and-beverages-and-growth-size-and#full-review)

Question 2. What is the relationship between complementary feeding and developmental milestones, including neurocognitive development?

Approach to Answering Question: Existing NESR systematic reviews

Conclusion Statements and Grade

Timing of Introduction of Complementary Foods or Beverages

There was insufficient evidence to draw a conclusion about the relationships between timing of introduction of complementary foods and beverages and developmental milestones. Grade:

Grade Not Assignable

Types and Amounts of Complementary Foods or Beverages

There was insufficient evidence to draw a conclusion about the relationships between types and amounts of complementary foods and beverages consumed and developmental milestones.

Grade: Grade Not Assignable

Summary of the Evidence

Timing of Introduction of Complementary Foods or Beverages

- Three articles (1 RCT; 2 observational studies) met criteria for inclusion that examined timing of introduction of CFB and developmental milestones²³:
 - The RCT found no associations between timing of CFB and receptive or expressive language or fine- or gross-motor milestones at ages 30 to 35 months.
 - One observational study reported that earlier CFB introduction at age 4 months relative to at or after age 6 months was associated with earlier gross-motor milestone achievement (e.g., crawling, cruising, and walking) by age 18 months, as reported by mothers.
 - The other observational study found no associations between timing of CFB introduction and reading or math skills at age 4 years.
- The relationship between timing of introduction of CFB and developmental milestones may be influenced by a number of related factors, such as birth weight, current weight, type of early feeding (breast, formula, or mixed feedings), types and/or amount of human milk and CFB consumed, and the interval between exposure and outcome assessment.

- The ability to draw conclusions was restricted by an inadequate amount of evidence that was limited by the potential for reverse causality, and wide variation in study design, type and age of outcome assessment, exposure assessment, and reported results.

For additional details on this body of evidence, visit: [nesr.usda.gov/what-relationship-between-timing-introduction-complementary-foods-and-beverages-and-developmental#full-review](https://www.nesr.usda.gov/what-relationship-between-timing-introduction-complementary-foods-and-beverages-and-developmental#full-review)

Types and Amounts of Complementary Foods or Beverages

- This review included 8 studies, including 3 RCTs and 5 PCSs, that examined the relationship between consuming different types and/or amounts of CFB and developmental milestones during childhood through age 18 years.²³
- The studies varied in terms of the types and/or amounts of CFB examined, which included dietary patterns consumed during the complementary feeding period, meat and/or fortified-cereal intake, and foods with differing levels of docosahexaenoic acid (DHA) or phytate.
- Different types of developmental milestone outcomes were measured between ages 4 months and 8.5 years, including communication (e.g., sentence repetition), cognition (e.g., mental development index), motor (e.g., psychomotor development index), and neurological (e.g., cortical processing).
- Three articles from 2 observational studies identified positive associations between dietary patterns emphasizing vegetables and meats during the complementary feeding period, and intelligence quotient (IQ) between ages 4 and 8.5 years. However, a conclusion could not be drawn due to low generalizability and heterogeneity in exposures, observed effects, and potential confounding.
- One high-quality study found a positive association between DHA-enriched baby food and visual acuity (cortical processing). However, it was not possible to draw a conclusion with only 1 study.
- Because the study designs varied substantially, it was difficult to compare and contrast the reported results.
- No conclusion regarding the relationship between types and/or amounts of CFB and developmental milestones could be drawn due to an inadequate number of studies that were comparable in terms of design, the types of CFB examined, how and when developmental milestones outcomes were assessed, and reported results.

For additional details on this body of evidence, visit: [nesr.usda.gov/what-relationship-between-types-and-amounts-complementary-foods-and-beverages-consumed-and-0#full-review](https://www.nesr.usda.gov/what-relationship-between-types-and-amounts-complementary-foods-and-beverages-consumed-and-0#full-review)

Question 3. What is the relationship between complementary feeding and nutrient status?

Approach to Answering Question: Existing NESR systematic reviews

Conclusion Statements and Grade

Timing of Introduction of Complementary Foods or Beverages

Moderate evidence suggests that introducing complementary foods and beverages at 4 months of age compared to 6 months of age offers no long-term advantages or disadvantages in terms of iron status among healthy, full-term infants who are breastfed, fed iron-fortified formula, or both. Grade: Moderate

There is not enough evidence to determine the relationship between timing of introduction of complementary foods and beverages and zinc, vitamin D, vitamin B₁₂, folate, or fatty acid status. Grade: Grade Not Assignable

Types and Amounts of Complementary Foods or Beverages

Strong evidence suggests that consuming complementary foods and beverages that contain substantial amounts of iron, such as meats or iron-fortified cereal, helps maintain adequate iron status or prevent iron deficiency during the first year of life among infants with insufficient iron stores or breastfed infants who are not receiving adequate iron from another source [Grade: Strong]. However, the benefit of these types of complementary foods and beverages for infants with sufficient iron stores, such as those consuming iron-fortified infant formula, is less evident. There is not enough evidence to determine the relationship between other types/amounts of complementary foods and beverages containing lesser amounts of iron, such as fruits and vegetables, and iron status.

Limited evidence suggests that consuming complementary foods and beverages that contain substantial amounts of zinc, such as meats or cereals fortified with zinc, supports zinc status during the first year of life, particularly among breastfed infants who are not receiving adequate

zinc from another source. However, the benefit of these types of complementary foods for infants consuming fortified infant formula is less evident. Grade: Limited

Moderate evidence suggests that consuming complementary foods and beverages with differing fatty acid profiles, particularly long-chain polyunsaturated fatty acids, can influence fatty acid status. Grade: Moderate

During the second year of life, good sources of micronutrients are still needed, but there is limited evidence to indicate which types and amounts of complementary foods and beverages are associated with adequate micronutrient status.

