

PART D. CHAPTER 3: FOOD, BEVERAGE, AND NUTRIENT CONSUMPTION DURING LACTATION

INTRODUCTION

Maternal nutrition is a key factor influencing the health of both the lactating woman and her child. For many nutrients, the requirements during lactation differ from those during pregnancy, so women who are lactating should adapt their dietary choices and supplement use to meet those needs. For example, requirements for energy, as well as for protein and several minerals and vitamins, increase substantially during the period of lactation, whereas the requirement for iron during lactation is one-third that of pregnancy.^{1,2} In well-nourished women, the energy requirements for lactation take into account energy released endogenously from mobilization of maternal fat stores,³ which may assist women in postpartum weight loss (PPWL).⁴

Lactation confers other short- and long-term health benefits to women's health as well. In the short-term, physiologic processes that accompany lactation during the early postpartum period facilitate uterine involution and enhance glucose tolerance and insulin sensitivity.⁵ Long-term benefits of lactation for women's health include reduction in risk of breast,⁶ ovarian, and endometrial cancers⁷; hypertension and cardiovascular disease⁸; non-alcoholic fatty liver disease⁹; and type 2 diabetes mellitus⁵ later in life. For some of these outcomes, the benefits are greater with longer durations of lactation.^{5,10} Surveillance data from the 2017-2018 National Immunization Survey¹¹ show that overall breastfeeding rates in the United States are meeting the Healthy People 2020 goals.¹² The percentage of infants who are "ever breastfed" (83.8 percent) now exceeds the Healthy People 2020 goal of 81.9 percent, and the objective for exclusive breastfeeding to 6 months (25.5 percent) has nearly been met (25.4 percent). In this survey, exclusive breastfeeding is defined as the infant being fed only human milk and no solids, water, or other fluids. Although these statistics are promising, they indicate that 75 percent of U.S. infants are not exclusively breastfed for 6 months, as recommended by the American Academy of Pediatrics (AAP)¹³ and the World Health Organization (WHO).¹⁴ Moreover, only 36 percent of infants in the United States are breastfed for at least 12 months,¹¹ as recommended by the AAP and WHO.

This chapter in the 2020 Dietary Guidelines Advisory Committee's report presents the evidence from a series of systematic reviews on associations of maternal diet, dietary patterns, and supplements consumed during lactation with maternal PPWL, micronutrient status, human milk composition and quantity, and selected health outcomes in the infant and child.

Subsequent chapters discuss the associations of consumption of human milk and/or infant formula and complementary foods with infant health outcomes, as well as an assessment of the ability of the USDA Food Patterns to meet nutrient needs during lactation (see ***Part D. Chapter 4: Duration, Frequency, and Volume of Exclusive Human Milk and/or Infant Formula Feeding*** and ***Part D. Chapter 5: Food, Beverage, and Nutrient Consumption During Infancy and Childhood*** and ***Part D. Chapter 14: USDA Food Patterns for Individuals Ages 2 Years and Older***).

Background

Lactation can be viewed along the continuum of the reproductive cycle from pre-pregnancy, through pregnancy and, finally, lactation. Just as pregnancy outcomes are influenced by maternal pre-pregnant body mass index (BMI) and metabolic status, lactation outcomes are affected by pre-pregnancy health status, gestational weight gain (GWG), and metabolic health during pregnancy. During pregnancy, physiological and metabolic changes occur in preparation for lactation, including growth and maturation of mammary tissue and deposition of adipose tissue. A number of these changes are influenced by the woman's dietary patterns and nutrient intake and were therefore included in the Committee's review.

Data from the WHO Collaborative Study showed that 3.7 kilograms (kg) of adipose tissue (range 3.1 to 4.4 kg or 6.8 to 9.7 pounds) was deposited in women with an average 12 kg GWG (approximately 26 pounds).¹⁵ During lactation, maternal energy requirements increase to support maternal metabolism, milk production, and tissue-specific growth. Lactation is energetically demanding; the energy in the milk secreted in the first 4 months of lactation is roughly equivalent to the total energy cost of pregnancy.^{1,16} However, energy from adipose tissue stores and many of the nutrients stored during pregnancy are available to support milk production. During the first 6 months of lactation, the Recommended Dietary Allowance (RDA) for women who are lactating is an additional 500 kcal per day from dietary intake, which assumes that an additional 170 kcal per day is mobilized from maternal adipose tissue.¹⁷ During the second 6 months of lactation, an additional 400 kcal per day from dietary intake is recommended, based on reduction in milk production from an average of 780 mL per day over the first 6 months of lactation to an estimated 600 mL per day thereafter.² Recommended intakes for several but not all vitamins and minerals also are higher during lactation than in pregnancy, with the notable exceptions of folate and iron. Because micronutrients are not evenly distributed among foods, women who are lactating should consume a varied, nutrient-

dense diet. Therefore, the Committee investigated how dietary patterns consumed by women who are lactating are related to maternal outcomes and human milk composition and quantity, as well as child neurocognitive development.

A review of NHANES 1999 to 2014 data showed that most (70 percent) women who are lactating use dietary supplements, compared to 45 percent of women who are not pregnant or lactating.¹⁸ More than half of the women surveyed continued to use prenatal supplements during lactation, often based on the recommendation of a health care provider.¹⁸ However, prenatal supplements are not designed to meet the needs of lactating women, and the folate and iron intakes from supplements alone exceed the RDA for these micronutrients by 2.4-fold and 3.7-fold, respectively.¹⁸ The Committee investigated how folate and omega-3 fatty acids from dietary supplements consumed by women who are lactating are related to various maternal and child outcomes and human milk composition.

Postpartum weight retention is common in women, particularly among women with high prepregnancy BMI or excessive GWG. The increased energy demands required to support lactation have the potential to contribute to PPWL and reduce the long-term risk of overweight or obesity.⁴ On average, women lose 0.6 to 0.8 kg (1.3 to 1.8 pounds) per month in the first 4 to 6 months of lactation. Women vary widely in the amount of weight they lose during lactation, and those who continue beyond 4 to 6 months postpartum ordinarily continue to lose weight.² Baker et al. (2008) showed that women from the Danish National Birth Cohort with a recommended GWG of approximately 12 kg (approximately 27 pounds) and who exclusively breastfed for 6 months, had no postpartum weight retention at 6 months.¹⁹ Because of the implications of PPWL for maternal health, the Committee investigated the association between dietary patterns consumed by women who are lactating and PPWL.

Human milk provides the biologic foundation for infant nutrient needs. Human milk has a unique array of nutrients and bioactive substances that support optimal infant growth and development.^{20,21} The amount of human milk produced varies in response to several factors, including demand by the infant, which may be related to the frequency of human milk removal from the breast, either by suckling or use of a breast pump, as well as other biological variables.²² The first milk produced following birth, colostrum, is a concentrated fluid, especially rich in nutrients and protective factors. By about 2 weeks postpartum, mature milk has been established.^{21,22} Specific nutrients and bioactive components in human milk vary throughout a single feeding, time of day of the feeding, and across time after delivery.^{21,22} The degree to which maternal nutrition influences human milk composition varies by the nutrient. The

components of human milk that are produced by the mammary gland are more likely influenced by maternal genetics than by dietary intake.²² Macronutrients produced by the mammary gland include casein and whey, the predominant proteins in human milk, and carbohydrates, including lactose and human milk oligosaccharides. Milk fat is comprised of fatty acids that are either synthesized *de novo* in the mammary gland or extracted from the maternal circulation. Thus, maternal diet affects the fat composition of human milk.²³ Accordingly, questions about how milk fatty acid composition varies with maternal diet have particular importance and were investigated by the Committee.

Concentrations of some micronutrients in human milk, but not all, are correlated with maternal nutrient status. These include vitamins A, D, E, K, B₁, B₂, B₆, B₁₂, choline, and the minerals iodine and selenium. Thus, the concentrations of these nutrients in human milk can be increased by maternal supplementation.²⁴ In contrast, concentrations of folate, calcium, copper, iron, and zinc are generally independent of maternal status, and maternal supplementation does not increase milk concentrations.²¹

Although at this time, no Acceptable Macronutrient Distribution Ranges (AMDR) have been established for infants,²⁵ the accretion of long-chain polyunsaturated fatty acids (LC-PUFA), such as docosahexaenoic acid (DHA), is critically important for the growth and development of the central and peripheral nervous systems and retina during infancy and childhood.^{26,27} Thus, an important question is whether maternal seafood consumption or dietary supplementation with DHA or other LC-PUFA during lactation further supports these developmental processes.

The Committee used systematic reviews to examine questions about the relationship between maternal dietary patterns during lactation (including seafood consumption and frequency of eating) and maternal PPWL, human milk composition and quantity, and child developmental milestones, including neurocognitive development. This chapter also examines the evidence for a relationship between the maternal diet consumed during lactation and the risk of food allergy and atopic diseases in the child. Atopic diseases cause significant morbidity and can be challenging to control. Therefore, there has been an emphasis on developing preventive strategies, which are particularly important for children at high risk of developing allergy due to family history.²⁸ Infancy offers a unique “window of opportunity” for allergy prevention.²⁹ Human milk contains nutrients and other bioactive components that could influence infant immune development and potentially atopic sensitization.³⁰ Some existing evidence suggests that modifying human milk composition via the maternal diet may prevent allergic diseases;

however, data are conflicting.³⁰ The Committee evaluated the association between maternal dietary intake during lactation and atopic diseases in the child.

Although the *Dietary Guidelines for Americans* focuses on food sources of nutrients, the Committee also examined the effect of some dietary supplements on maternal and child outcomes. Initially, six nutrients (folic acid, omega-3 fatty acids, iron, iodine, vitamin D, and vitamin B₁₂) from supplements and fortified foods were to be included in the review. Due to time constraints and, in some cases, existing systematic reviews or guidance that addressed some of the outcomes of interest, the scope of the Committee's reviews was prioritized to focus on 2 of these nutrients, folic acid and omega-3 fatty acids. For folic acid, the Committee investigated 3 outcomes (maternal micronutrient status, human milk composition, and neurocognitive development of the child), whereas for omega-3 fatty acids, the Committee reviewed only the evidence for neurocognitive development of the child.

LIST OF QUESTIONS

1. What is the relationship between dietary patterns consumed during lactation and postpartum weight loss?
2. What is the relationship between frequency of eating during lactation and postpartum weight loss?
3. What is the relationship between dietary patterns consumed during lactation and human milk composition and quantity?
4. What is the relationship between maternal diet during lactation and risk of child food allergies and atopic allergic diseases, including atopic dermatitis, allergic rhinitis, and asthma?
5. What is the relationship between dietary patterns consumed during lactation and developmental milestones, including neurocognitive development, in the child?
6. What is the relationship between seafood consumption during lactation and neurocognitive development in the child?
7. What is the relationship between omega-3 fatty acids from supplements consumed during lactation and developmental milestones, including neurocognitive development, in the child?
8. What is the relationship between folic acid from supplements and/or fortified foods consumed during lactation and 1) maternal micronutrient status, 2) human milk composition, and 3) developmental milestones, including neurocognitive development, in the child?

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 8 in this chapter were answered using new NESR systematic reviews. The Committee developed a systematic review protocol for each question, which described how the Committee would apply NESR's methodology to answer the question. The protocol included an analytic framework and inclusion and exclusion criteria to guide identification of the most relevant and appropriate bodies of evidence to use in answering each systematic review question. Each analytic framework outlined core elements of the systematic review question (i.e., population, intervention and/or exposure and comparator [i.e., the alternative being compared to the intervention or exposure], and outcomes), and included definitions for key terms, key confounders, and other factors to be considered when reviewing the evidence. The inclusion and exclusion criteria were selected a priori to operationalize the elements of the analytic framework and specify what made a study relevant for each systematic review question.