There is not enough evidence to determine the relationship between types and amounts of complementary foods and beverages and vitamin B₁₂, vitamin D, or folate status. Grade: Grade Not Assignable

Summary of the Evidence

Timing of Introduction of Complementary Foods or Beverages

- Nine studies met the inclusion criteria for this systematic review, with most studies examining the relationship between timing of introduction of CFB and iron status. Few studies examined zinc, vitamin D, vitamin B₁₂, folate, and/or fatty acid status.²⁴
- The majority of studies reported no significant associations between timing of CFB introduction and nutrient status.
- Additional factors that need to be considered in examining the relationship between the age at which CFB are introduced and nutrient status include: birth weight, post-natal growth, type of feeding (i.e., breast, formula, or mixed feedings), iron stores at birth, and intake and absorption of iron from sources other than human milk, including types and amounts of CFB being consumed.

For additional details on this body of evidence, visit: [nesr.usda.gov/what-relationship-between-timing-introduction-complementary-foods-and-beverages-and-micronutrient#full-review](https://www.nesr.usda.gov/what-relationship-between-timing-introduction-complementary-foods-and-beverages-and-micronutrient#full-review)

Types and Amounts of Complementary Foods or Beverages

- Thirty-one studies met the inclusion criteria for this systematic review.²⁴
 - Most studies examined the relationship between types and/or amounts of CFB and iron status, and the CFB examined were largely limited to iron-fortified cereals and meats.
 - Several studies examined zinc and fatty acid status and few studies examined vitamin D, vitamin B₁₂, and folate.
- One RCT, conducted in both breastfed and formula fed infants, showed that consuming meats or iron- and/or zinc-fortified cereals as CFB generally protected against iron deficiency anemia and supported zinc status in the first year of life, though evidence is more limited in the second year of life.
 - Among breastfed infants, meat and iron- and zinc-fortified cereals supported iron and zinc status in later infancy. Meat provided a valuable source of trace minerals for breastfed infants who may not have been fed iron- and zinc-fortified products. In fact, the frequency of meat consumption was associated with iron status in the first and second years of life.
 - In infants and toddlers whose diets already contained other bioavailable iron and zinc sources (i.e., infant formulas and cereal fortified with iron and/or zinc), meat offered little additional benefit for iron or zinc status, though it is an important source of bioavailable iron and zinc.
- Dietary sources of fatty acids, particularly long-chain polyunsaturated fatty acids, in CFB (i.e., oils, fish, meats, and eggs) influenced the plasma fatty acid profile of infants and toddlers.
- A limitation of some of the studies included in this systematic review was lack of accounting for whether infants were fed breast milk and/or infant formula, and other aspects of the overall diet, including consumption of fortified products and bioavailability of nutrients consumed. Another limitation was a lack of studies that examined vitamin D, vitamin B₁₂, and folate.

For additional details on this body of evidence, visit: [nesr.usda.gov/what-relationship-between-types-and-amounts-complementary-foods-and-beverages-consumed-and#full-review](https://www.nesr.usda.gov/what-relationship-between-types-and-amounts-complementary-foods-and-beverages-consumed-and#full-review)

Question 4. What is the relationship between complementary feeding and bone health?

Approach to Answering Question: Existing NESR systematic reviews

Conclusion Statements and Grade

Timing of Introduction of Complementary Foods or Beverages

Insufficient evidence is available to draw conclusions about the relationship between the timing of introduction of complementary foods and beverages and bone health. Grade: Grade Not Assignable

Types and Amounts of Complementary Foods or Beverages

Insufficient evidence is available to draw conclusions about the relationship between the types and/or amounts of complementary foods and beverages consumed and bone health. Grade: Grade Not Assignable

Summary of the Evidence

Timing of Introduction of Complementary Foods or Beverages

- Three studies met the inclusion criteria for this systematic review, including 1 RCT, 1 PCS, and 1 case-control study.²⁵
- The RCT included a small sample of infants fed only vitamin D-fortified infant formula, and did not follow infants long enough to assess the impact of timing of introduction to CFB and bone health, as outcomes were assessed when infants were age 26 weeks.
- The observational studies did not measure and/or account for a number of confounding factors that could have influenced the relationship between timing of CFB introduction and bone health later in childhood.
- The ability to draw conclusions about the relationship between the timing of CFB introduction and bone health was limited by an overall lack of research, as well as heterogeneity in the 3 studies included in this systematic review with regard to methodology, subject populations, and results.

For additional details on this body of evidence, visit: [nesr.usda.gov/what-relationship-between-timing-introduction-complementary-foods-and-beverages-and-bone-health#full-review](https://www.nesr.usda.gov/what-relationship-between-timing-introduction-complementary-foods-and-beverages-and-bone-health#full-review)

Types and Amounts of Complementary Foods or Beverages

- Two PCSs met the inclusion criteria for this review, both of which examined the relationship between infants' and toddlers' dietary patterns and bone health.²⁵
- The ability to draw conclusions about the relationship between the types and/or amounts of CFB consumed and bone health was limited by an overall lack of research.
- Although both cohort studies included in this review assessed dietary patterns at ages 12 to 13 months in relationship to a single assessment of bone mineral content at ages 4 or 6 years, it was not possible to draw conclusions for types and/or amounts of CFB and bone health. This was due to the non-specific nature of the dietary patterns, as well as the long interval between the assessment of dietary pattern and radiological measurement of bone health.

For additional details on this body of evidence, visit: [nesr.usda.gov/what-relationship-between-types-and-amounts-complementary-foods-and-beverages-consumed-and-bone#full-review](https://www.nesr.usda.gov/what-relationship-between-types-and-amounts-complementary-foods-and-beverages-consumed-and-bone#full-review)

Question 5. What is the relationship between complementary feeding and food allergies and atopic allergic diseases?

Approach to Answering Question: Existing NESR systematic reviews

Conclusion Statements and Grades

Timing of Introduction of Complementary Foods or Beverages

Moderate evidence suggests that there is no relationship between the age at which complementary feeding first begins and risk of developing food allergy, atopic dermatitis/eczema, or asthma during childhood. Grade: Moderate

There is insufficient evidence to determine the relationship between the age at which complementary foods or beverages are first introduced and risk of developing allergic rhinitis during childhood. Grade: Grade Not Assignable

Types and Amounts of Complementary Foods or Beverages

Peanut, Tree Nuts, Seeds

Strong evidence suggests that introducing peanut in the first year of life (after 4 months of age) may reduce risk of food allergy to peanuts [Grade: Strong]. This evidence is strongest for introducing peanut in infants at the highest risk (with severe atopic dermatitis and/or egg allergy) to prevent peanut allergy, but is also applicable to infants at lower risk. However, the evidence for tree nuts and sesame seeds is limited. Limited evidence also suggests that there is no relationship between consumption of peanut, tree nuts, or sesame seeds during the complementary feeding period and risk of atopic dermatitis/eczema and asthma [Grade: Limited]. There is not enough evidence to determine the relationship between consuming peanut, tree nuts, or seeds as complementary foods and allergic rhinitis.

Egg

Moderate evidence suggests that introducing egg in the first year of life (after 4 months of age) may reduce risk of food allergy to egg [Grade: Moderate]. Limited evidence suggests that there is no relationship between the age of introduction to egg and risk of atopic dermatitis/eczema and asthma [Grade: Limited]. There is not enough evidence to determine if there is a relationship between consuming egg as a complementary food and allergic rhinitis.

Fish

Limited evidence suggests that introducing fish in the first year of life (after 4 months of age) may reduce risk of atopic dermatitis/eczema [Grade: Limited]. There is not enough evidence to determine if there is a relationship between consuming fish as a complementary food and risk of allergy to fish or other foods, asthma, or allergic rhinitis. There is also not enough evidence to determine if there is a relationship between consuming shellfish as a complementary food and risk of food allergy, atopic dermatitis/eczema, asthma, or allergic rhinitis.

Cow Milk Products

Limited evidence suggests there is no relationship between age of introduction of cow milk products, such as cheese and yogurt, and risk of food allergy and atopic dermatitis/eczema [Grade: Limited]. There is not enough evidence to determine if there is a relationship between consuming milk products during the complementary feeding period and risk of asthma or allergic rhinitis.

Other Foods

Wheat: There is not enough evidence to determine if there is a relationship between wheat consumption during the complementary feeding period and risk of food allergy, atopic dermatitis/eczema, asthma, or allergic rhinitis. Grade: Grade Not Assignable

Soy: There is not enough evidence to determine if there is a relationship between soybean consumption during the complementary feeding period and risk of food allergy, atopic dermatitis/eczema, asthma, or allergic rhinitis. Grade: Grade Not Assignable

Foods and beverages that are not common allergens: Limited evidence from observational studies suggests that introducing foods not commonly considered to be allergens, such as fruits, vegetables, and meat, in the first year of life (after 4 months of age) is not associated with risk of food allergy, atopic dermatitis/eczema, asthma, or allergic rhinitis. Grade: Limited

Diet diversity and dietary patterns: There is not enough evidence to determine a relationship between diet diversity or dietary patterns and risk of food allergy, atopic dermatitis/eczema, asthma, or allergic rhinitis. Grade: Grade Not Assignable

Summary of the Evidence

Timing of Introduction of Complementary Foods or Beverages

- The 31 observational studies included in this systematic review examined the relationship between the age of first introduction to a CFB and risk of food allergies, atopic dermatitis/eczema, asthma, or allergic rhinitis occurring during childhood through age 18 years.¹⁴
 - The studies included in this review examined the timing of introduction to CFB, or the age at which infants were first introduced to any foods or beverages other than human milk or infant formula. (Note: Studies that examined the timing of introduction of specific types of CFB, including common allergenic foods, such as peanuts, eggs, and fish, were addressed under Types and Amounts of Complementary Foods and Beverages below).
 - These studies did not specify what food or beverage was first introduced. However, highly allergenic foods are not typically the first CFB introduced into an infant's diet. Therefore, it is likely that the studies in this body of evidence reflected the first introduction of cereals, fruits, and vegetables.

- Nine studies examined risk of food allergy, 20 studies examined risk of eczema or atopic dermatitis, 8 studies examined risk of asthma, and 4 studies examined risk of allergic rhinitis.
- Most evidence reported no significant associations between age of first introduction to CFB and risk of food allergy. Although some evidence suggested that earlier first introduction of CFB may be associated with increased risk of developing food allergy, confidence in the results was restricted by methodological limitations.
- The inability to draw stronger conclusions about the relationship between the timing of first introduction to CFB and the risk of atopic disease is due to several limitations:
 - Use of non-validated or unreliable measures to assess risk of atopic disease (e.g., parent report of a physician diagnosis or the child's symptoms) and assessment of outcomes later in childhood (through age 10 years), when some atopic diseases, such as eczema, may have already resolved, or very early in childhood (age 3 to 4 months), before some atopic diseases may have occurred.
 - Lack of adjustment for key confounders, such as consumption of human milk and/or human milk substitutes (e.g., cow milk formula, hydrolyzed infant formula, or fluid cow milk), parental smoking, and exposure to household pets.
 - Potential for reverse causality due to baseline atopic disease risk status affecting both the timing and types and amounts of CFB introduced, and risk of developing atopic disease.