Next, NESR conducted a literature search to identify all potentially relevant articles, and those articles were screened by two NESR analysts independently based on the criteria selected by the Committee. For each included article, data were extracted, and risk of bias assessed. The Committee qualitatively synthesized the body of evidence to inform development of a conclusion statement(s) and graded the strength of evidence using pre-established criteria for risk of bias, consistency, directness, precision, and generalizability. Finally, recommendations for future research were identified. A detailed description of NESR's systematic review methodology is provided in **Part C. Methodology**, including standard inclusion and exclusion criteria applied in many of the Committee's systematic reviews. Complete documentation of each systematic review is available on the following website: nestr.usda.gov/2020-dietary-guidelines-advisory-committee-systematic-reviews. Below is a summary of the unique elements of the protocols developed to answer the questions addressed in this chapter.

For all questions discussed in this chapter, the population of interest for the intervention or exposure was women who are lactating. For Question 4 and the part of Question 3 that examined human milk quantity as the outcome, the Committee included only studies that

enrolled women who were exclusively or predominantly feeding human milk. The population of interest for outcomes varied depending on the outcome examined, as described below.

For Questions 1, 3, and 5, consumption of and/or adherence to a dietary pattern during lactation was the primary intervention or exposure of interest. The comparators of interest were consumption of and/or adherence to a different dietary pattern or different levels of consumption of and/or adherence to a dietary pattern. Dietary patterns were defined as “the quantities, proportions, variety, or combination of different foods, drinks, and nutrients in diets, and the frequency with which they are habitually consumed.” To be included in the review on dietary patterns, studies needed to provide a description of the foods and beverages in the pattern. Dietary patterns considered in the review were measured or derived using a variety of approaches, such as adherence to a priori patterns (indices/scores), data-driven patterns (factor or cluster analysis), reduced rank regression, or other methods, including clinical trials.

Questions 1, 3, and 5 also examined diets based on a macronutrient distribution outside of the AMDR, at any level above or below, as an intervention or exposure of interest. The comparator of interest was consumption of and/or adherence to a macronutrient distribution of carbohydrate, fat, and protein within the AMDR. To be included in the review, articles needed to describe the entire macronutrient distribution of the diet by reporting the proportion of energy from carbohydrate, fat, and protein, and have at least one macronutrient proportion outside of the AMDR.

The Committee established these criteria to take a holistic approach to answer the scientific questions, and thus needed to examine the entire distribution of macronutrients in the diet, and not one macronutrient in isolation. These criteria allowed the Committee to consider both the relationships with health outcomes of consuming a diet with one macronutrient outside of the AMDR, and also how consumption of that macronutrient displaces or replaces intake of other macronutrients within the distribution. A study did not need to report the foods/food groups consumed to be included. The criteria were designed to cast a wide, comprehensive net to capture any study that examined carbohydrate levels less than 45 percent or greater than 65 percent of energy, fat levels less than 20 percent or greater than 35 percent of energy, and/or protein levels less than 10 percent or greater than 35 percent of energy. Furthermore, when describing and categorizing studies included in these reviews, the Committee did not label the diets examined as “low” or “high,” because no universally accepted, standard definition is currently available, for example, for “low-carbohydrate” or “high-fat” diets. Instead, the

Committee focused on whether, and the extent to which, the proportions of the macronutrients were below or above the AMDR.

The outcome examined in Question 1 was PPWL, which was defined as the change in weight from baseline (postpartum) to a later time point during the postpartum period, or as postpartum weight retention, if GWG was controlled for. Two literature searches were conducted to identify all potentially relevant articles for this question. The first search was designed to capture all potentially relevant articles on dietary patterns published from January 2000 to June 2019. The second search was designed to identify all potentially relevant articles on diets based on macronutrient distribution published from January 2000 to November 2019, and to capture any additional articles on dietary patterns published between June and November 2019. Articles for this question were searched for and screened together with Question 3 in **Part D. Chapter 2: Food, Beverage, and Nutrient Consumption During Pregnancy** (dietary patterns and GWG). This was done to leverage the overlap in topical areas and to improve efficiency. For Questions 1, 3 and 5, the Committee searched for and included studies that were published starting in 2000 because the field of dietary patterns research is relatively new, particularly for the populations and outcomes of interest in the questions being addressed in this chapter. Previous systematic reviews on dietary patterns searched for literature starting in 1980, but relevant studies published before the year 2000 were uncommon. Therefore, the Committee determined that the preponderance of evidence for these new reviews would be captured by searching literature starting in the year 2000.

For Question 2, frequency of eating during lactation was the intervention or exposure and PPWL was the outcome (see **Part D. Chapter 13: Frequency of Eating** for details about the methodology used to answer this question).

For Question 3, dietary patterns during lactation, including diets based on macronutrient distribution (as defined above), was the intervention or exposure and human milk quantity and composition was the outcome. Human milk composition included macronutrients (fatty acids, total protein), water-soluble vitamins (vitamins B, C, and choline), fat-soluble vitamins (A, D, E, K), minerals (iodine and selenium), human milk oligosaccharides, and bioactive components. Due to the changes in human milk during the first weeks after delivery, the Committee required that only studies assessing milk composition and quantity in mature milk (defined as milk produced ≥ 14 days postpartum) be included. In addition, the Committee included cross-sectional studies for these outcomes because of the dearth of longitudinal studies that address

human milk composition and quantity. A literature search was conducted to identify all potentially relevant articles published from January 2000 to July 2019.