For additional details on this body of evidence, visit: [nesr.usda.gov/what-relationship-between-timing-introduction-complementary-foods-and-beverages-and-food-allergy#full-review](https://www.nesr.usda.gov/what-relationship-between-timing-introduction-complementary-foods-and-beverages-and-food-allergy#full-review)

Types and Amounts of Complementary Foods or Beverages

- The 39 studies included in this systematic review examined the relationship between consuming specific types of CFB (including amounts and the age at which the specific CFB were introduced) and risk of food allergies, atopic dermatitis/eczema, asthma, and allergic rhinitis occurring during childhood through age 18 years. An additional 12 studies examined diet diversity and 2 studies examined dietary patterns during the complementary feeding period in relation to these outcomes.¹⁴
- A number of studies examined consumption of the most common allergenic foods during the complementary feeding period and risk of atopic disease.

- Fourteen studies, including 2 RCTs, 6 PCSs, 4 nested case-control studies, and 2 case-control studies, examined the consumption of peanuts, tree nuts, or seeds during the complementary feeding period in relation to risk of developing atopic disease. Nine studies (2 RCTs) examined food allergy, 5 studies examined atopic dermatitis/eczema, and 2 studies examined asthma; no studies were identified that examined risk of allergic rhinitis.
- Twenty-eight studies, including 6 RCTs, 15 PCSs, 5 nested case-control studies, and 2 case-control studies, examined the consumption of eggs as a complementary food in relation to risk of developing any atopic disease. Thirteen studies (6 RCTs) examined food allergies, 15 studies (1 RCT) examined atopic dermatitis/eczema, 4 studies examined asthma, and 5 studies examined allergic rhinitis.
- Twenty-four studies, including 1 RCT, 18 PCSs, 3 nested case-control studies, and 2 case-control studies, examined the consumption of fish as a complementary food in relation to risk of developing atopic disease. Six studies (1 RCT) examined food allergies, 15 studies examined atopic dermatitis/eczema, 7 studies examined asthma, and 7 studies examined allergic rhinitis.
- Sixteen studies, including 1 RCT, 11 PCSs, 2 nested case-control studies, and 2 case-control studies, examined the consumption of cow milk products, such as cheese and yogurt, during the complementary feeding period in relation to risk of developing atopic disease. Four studies (1 RCT) examined food allergies, 9 studies examined atopic dermatitis/eczema, 3 studies examined asthma, and 3 studies examined allergic rhinitis.
- Eighteen studies, including 1 RCT, 11 PCSs, 5 nested case-control studies, and 1 case-control study, examined the consumption of wheat or cereals (including, but not limited to, wheat cereal) during the complementary feeding period in relation to risk of developing atopic disease. Eight studies examined food allergies, 9 studies examined atopic dermatitis/eczema, 3 studies examined asthma, and 2 studies examined allergic rhinitis.
- Four PCSs examined the relationship between age of introduction to soy and risk of developing atopic disease. One study examined food allergies, 3 studies examined atopic dermatitis/eczema, and 1 study examined asthma.
- A number of observational studies also examined the relationship between other types of CFB, not considered to be major allergens (e.g., fruit, vegetables, meat) and atopic diseases.

- The studies that examined diet diversity or dietary patterns were all observational, including 11 PCSs (from 6 cohorts) and 3 case-control studies.
- Many of the studies included in this review exclusively enrolled or primarily enrolled participants who were at greater risk of allergies and/or atopic disease than the general population on the basis of family history. However, despite the inclusion of higher risk populations in this body of evidence, the results are probably generalizable to infants and toddlers who are lower risk for atopic disease, but the benefit of early introduction on preventing allergy may not be as great.

For additional details on this body of evidence, visit: [nesr.usda.gov/what-relationship-between-types-and-amounts-complementary-foods-and-beverages-consumed-and-food#full-review](https://www.nesr.usda.gov/what-relationship-between-types-and-amounts-complementary-foods-and-beverages-consumed-and-food#full-review)

Question 6. What is the relationship between added sugars consumption during infancy and toddlerhood and risk of cardiovascular disease?

Approach to Answering Question: NESR systematic review

See *Part D. Chapter 12: Added Sugars*, Question 3, for a review that addressed added sugars and risk of CVD. This review included 1 study that examined the birth to age 24 months population.

Question 7. What is the relationship between types of dietary fats consumed during infancy and toddlerhood and risk of cardiovascular disease?

Approach to Answering Question: NESR systematic review

See *Part D. Chapter 9: Dietary Fats and Seafood*, Question 1, for a review that addressed dietary fat and risk of CVD. This review included 3 studies that examined the birth to age 24 months population.

Question 8. What is the relationship between seafood consumed during infancy and toddlerhood and risk of cardiovascular disease and neurocognitive development?

Approach to Answering Question: NESR systematic review

See *Part D. Chapter 9: Dietary Fats and Seafood*, Questions 2 and 3, for reviews that addressed seafood consumption and risk of cardiovascular disease and neurocognitive development, respectively. The reviews did not identify any studies that examined the birth to age 24 months population.

DISCUSSION

Timing of Introduction of Complementary Foods and Beverages

Growth, Size, and Body Composition

The Committee concluded that introducing CFB between ages 4 and 5 months, compared with age 6 months, offers no long-term advantages or disadvantages in terms of weight status, body composition, body circumferences, weight, or length of healthy, full-term infants. This conclusion was considered applicable to the U.S. population but was graded as “Moderate” because the evidence included only 2 RCTs and the observational studies were limited by lack of controlling for all of the key potential confounders and other methodological issues. The Committee concluded that introducing CFB before age 4 months may increase the odds of becoming overweight or obese, though this conclusion was graded as “Limited” because the evidence was scarce. Insufficient evidence was available to determine whether introducing CFB after age 7 months affects growth, size, or body composition.

The conclusions above regarding growth, size, and body composition are generally consistent with those of other recent reviews.^{26,27} For example, in a meta-analysis of PCSs, Wang et al²⁶ found that introducing CFB before age 4 months was associated with increased risk of overweight (relative risk (RR)=1.18; 95% confidence interval (CI): 1.06, 1.31) and obesity (RR=1.33; 95% CI: 1.07, 1.64) at ages 2 to 12 years. Grote et al²⁷ suggest that formula-fed infants may be at particular risk of excess energy intake when CFB are introduced early, as they appear to exhibit less self-regulation of energy intake than is observed among breastfed infants.

Developmental Milestones

The Committee was unable to draw a conclusion about the relationship between the timing of introduction of CFB and developmental milestones due to the limited number of studies, as well as variability in study design, type of developmental milestones, age of assessment, validity and reliability of assessment of milestones, and potential for reverse causality.

Nutrient Status

The Committee concluded that introducing CFB at age 4 months compared to age 6 months offers no long-term advantages or disadvantages in terms of iron status. This conclusion was graded as “Moderate” based mainly on the RCTs, as the observational studies available had several serious limitations, including lack of adjustment for potential confounders. Study populations were likely relevant to the U.S. population, but information for lower-income populations was lacking and racial/ethnic diversity was limited. Also, most of the studies included infants who were iron-replete at baseline, so effects among iron-deficient infants could differ. Evidence was insufficient to determine the relationship between timing of introduction of CFB and other biomarkers of nutrient status.

Bone Health

No conclusion could be drawn with regard to the relationship between the timing of introduction of CFB and bone health. Mixed findings were reported from the 3 studies that examined this relationship, and the age and methods of outcome assessment, as well as whether key confounders were taken into account varied widely across the studies.

Food Allergies and Atopic Allergic Diseases

The Committee examined whether the age at which infants are first introduced to any foods or beverages other than human milk or infant formula (i.e., not specific foods) is related to the risk of atopic diseases occurring during childhood through age 18 years. The conclusion, based on moderate evidence, was that no relationship exists between the age at which complementary feeding first begins and risk of developing food allergy, atopic dermatitis/eczema, or asthma. For allergic rhinitis, evidence was insufficient to determine a relationship. For most of the 31 studies in this evidence base, the majority of infants enrolled were at high risk of developing atopic disease based on family history (parent or sibling) of atopic disease. Some studies enrolled

exclusively breastfed infants, whereas other studies included infants who were breastfed, formula-fed, or mixed-fed. For food allergies, most of the 9 studies applied multiple valid and reliable methods to diagnose the condition, but a few studies relied on less valid methods, such as parent or physician report of either symptoms or the diagnosis. Five reported no significant associations between age of first introduction to CFB and risk of food allergy, whereas 4 reported that earlier introduction of CFB may be associated with increased risk of developing food allergy. Confidence in these results was restricted by methodological limitations. For other outcomes, the majority of studies showed no significant associations: 15 of 20 studies of atopic dermatitis, 7 of 8 studies of asthma, and 3 of 4 studies of allergic rhinitis.

Types and Amounts of Complementary Foods and Beverages

Growth, Size, and Body Composition

In general, the Committee found relatively little evidence with regard to whether the types and amounts of different CFB are related to growth, size, or body composition. Two conclusions were graded as “Moderate.” The first was that consuming different amounts of meat, or meat instead of iron-fortified cereal, during the complementary feeding period offers no long-term advantages or disadvantages in terms of growth, size, or body composition. Even though the majority of this evidence was from well-designed RCTs, these studies were not intended to ascertain the effects of sufficient versus insufficient meat consumption on growth, size, and body composition. Outcomes were measured before age 18 months, and thus the studies provided no evidence on outcomes later in childhood. The observational studies varied with respect to when meat intake was examined, how outcomes were assessed, and adjustment for key confounders. It should be noted that this conclusion does not apply to overweight or obesity outcomes, for which insufficient evidence was available.

The second conclusion graded as “Moderate” was that consuming complementary foods with different dietary fats or fatty acid composition does not influence growth, size, or body composition. The studies varied with regard to the types of fats and outcomes examined, and outcomes after age 24 months were not examined. Again, evidence was insufficient to determine a relationship with overweight or obesity.

Two conclusions were graded as “Limited.” First, consumption of SSB is associated with an increased risk of obesity in childhood but not with other measures of growth, size, or body composition. This body of evidence is from a small number of observational studies and they were inconsistent in how SSB were defined or examined. Second, juice intake is positively

associated with infant weight-for-length and child body mass index (BMI) z scores, but not enough evidence is available to determine a relationship with other outcome measures. Only a few observational studies were available, and most did not specify the type or percentage of fruit in the juice. In addition, the types of outcomes and ages of children in the studies varied.

Limited evidence suggested that type or amount of cereal given does not favorably or unfavorably influence growth, size, body composition, and/or prevalence/incidence of overweight or obesity, but a grade was not assigned because of inconsistency in the types of cereal and outcomes examined. Evidence was insufficient for the relationships of these outcomes to the types or amounts of other CFB, such as vegetables, fruit, dairy products and/or cow milk, cereal-based products, milk-cereal drinks, and/or categories such as “ready-made foods.” Study designs and types of CFB examined were heterogeneous and generalizability to the U.S. population was low. Similarly, evidence was insufficient as to whether different dietary patterns are related to growth, size, body composition, and/or prevalence of malnutrition, overweight, or obesity. The studies were difficult to compare due to variation in dietary patterns, health outcomes, and adjustment for confounding factors.