For Question 4, maternal diet during lactation was the intervention or exposure, including foods that may be considered allergens (e.g., cow milk products, eggs, peanuts, tree nuts, and soybean) and foods that are not considered allergens (including but not limited to meat, vegetables, and fruits). The outcomes for this question were food allergies and atopic allergic diseases, including atopic dermatitis/eczema, allergic rhinitis, and asthma, in infants and toddlers (birth to age 24 months) and children and adolescents (ages 2 to 18 years). Maternal diet during pregnancy and food allergies and atopic allergic diseases is discussed in **Part D. Chapter 2**, Question 8. Food allergy was defined as a diagnosis based on either the gold standard of a double-blind, placebo-controlled oral food challenge, or as parental report of clinical history together with blood immunoglobulin E (IgE) levels 0.35 kilo unit per liter (kU/L) or greater and/or skin prick test wheal 3 or greater millimeters (mm). Because of difficulty diagnosing asthma during infancy and toddlerhood, only those studies that assessed asthma in children who were age 2 years or older were included. A literature search was conducted to identify all potentially relevant articles published from January 1980 to January 2020.

For Question 5, dietary patterns during lactation (including diets based on macronutrient distribution, as defined above) was the intervention or exposure and the outcome was developmental milestones, including neurocognitive development in infants and toddlers (birth to age 24 months) and children and adolescents (ages 2 to 18 years). This included developmental domains (i.e., cognitive, language and communication, movement and physical and social-emotional development), academic performance, attention deficit disorder (ADD) or attention deficit/hyperactivity disorder (ADHD), anxiety, depression, and autism spectrum disorder (ASD). A literature search was conducted to identify all potentially relevant articles published from January 2000 to January 2020.

For Question 6, seafood consumption during lactation was the intervention or exposure and neurocognitive development was the outcome (see **Part D. Chapter 9: Dietary Fats and Seafood** for details about the methodology used to answer this question).

For Question 7, omega-3 fatty acids from supplements was the intervention or exposure. Fortified foods were not considered for this question because supplements are generally the major source of omega-3 fatty acids. The outcome for this question was developmental milestones (as described above for Question 5). Omega-3 fatty acids from supplements during pregnancy and child developmental milestones is discussed in **Part D. Chapter 2**, Question 10.

A literature search was conducted to identify all potentially relevant articles published from January 1980 to February 2020.

For Question 8, folic acid from supplements and/or fortified foods was the intervention or exposure. The outcomes considered were as follows:

- **Maternal micronutrient status:** Assessment of folate (including but not limited to serum folate, red blood cell [RBC] folate), vitamin B₁₂, hemoglobin, mean corpuscular volume (MCV), and RBC distribution width.
- **Human milk composition:** Folate in human milk, including but not limited to total folate, reduced folates, and unmetabolized folic acid. Human milk quantity was not considered as an outcome for this question.
- **Developmental milestones,** as described above for Question 5.

In order to capture fortification studies, this question also included uncontrolled before-and after studies. In addition, cross-sectional studies were included for the human milk composition outcome alone, because of the dearth of longitudinal studies that address this outcome. Folic acid from supplements and/or fortified foods before and during pregnancy and gestational diabetes mellitus (GDM), hypertensive disorders during pregnancy, micronutrient status in pregnant women, human milk composition and developmental milestones is discussed in **Part D. Chapter 2**, Question 11. Two separate literature searches were conducted to identify all potentially relevant articles for Question 8. The first search was designed to identify articles on folic acid and micronutrient status or human milk composition, published from January 1980 to June 2019. The second search was designed to identify articles on folic acid and developmental milestones, published from January 1980 to July 2019.

REVIEW OF THE SCIENCE

Question 1. What is the relationship between dietary patterns consumed during lactation and postpartum weight loss?

Approach to Answering Question: NESR systematic review

Conclusion Statement and Grade

Insufficient evidence is available to determine the relationship between dietary patterns during lactation and postpartum weight loss. Grade: Grade Not Assignable

Summary of the Evidence

- This systematic review includes 1 randomized controlled trial (RCT) conducted in the United States,³¹ which compared PPWL in women who were lactating between those who were randomized to a Mediterranean-style diet vs the USDA MyPyramid diet.
- The two groups showed no significant differences in PPWL.
- This study had notable limitations, including high attrition (approximately 21 percent), issues with implementation of the intervention, and lack of blinding of participants and investigators.

For additional details on this body of evidence, visit: nesr.usda.gov/2020-dietary-guidelines-advisory-committee-systematic-reviews/pregnancy-and-lactation-subcommittee/dietary-patterns-lactation-postpartum-weight-loss

Question 2. What is the relationship between frequency of eating during lactation and postpartum weight loss?

Approach to Answering Question: NESR systematic review

Conclusion Statement and Grade

Insufficient evidence is available to determine the relationship between the frequency of eating during lactation and postpartum weight loss. Grade: Grade Not Assignable

Summary of the Evidence

- Frequency of eating was defined as the number of daily eating occasions. An eating occasion was defined as an ingestive event (solid food or beverage, including water) that is either energy yielding or non-energy yielding.
- PPWL was defined as a change in weight from baseline (postpartum) to a later time point during the postpartum period. Additionally, it could be postpartum weight retention, if GWG was controlled for in the analysis.
- This review included 1 prospective cohort study (PCS) (using data from a multicomponent RCT) that met the inclusion criteria for this systematic review and was published within the date range of January 2000 and September 2019.³²
- The 1 included study did not report a significant association between a change in eating frequency and a change in weight from baseline over a 12-week follow-up.
- The study had several limitations, including:
 - Key confounders were not accounted for.
 - Data were from a multi-component RCT that was not designed to test frequency of eating.
 - One PCS with critical limitations was not sufficient to draw conclusions.

For additional details on this body of evidence, visit: [nesr.usda.gov/2020-dietary-guidelines-advisory-committee-systematic-reviews/frequency-eating-subcommittee/frequency-eating-postpartum-weight-loss](https://www.nesr.usda.gov/2020-dietary-guidelines-advisory-committee-systematic-reviews/frequency-eating-subcommittee/frequency-eating-postpartum-weight-loss)

Question 3. What is the relationship between dietary patterns consumed during lactation and human milk composition and quantity?