The findings that growth and body composition were generally unrelated to intakes of meat, cereal, or complementary foods differing in fat content or composition are consistent with the conclusions of a recent umbrella review,²⁸ which found no evidence to suggest associations between certain types or patterns of CFB and subsequent body composition, overweight, or obesity. The authors also found no relationship between total fat or polyunsaturated fatty acid intake in the first years of life and these outcomes.

The relationship between consumption of SSB by children younger than age 2 years and subsequent risk of overweight or obesity is of great interest, considering the high prevalence of overweight in the U.S. population, but relatively little evidence is available on this topic. For that reason, the conclusion statement from this review was graded as “Limited.” This uncertainty is echoed by the conclusion of the umbrella review by Patro-Golub et al²⁸, which stated that “there is inconsistent evidence to suggest an association between SSB intake in early childhood and long-term overweight and obesity; current diet is likely to be a major confounder.” Nonetheless, other evidence indicates that intake of SSB in early life is a strong predictor of SSB consumption later in life.²⁹

The relationship between juice intake in early life and risk of overweight also is of great interest. This NESR review suggested a positive association between juice intake and BMI z-score, but the conclusion was graded as “Limited.” In a recent meta-analysis,³⁰ consumption of 100% fruit juice was associated with a 0.087 (95% CI: 0.008, 0.167) unit increase in BMI z score

(4 percent increase in BMI percentile), which the authors judged to be not clinically meaningful. However, as for SSB, the consumption of juice in early life may be associated with consumption of juice and SSB later in childhood.³¹

Developmental Milestones, Including Neurocognitive Development

Evidence was insufficient to draw any conclusions about the relationship between the types or amounts of CFB and developmental milestones, due to an inadequate number of studies that were comparable in design, type of CFB consumed, how and when outcomes were assessed, and which results were reported.

The Committee examined associations between seafood consumption and neurocognitive development, but no studies were located for the birth to age 24 months population.

Nutrient Status

Strong evidence showed that iron-rich or iron-fortified CFB, such as meats or iron-fortified cereals, can help maintain adequate iron status or prevent iron deficiency during the first year of life, particularly among breastfed infants who are not receiving adequate iron from another source once iron stores present at birth are no longer sufficient (e.g., between ages 6 to 8 months).⁵ The benefit of these types of CFB for infants consuming iron-fortified infant formula is less evident. Not enough evidence was available to determine the relationship between other types and amounts of CFB containing lesser amounts of iron, such as fruits and vegetables, and iron status.

Some evidence, though limited, suggested 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 breastfed infants who are not receiving adequate zinc from another source. Again, the benefit of these types of CFB for infants consuming fortified infant formula is less evident. Plasma or serum zinc was the most common biomarker of zinc status used in the studies reviewed. This biomarker has several limitations²⁴ so the findings of studies using this zinc status outcome should be considered with caution. Only one study assessed zinc homeostasis by measuring total absorbed zinc from CFB and the exchangeable zinc pool. It showed lower zinc status in infants randomly assigned to receive infant cereal not fortified with zinc.

Moderate evidence indicated that CFB with differing fatty acid profiles, particularly long-chain polyunsaturated fatty acids, can influence fatty acid status. The studies reviewed varied in

terms of the CFB tested and the outcomes that were measured, but the results were generally consistent.

Not enough evidence was available to determine the relationship between types and amounts of CFB and vitamin B₁₂, vitamin D, or folate status. In addition, the Committee found only limited evidence to indicate which types and amounts of CFB are associated with adequate nutrient status in the second year of life, partly because only a few studies have gone beyond age 12 months.

The conclusion regarding the importance of iron-rich CFB is consistent with the findings of numerous authoritative organizations regarding the need for an adequate source of dietary iron after age 6 months,^{32,33} when iron stores at birth may become depleted. Iron is particularly important for normal neurological development and immune function.³²

The evidence showing that zinc-rich CFB are associated with the ability to maintain adequate zinc status is in agreement with the current understanding of zinc requirements during infancy.³⁴ The concentration of zinc in human milk declines sharply during lactation, such that by age 6 months, zinc intake from human milk is a very small proportion of estimated requirements. For this reason, both iron and zinc are considered “problem nutrients” for breastfed infants at ages 6 to 12 months, and complementary foods rich in these nutrients are needed to fill the gap.

As mentioned previously, polyunsaturated fatty acids are key nutrients for brain development. The evidence showing that CFB differing in fatty acid content can influence infant fatty acid status indicates that particular attention needs to be devoted to the fat content and composition of complementary foods. It has been recognized that intakes of DHA and arachidonic acid (ARA) from complementary foods are likely to be low in many low- and middle-income countries,³⁵ but the same may be true in higher-income countries if intakes of foods rich in these fatty acids are low.

Bone Health

Evidence was insufficient to determine whether the types and amounts of CFB consumed are related to bone health. Only 2 studies were included in the Committee’s review, both of which were PCSs that examined dietary patterns. It was difficult to compare the studies because the patterns examined differed with regard to the combinations of foods and food groups included. These studies assessed bone health outcomes at age 4 or 6 years and did not account for how dietary patterns may have shifted during the follow-up period.