Approach to Answering Question: NESR systematic review

Conclusion Statements and Grades

No evidence is available to determine the relationship between maternal dietary patterns during lactation and human milk quantity. Grade: Grade Not Assignable

Insufficient evidence is available to determine the relationship between maternal diets differing in macronutrient distributions during lactation and human milk quantity. Grade: Grade Not Assignable

Insufficient evidence is available to determine the relationship between dietary patterns during lactation and total fat in human milk. Grade: Grade Not Assignable

Limited evidence suggests that maternal consumption of diets higher in fat (>35 percent fat) and lower in carbohydrate during lactation is related to higher total fat in human milk collected in the maternal postprandial period. Grade: Limited

Limited evidence suggests that certain maternal dietary patterns during lactation, including diets based on macronutrient distributions, are related to the relative proportions of saturated fat and monounsaturated fatty acids in human milk, and of polyunsaturated fatty acids in human milk collected in the maternal postprandial period. Grade: Limited

No evidence is available to determine the relationship between maternal dietary patterns during lactation and total protein concentration in human milk. Grade: Grade Not Assignable

Insufficient evidence is available to determine the relationship between maternal diets differing in macronutrient distribution during lactation and total protein concentration in human milk. Grade: Grade Not Assignable

No evidence is available to determine the relationship between maternal dietary patterns during lactation and bioactive proteins, including alpha-lactalbumin, lactoferrin, casein, alpha (1) antitrypsin, osteopontin, secretory immunoglobulin A, and lysozyme in human milk. Grade: Grade Not Assignable

No evidence is available to determine the relationship between maternal dietary patterns during lactation and human milk oligosaccharides. Grade: Grade Not Assignable

Insufficient evidence is available to determine the relationship between maternal dietary patterns during lactation and vitamin B₁₂ concentration in human milk. Grade: Grade Not Assignable

No evidence is available to determine the relationship between maternal dietary patterns during lactation and vitamin C, choline, and B vitamins (other than vitamin B₁₂) in human milk. Grade: Grade Not Assignable

No evidence is available to determine the relationship between maternal dietary patterns during lactation and vitamins A, D, E, and K in human milk. Grade: Grade Not Assignable

No evidence is available to determine the relationship between maternal dietary patterns during lactation and iodine and selenium in human milk. Grade: Grade Not Assignable

Summary of the Evidence

- This systematic review includes 3 RCTs (4 articles) and 2 cross-sectional studies (3 articles) published between 2009 and 2019.³³⁻³⁹
- Studies included in this review assessed one of the following maternal interventions or exposures during lactation:
 - Dietary patterns (2 studies)
 - Diets based on macronutrient distributions outside of the AMDR (3 studies)
- Two of the 3 RCTs reported that a maternal diet higher in fat during lactation (i.e., >35 percent of total energy from fat, which is greater than the AMDR) resulted in higher total fat in human milk.
- Some, but not all studies showed that maternal dietary patterns during lactation were related to the relative proportions of saturated fat, monounsaturated fatty acids, and polyunsaturated fatty acids in human milk, which differed depending on whether milk samples were collected in a fed or fasted state.
- This body of evidence had notable limitations:
 - All RCTs had a small sample size (<20 participants) and none reported power analyses.
 - The cross-sectional studies did not account for most of the confounders.
 - One cross-sectional study reported that the participants differed on supplement intake during lactation, in addition to differing on dietary patterns. However, this was not controlled for in the statistical analysis or accounted for in the interpretation of the study findings.
 - The timing and methods of human milk collection were heterogeneous.
 - The study populations did not represent the racial/ethnic or socioeconomic diversity of the U.S. population.

- Insufficient or no evidence was available to assess the association between dietary patterns and several other outcomes, including human milk quantity and human milk composition of total protein, water-soluble vitamins (B, C, and choline), fat-soluble vitamins (A, D, E, and K), minerals (iodine and selenium), human milk oligosaccharides, and bioactive proteins (alpha-lactalbumin, lactoferrin, casein, alpha (1) antitrypsin, osteopontin, secretory immunoglobulin A (sIgA), and lysozyme).

For additional details on this body of evidence, visit: [nesr.usda.gov/2020-dietary-guidelines-advisory-committee-systematic-reviews/pregnancy-and-lactation-subcommittee/dietary-patterns-lactation-human-milk](https://www.nesr.usda.gov/2020-dietary-guidelines-advisory-committee-systematic-reviews/pregnancy-and-lactation-subcommittee/dietary-patterns-lactation-human-milk)

Question 4. What is the relationship between maternal diet during lactation and risk of child food allergies and atopic allergic diseases including atopic dermatitis, allergic rhinitis, and asthma?

Approach to Answering Question: NESR systematic review

Conclusion Statements and Grades

Food Allergy

Insufficient evidence is available to determine the relationship between lower or restricted consumption of cow milk products during both pregnancy and lactation, and risk of food allergy in the child. Grade: Grade Not Assignable

No evidence is available to determine the relationship between maternal dietary patterns or cow milk products, eggs, peanuts, soybean, wheat, fish, tree nuts and seeds, and foods not commonly considered to be allergens, such as meat, vegetables, and fruits consumed during lactation and risk of food allergy in the child. Grade: Grade Not Assignable

Atopic Dermatitis

Insufficient evidence is available to determine the relationship between cow milk products restricted during both pregnancy and lactation, or during lactation only, and risk of atopic dermatitis/eczema in the child. Grade: Grade Not Assignable

Insufficient evidence is available to determine the relationship between egg consumption restricted during both pregnancy and lactation and risk of atopic dermatitis/eczema in the child. Grade: Grade Not Assignable

No evidence is available to determine the relationship between maternal dietary patterns or yogurt and probiotic milk products, eggs, fish, peanuts, tree nuts and seeds, soybean, wheat/cereal, and foods not commonly considered to be allergens, such as meat, vegetables, and fruits, consumed during lactation and risk of atopic dermatitis/eczema in the child. Grade: Grade Not Assignable

Allergic Rhinitis

Insufficient evidence is available to determine the relationship between cow milk products consumed during both pregnancy and lactation, and risk of allergic rhinitis in the child. Grade: Grade Not Assignable

No evidence is available to determine the relationship between maternal dietary patterns or cow milk products, eggs, fish, peanuts, tree nuts and seeds, soybean, wheat, and foods not commonly considered to be allergens, such as meat, vegetables, and fruits consumed during lactation and risk of allergic rhinitis in the child. Grade: Grade Not Assignable

Asthma

Insufficient evidence is available to determine the relationship between cow milk products consumed during both pregnancy and lactation, or during lactation only and risk of asthma in the child. Grade: Grade Not Assignable

Insufficient evidence is available to determine the relationship between fish, and other foods, such as margarine, oil, butter and butter-spreads, meat, and meat products consumed during lactation and risk of asthma in the child. Grade: Grade Not Assignable

No evidence is available to determine the relationship between maternal dietary patterns or eggs, peanuts, wheat, tree nuts and seeds, and soybean consumed during lactation and risk of asthma in the child. Grade: Grade Not Assignable

Summary of the Evidence

- This systematic review included 8 articles from 4 RCTs, one non-RCT, and 1 PCS that assessed the relationship between maternal diet during both pregnancy and lactation, or during lactation alone, and risk of food allergy, atopic dermatitis/eczema, allergic rhinitis, and asthma in the child occurring from birth through age 18 years.⁴⁰⁻⁴⁷ The articles were published between 1989 and 2013.
 - Six articles from 4 studies included women who were pregnant as well as those who were lactating.
 - Two studies included only women who were lactating.
- Four articles from 2 RCTs examined maternal avoidance of cow milk products, eggs, soybean, wheat, and peanuts, during both pregnancy and lactation, in relation to risk of food allergy, and allergic rhinitis in the child from birth through age 18 years. None of these studies was conducted exclusively in lactating women.
- Seven articles from 4 RCTs and 1 non-RCT examined maternal avoidance of cow milk products, eggs, soybean, wheat, and peanuts, during both pregnancy and lactation, or during lactation alone, in relation to the risk of atopic dermatitis/eczema in the child from birth through age 18 years. Of these, only 1 RCT was conducted exclusively in women who were lactating.
- Four articles from 2 RCTs and 1 PCS examined maternal avoidance and/or consumption of cow milk products, eggs, fish, soybean, peanuts, wheat, and other foods during both pregnancy and lactation, or during lactation alone, in relation to risk of asthma in the child from ages 2 through 18 years. Of these, 1 PCS was conducted exclusively in women who were lactating.
- No articles were identified that examined maternal avoidance or consumption of seeds during lactation in relation to the risk of atopic outcomes in the child from birth through age 18 years.
- The ability to draw strong conclusions was limited by the following issues:
 - Very few studies assessed the relationship between maternal diet during lactation alone and risk of atopic dermatitis, food allergy, allergic rhinitis and asthma.
 - Key confounders were not consistently controlled for in most of the studies.
 - Women with lower socioeconomic status (SES), adolescents, and racially and ethnically diverse populations were underrepresented in the body of evidence.

See **Part D. Chapter 2: Food, Beverage, and Nutrient Consumption During Pregnancy**, Question 8, for a review that addressed maternal diet during both pregnancy and lactation, and pregnancy only, and risk of child food allergy and atopic allergic diseases.

For additional details on this body of evidence, visit: nestr.usda.gov/2020-dietary-guidelines-advisory-committee-systematic-reviews/pregnancy-and-lactation-subcommittee/maternal-diet-pregnancy-lactation-child-food-allergies-and-atopic-allergic-diseases

Question 5. What is the relationship between dietary patterns consumed during lactation and developmental milestones, including neurocognitive development, in the child?

Approach to Answering Question: NESR systematic review

Conclusion Statement and Grade

No evidence is available to determine the relationship between maternal dietary patterns during lactation and developmental outcomes, including neurocognitive development, in the child.

Grade: Grade Not Assignable

Summary of the Evidence

- The outcomes for this systematic review included developmental domains (examined through milestone achievement and/or scales/indices, including cognitive, language and communication, movement and physical, and social-emotional), academic performance, ADD or ADHD, anxiety, depression, and ASD.
- This review identified 0 studies published between January 2000 and January 2020 that met the inclusion criteria for this systematic review.

For additional details on this body of evidence, visit: nestr.usda.gov/2020-dietary-guidelines-advisory-committee-systematic-reviews/pregnancy-and-lactation-subcommittee/dietary-patterns-lactation-neurocognitive-development

Question 6. What is the relationship between seafood consumption during lactation and neurocognitive development, in the child?

Approach to Answering Question: NESR systematic review

Conclusion Statement and Grade

No evidence is available to determine the relationship between maternal seafood intake during lactation and neurocognitive development in the child. Grade: Grade Not Assignable

Summary of the Evidence

- The Committee used the same seafood definition as that used in the *2015-2020 Dietary Guidelines for Americans*: Marine animals that live in the sea and in freshwater lakes and rivers. Seafood includes fish (e.g., salmon, tuna, trout, and tilapia) and shellfish (e.g., shrimp, crab, and oysters).⁴⁸
- Neurocognitive outcomes evaluated within this systematic review included developmental domains (i.e., cognitive, language and communication, movement and physical, social-emotional and behavioral development), academic performance, ADD or ADHD, anxiety, depression, and ASD.
- This review identified 0 studies published between January 2000 and October 2019 that met the inclusion criteria for this systematic review.

See ***Part D. Chapter 2: Food, Beverage, and Nutrient Consumption During Pregnancy***, Question 9, for a review that addressed maternal seafood consumption during both pregnancy and lactation, and pregnancy only, and neurocognitive developmental outcomes in the child.

For additional details on this body of evidence, visit: [nesr.usda.gov/2020-dietary-guidelines-advisory-committee-systematic-reviews/dietary-fats-and-seafood-subcommittee/seafood-pregnancy-lactation-infant-neurocognitive-development](https://www.nesr.usda.gov/2020-dietary-guidelines-advisory-committee-systematic-reviews/dietary-fats-and-seafood-subcommittee/seafood-pregnancy-lactation-infant-neurocognitive-development)

Question 7. What is the relationship between omega-3 fatty acids from supplements consumed during lactation and developmental milestones, including neurocognitive development, in the child?