Food Allergies and Atopic Allergic Diseases

Table D5.1 summarizes the findings with respect to food allergies, atopic dermatitis/eczema, asthma and allergic rhinitis. Strong evidence indicated that introducing peanut in the first year of life (after age 4 months) reduces the risk of food allergy to peanuts. This conclusion is consistent with other reviews. A meta-analysis of two high-quality RCTs^{15,16} revealed that peanut introduction at 4 to 11 months of age was associated with a 71 percent reduced risk of peanut allergy ($p=0.009$).³⁶ Historically, preventing food allergy in high-risk infants focused on allergen avoidance, with delayed introduction of potentially allergenic foods,³⁷ but the new evidence prompted a shift in the guidance from avoidance to early introduction of potentially allergenic foods. By 2017, the American Academy of Pediatrics (AAP)³⁸ and other professional and medical organizations³⁹⁻⁴¹ endorsed the introduction of peanut in the first year of life as an approach to prevent peanut allergy. Guidelines from the AAP for the timing of peanut exposure have been set based on an individual infant's risk of peanut allergy,¹³ although implementation of this guidance has been challenging.¹⁷

The evidence on whether the early introduction of other foods containing common dietary antigens can help prevent allergies and related atopic diseases is less strong, as shown in Table D5.1. However, the recent AAP document¹³ states that “there is no evidence that delaying the introduction of allergenic foods, including peanuts, eggs, and fish, beyond 4 to 6 months prevents atopic disease,” and the evidence from the Committee's review suggests that introduction of egg in the first year of life may be beneficial.

To better understand how specific types of foods consumed during infancy and toddlerhood influence risk of developing atopic disease, more research is needed that: a) uses RCT study designs, b) uses valid and reliable measures, c) uses consistent definitions of diet diversity and/or dietary patterns, and assesses these exposures at multiple time points across the complementary feeding period, d) adjusts for key confounders, e) takes into consideration the mechanisms by which specific types of foods may affect risk of developing atopic disease, and what analyses are appropriate, and f) accounts for the potential for reverse causality due to baseline atopic disease risk status affecting both complementary feeding behaviors and risk of developing atopic disease.

Table D5.1. Conclusion statements and grades from a systematic review examining the relationship between the types and amounts of complementary foods consumed and food allergy, atopic dermatitis/eczema, asthma, and allergic rhinitis

| |
|---|
| Peanut, tree nuts, seeds |
| <ul style="list-style-type: none"> • Strong evidence suggests that introducing peanut in the first year of life (after 4 months of age) may reduce risk of food allergy to peanuts [Grade: Strong]. This evidence is strongest for introducing peanut in infants at the highest risk (with severe atopic dermatitis and/or egg allergy) to prevent peanut allergy, but is also applicable to infants at lower risk. However, the evidence for tree nuts and sesame seeds is limited. • Limited evidence also suggests that there is no relationship between consumption of peanut, tree nuts, or sesame seeds during the complementary feeding period and risk of atopic dermatitis/eczema and asthma. Grade: Limited • There is not enough evidence to determine the relationship between consuming peanut, tree nuts, or seeds as complementary foods and allergic rhinitis. |
| Egg |
| <ul style="list-style-type: none"> • Moderate evidence suggests that introducing egg in the first year of life (after 4 months of age) may reduce risk of food allergy to egg. Grade: Moderate • Limited evidence suggests that there is no relationship between the age of introduction to egg and risk of atopic dermatitis/eczema and asthma. Grade: Limited • There is not enough evidence to determine if there is a relationship between consuming egg as a complementary food and allergic rhinitis. |
| Fish |
| <ul style="list-style-type: none"> • Limited evidence suggests that introducing fish in the first year of life (after 4 months of age) may reduce risk of atopic dermatitis/eczema. Grade: Limited • There is not enough evidence to determine if there is a relationship between consuming fish as a complementary food and risk of allergy to fish or other foods, asthma, or allergic rhinitis. • There is also not enough evidence to determine if there is a relationship between consuming shellfish as a complementary food and risk of food allergy, atopic dermatitis/eczema, asthma, or allergic rhinitis. |
| Cow milk products |
| <ul style="list-style-type: none"> • Limited evidence suggests there is no relationship between age of introduction of cow milk products, such as cheese and yogurt, and risk of food allergy and atopic dermatitis/eczema. Grade: Limited • There is not enough evidence to determine if there is a relationship between consuming milk products during the complementary feeding period and risk of asthma or allergic rhinitis. |
| Wheat |
| <ul style="list-style-type: none"> • There is not enough evidence to determine if there is a relationship between wheat consumption during the complementary feeding period and risk of food allergy, atopic dermatitis/eczema, asthma, or allergic rhinitis. Grade: Grade Not Assignable |
| Soy |
| <ul style="list-style-type: none"> • There is not enough evidence to determine if there is a relationship between soybean consumption during the complementary feeding period and risk of food allergy, atopic dermatitis/eczema, asthma, or allergic rhinitis. Grade: Grade Not Assignable |
| Foods and beverages that are not common allergens |
| <ul style="list-style-type: none"> • Limited evidence from observational studies suggests that introducing foods not commonly considered to be allergens, such as fruits, vegetables, and meat, in the first year of life (after 4 months of age) is not associated with risk of food allergy, atopic dermatitis/eczema, asthma, or allergic rhinitis. Grade: Limited |

Diet diversity and dietary patterns

- There is not enough evidence to determine a relationship between diet diversity or dietary patterns and risk of food allergy, atopic dermatitis/eczema, asthma, or allergic rhinitis. Grade: Grade Not Assignable
-

Cardiovascular Disease

Only 1 article⁴² examined the relationship between added sugars consumption during infancy and toddlerhood and risk of cardiovascular disease. That study found no significant associations between sugar-containing beverage intake at age 12 months and CVD-related outcomes (systolic blood pressure, diastolic blood pressure, total cholesterol, high-density lipoprotein cholesterol, low-density lipoprotein cholesterol, and triglycerides) at about age 6 years. However, the investigators found an association between higher intake of sugar-containing beverages and higher cardiometabolic risk factor score at age 6 years in boys (only). The study had limitations: not all key confounders were accounted for (gestational age, race/ethnicity, anthropometry at birth or baseline), several other important factors were not taken into account (maternal diet, parity, participation in a supplemental food program, family history of CVD, and complementary feeding practices), no information on non-completers was given, exposure data were measured only once, and the study provided no pre-registered data analysis plan.