Approach to Answering Question: NESR systematic review

Conclusion Statements and Grades

Insufficient evidence is available to determine the relationship between omega-3 fatty acid supplementation during both pregnancy and lactation or during lactation alone, and cognitive, language, motor, and visual development in the child. Grade: Grade Not Assignable

No evidence is available to determine the relationship between omega-3 fatty acid supplementation during both pregnancy and lactation or during lactation alone and academic performance, anxiety, depression, or the risk of attention-deficit disorder, attention-deficit/hyperactivity disorder, or autism spectrum disorder in the child. Grade: Grade Not Assignable

No evidence is available to determine the relationship between omega-3 fatty acid supplementation during lactation and social-emotional development in the child. Grade: Grade Not Assignable

Summary of the Evidence

- This systematic review included 8 articles from 4 RCTs published between 1980 and 2020.⁴⁹⁻⁵⁶
- Studies included in this review assessed interventions and exposures during:
 - Both pregnancy and lactation: 3 RCTs (6 articles)
 - Lactation alone: 1 RCT (2 articles)
- All 4 RCTs assessed cognitive development:
 - Three RCTs delivered omega-3 fatty acid supplements during both pregnancy and lactation. Of those 3 RCTs, 1 study reported at least one statistically significant finding that supplementation resulted in favorable cognitive development in the child. All 3 studies reported at least one statistically non-significant result.
 - One RCT delivered omega-3 fatty acid supplements during lactation alone and showed a benefit of supplementation on one measure of cognitive development in the child. The

study also reported statistically non-significant results on other measures of cognitive development.

- For language, motor, and social-emotional development, findings were inconsistent and therefore a conclusion statement could not be drawn. Although all studies reported at least one statistically non-significant result, the number and direction of statistically significant findings varied across the body of evidence.
- No evidence was available on omega-3 fatty acid supplementation and visual development, academic performance, anxiety, depression or the risk of ADD, ADHD, or ASD.
- The ability to draw strong conclusions was limited by the following issues:
 - Wide variation in the developmental domains assessed, as well as in the measures used to evaluate child performance in each of those domains, limited the ability to compare results across studies.
 - Missing outcome data raised concerns about risk of bias. Further, a lack of preregistered data analysis plans potentially increased the risk of bias due to selectivity in the results presented.
 - Findings were mixed both within and between studies, and these inconsistencies could not be explained by methodological differences.
 - Although some studies published results from multiple follow-up assessments, an insufficient number of studies were available to investigate the relationship between omega-3 fatty acid supplementation and developmental milestones in the child for many exposure-outcome pairs. Additionally, multiple studies did not provide evidence of sufficient sample size to detect effects, either because the study did not achieve the required sample size estimated by power calculations or because the study did not report a power calculation. This is particularly true for the long-term outcome assessments.
 - People with lower-SES, adolescents, and racially and ethnically diverse populations were underrepresented in the body of evidence.

See *Part D. Chapter 2: Food, Beverage, and Nutrient Consumption During Pregnancy*, Question 10, for a review of omega-3 fatty acid supplementation during both pregnancy and lactation, and pregnancy only, and neurocognitive outcomes in the child.

For additional details on this body of evidence, visit: [nesr.usda.gov/2020-dietary-guidelines-advisory-committee-systematic-reviews/pregnancy-and-lactation-subcommittee/omega-3-pregnancy-lactation-neurocognitive-development](https://www.nesr.usda.gov/2020-dietary-guidelines-advisory-committee-systematic-reviews/pregnancy-and-lactation-subcommittee/omega-3-pregnancy-lactation-neurocognitive-development)

Question 8. What is the relationship between folic acid from supplements and/or fortified foods consumed during lactation and: 1) maternal micronutrient status, 2) human milk composition, and 3) developmental milestones, including neurocognitive development, in the child?

Approach to Answering Question: NESR systematic review

Conclusion Statements and Grades

Maternal Micronutrient Status

Moderate evidence indicates that folic acid supplements consumed during lactation are positively associated with red blood cell folate, and may be positively associated with serum or plasma folate. Grade: Moderate

Insufficient evidence is available to determine the relationship between folic acid from supplements consumed during lactation and hemoglobin, mean corpuscular volume, and serum vitamin B₁₂. Grade: Grade Not Assignable

No evidence is available to determine the relationship between folic acid from supplements consumed during lactation and red blood cell distribution width. Grade: Grade Not Assignable

No evidence is available to determine the relationship between folic acid from fortified foods consumed during lactation and micronutrient status. Grade: Grade Not Assignable

Human Milk Composition

Moderate evidence indicates that folic acid supplements consumed during lactation does not influence folate levels in human milk. Grade: Moderate

No evidence is available to determine the relationship between folic acid from fortified foods consumed during lactation and human milk folate. Grade: Grade Not Assignable

Neurocognitive Development

No evidence is available to determine the relationship between folic acid from supplements or fortified foods consumed during lactation and developmental milestones, including neurobehavioral development, in the child. Grade: Grade Not Assignable

Summary of the Evidence

Maternal Micronutrient Status

- Five articles from 4 studies were identified through a literature search from 1980 to 2019 which met the criteria for inclusion in this systematic review.⁵⁷⁻⁶¹ Studies included in this review assessed interventions and exposures during lactation: 3 RCTs, 1 uncontrolled before-and-after study, and 1 PCS that was nested within one of the RCTs.
- Studies varied in intervention details. including:
 - Folic acid supplement type (folic acid or 5-methyltetrahydrofolate [5-MTHF])
 - Dose and comparator
 - Three RCTs and 1 PCS compared no folic acid supplementation to folic acid supplementation (300 µg/d to 1.0 mg/d)
 - One RCT also compared folic acid to 5-MTHF supplementation at the same dose (400 µg/d)
 - One uncontrolled before-and-after study compared folate levels before to after supplementation of 1.0 mg/d synthetic folic acid
 - Duration (1 month, 3 months, 4 months)
- Of the 5 outcome measures defined in the analytic framework, all but RBC distribution width were reported in the body of evidence.
- All studies found a significant association between folic acid supplementation and at least 1 outcome measure.
- All 4 studies assessed plasma or serum folate:
 - Four studies (5 articles: 3 RCTs; 1 PCS; 1 uncontrolled before-and-after study) assessed the relationship between folic acid from supplements during lactation. Two found that supplementation was associated with higher values on at least 1 measure of plasma/serum folate and two found no association.
- All 4 studies assessed RBC folate.