The Committee examined associations between seafood consumption or dietary fat intake and later risk of CVD. For seafood consumption, no studies were located for the birth to age 24 months group. For fat intake and CVD, 3 studies included the birth to age 24 months group but the evidence provided was insufficient to generate separate conclusions for this population.

For these reasons, no conclusions could be drawn for the associations of interest described above for CVD.

SUMMARY

The evidence reviewed has several implications in terms of feeding guidelines for infants and children younger than age 2 years. The existing evidence suggests that CFB should not be introduced to infants before 4 months of age, and that introduction at age 4 to 5 months, as compared to 6 months, does not offer long-term advantages or disadvantages with regard to growth, size, body composition, overweight or obesity; iron status; or risk of developing food allergy, atopic dermatitis/eczema, or asthma during childhood. This recommendation is

consistent with infant feeding guidelines from authoritative sources in high-income countries. Several of these guidelines indicate that complementary foods should be introduced at “about” or “around” 6 months,^{33,43-47} although some recommend an age range of 4 to 6 months.⁴⁰ It should be noted that the outcomes included in the Committee’s reviews were limited to infant growth and body composition, nutrient status, developmental milestones, bone health, and atopic or allergic diseases, and did not include infant infectious diseases (e.g., gastrointestinal, respiratory and ear infections) nor any maternal outcomes that may be related to duration of exclusive breastfeeding (and, hence, age of introduction of complementary foods among breastfed infants). Recommendations regarding feeding of infants and children younger than age 2 years should ideally take into account the benefits and risks related to all relevant outcomes.

With regard to the types of CFB needed, the evidence supports guidance to provide foods that are rich in iron and zinc, either intrinsically (e.g., meats) or due to fortification (e.g., iron fortified infant cereal), particularly during the second 6 months of life among breastfed infants. As explained in the Introduction, after iron stores at birth are depleted, an external source of iron is needed to meet the very high requirements for iron to support growth and development. Results of data analysis and food pattern modeling confirm the challenges of meeting iron needs for breastfed infants at ages 6 to 12 months (see **Part D. Chapter 7: USDA Food Patterns in Infancy and Toddlerhood**). Iron requirements are lower in the second year of life than during infancy but a good source of iron is still needed. Foods that are rich in zinc can support zinc status in the first year of life. As is the case for iron in human milk, the zinc content of human milk after 6 months postpartum is relatively low, so breastfed infants who consume CFB that are high in zinc, such as meat or zinc-fortified foods, are better able to meet zinc requirements. Guidelines from several high-income countries emphasize the need for foods rich in iron and zinc,^{32,33,43,45-48} with some recommending that these foods be the first CFB introduced.

The evidence also supports the need to provide CFB that contain adequate amounts of polyunsaturated fatty acids, given their critical role in brain development and the link between dietary intake and the child’s fatty acid status. As described in **Part D. Chapter 1: Current Intakes of Foods, Beverages, and Nutrients**, intakes of omega-3 and omega-6 fatty acids from CFB among human milk-fed infants at ages 6 to 12 months are below the estimated needs. Although human milk is an important source of key fatty acids, milk concentrations are influenced by maternal dietary intake (see **Part D. Chapter 3: Food, Beverage, and Nutrient Consumption During Lactation**). Thus, both mother and child should consume diets adequate

in these nutrients. Canadian authorities emphasize that higher-fat CFB that are nutrient-dense are key components of a healthy diet for children younger than age 2 years.⁴⁴

The evidence indicates that introducing peanut and egg in the first year of life (after age 4 months) may reduce the risk of food allergy to peanuts and eggs. For other types of food allergy (to fish, shellfish, cow milk products, tree nuts, seeds, wheat, and soy), the evidence for such protective effects is less clear, but the Committee found no evidence that avoiding such foods in the first year of life is beneficial with regard to preventing food allergies or other atopic or allergic diseases. Recent guidelines from high-income countries are generally consistent in recommending that introduction of potentially allergenic foods should not be delayed beyond the first year of life.^{13,33,40}

Avoiding consumption of SSB by children younger than age 2 years is important for several reasons. First, the energy contributed by such beverages leaves less “room” for energy from nutritious CFB, leading to potential nutrient gaps (see **Part D. Chapter 7: USDA Food Patterns in Infancy and Toddlerhood**). Second, the evidence, though limited, suggests that SSB consumption by infants and young children is related to subsequent risk of child overweight. Lastly, intake of SSB in early life may set the stage for greater intake of SSB later in life, with adverse consequences with regard to overweight and obesity and risk of CVD. Consensus is widespread among authoritative bodies in high-income countries that SSB should not be consumed by children younger than 2 years of age.^{40,46,47,49}

The evidence for avoiding or limiting juice intake by the birth to age 24 months population is less clear. A consensus statement from four organizations⁴⁹ recommended that juice not be given in the first year of life, and that no more than 4 ounces per day of 100% fruit juice should be consumed at ages 1 to 3 years. That statement was based on the finding that fruit juice consumption in early life may influence consumption of juice and SSB later in childhood.

As mentioned in the Introduction, the Committee was asked to address several questions related to “what to feed” infants and young children. The topics reviewed represent only a portion of all the feeding questions that are relevant to infants and toddlers from birth to age 24 months. Questions of “how to feed” were not among the topics selected to be addressed by the 2020 Committee, but are of critical importance with regard to building healthy eating habits that can be maintained throughout life.^{20,21} These key issues should be taken up by the next Dietary Guidelines Advisory Committee.

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