- All 4 studies (5 articles: 3 RCTs; 1 PCS; 1 uncontrolled before-and-after study) that assessed supplementation during lactation found that supplementation was associated with higher values on at least one measure of RBC folate.
- Two RCTs assessed hemoglobin. The findings were inconsistent and therefore a conclusion statement could not be drawn.
- One RCT each assessed the effect of supplementation on MCV or vitamin B₁₂ status; therefore, conclusions could not be drawn.
- This body of evidence had important limitations:
 - None of the studies preregistered data analysis plans, indicating a potential risk of bias due to selectivity in results presented.
 - Neither the PCS nor the uncontrolled before-and-after study adequately accounted for potential confounding.
 - Risk of bias due to classification of exposures or deviations from intended exposures was a concern for the cohort study and the uncontrolled before-and-after study.
 - The study populations did not fully represent the racial/ethnic or socioeconomic diversity of the U.S. population.
 - No studies that examined the effect of intake of folic acid from fortified foods on the outcome of interest met the inclusion criteria.

Human Milk Composition

- Four studies were identified through a literature search from 1980 to 2019 which met the criteria for inclusion in this systematic review: 3 RCTs and 1 uncontrolled before-and-after study.⁵⁹⁻⁶²
- Studies varied in intervention details, including folic acid supplement type (folic acid, 5-MTHF, or pteroylmonoglutamate), dose (300 µg/d, 400 µg/d, or 1 mg/d), time of initiation (1 to 25 weeks postpartum), duration (4 weeks, 12 weeks, or 16 weeks), and sample characteristics.
- As defined by the inclusion criteria, all studies took place in high or very high HDI countries⁶³; therefore, the participants were likely to be folate replete.
- None of the studies found an association between folic acid supplementation in women who were lactating and milk folate levels.
- This body of evidence had important limitations:

- In one of the 3 RCTs, the reference group was not recruited and randomized with the other 2 study groups. In another study, milk folate was significantly different between the control and intervention groups at baseline, and this was not controlled for in the analyses.
- Only 1 study reported a power calculation and that study did not reach the target sample size.
- The study populations did not fully represent the racial/ethnic or socioeconomic diversity of the U.S. population.

Neurocognitive Development

- The search identified 0 studies published between 1980 and 2019 that met the inclusion criteria.

See ***Part D. Chapter 2: Food, Beverage, and Nutrient Consumption During Pregnancy***, question 11 for a review that addressed maternal folic acid supplementation during pregnancy and select health outcomes.

For additional details on this body of evidence, visit: [nesr.usda.gov/2020-dietary-guidelines-advisory-committee-systematic-reviews/pregnancy-and-lactation-subcommittee/folic-acid-pregnancy-lactation-health-outcomes](https://www.nesr.usda.gov/2020-dietary-guidelines-advisory-committee-systematic-reviews/pregnancy-and-lactation-subcommittee/folic-acid-pregnancy-lactation-health-outcomes)

DISCUSSION

The 2020 Committee evaluated maternal dietary patterns during lactation, including frequency of eating, and their relationship to maternal PPWL. The Committee also examined the relationship between maternal folic acid supplementation and maternal micronutrient status. Maternal dietary patterns and folic acid supplementation also were considered in relation to human milk composition and quantity. In addition, maternal dietary patterns were examined in relation to child outcomes, including the risk of child food allergy and atopic allergic disease, and developmental milestones, such as neurocognitive development. The Committee also examined the relationship of maternal seafood consumption, omega-3 fatty acid supplementation, and folic acid supplementation during lactation with developmental milestones in the child. The following sections discuss the Committee's findings and in some cases highlight issues needing additional research; these research needs are articulated in ***Part E. Future Directions***.

Maternal Outcomes

Postpartum Weight Loss

Excess postpartum weight retention is common in the United States. For example, among 774 women in the National Institute of Child Health and Human Development Community Child Health Network, a national 5-site PCS in which the sample of women was predominantly low income, almost 50 percent had retained 10 or more pounds and about one-fourth had retained 20 or more pounds at 12 months postpartum compared to their prepregnancy weight.⁶⁴ Excess postpartum weight retention (≥ 20 pounds) was more likely among younger women, African-American women, and those who had gained more weight during pregnancy, whereas women who breastfed and exercised moderately lost more weight.

The determinants of PPWL are complex, as the period after childbirth is dynamic and includes potential changes in physical activity, appetite, sleep patterns, mental health status, and hormonal levels that influence eating behaviors and weight change.^{65,66} For example, maternal prolactin levels are very high during the first 2 to 3 months postpartum while lactation is being established, and this, together with other early postpartum hormonal changes may stimulate appetite.⁶⁷ Thereafter, the hormonal milieu shifts, including a decrease in prolactin levels, even though milk production (and thus energy output in milk) may be as high or higher than in early lactation; this is thought to help “reset” maternal appetite and metabolism and stimulate fat mobilization among women who continue to breastfeed.^{68,69}

Little information exists on dietary predictors of PPWL or weight retention.⁶⁵ Dietary patterns may play a role, but in its systematic review, the Committee identified only 1 study that examined dietary patterns during lactation in relation to PPWL.³¹ That study, an RCT of women who were lactating, was conducted in the United States and compared outcomes between those assigned to a Mediterranean-style diet, which emphasized nuts (especially walnuts), olive oil, and fruits and vegetables, or USDA’s MyPyramid diet. Women in both the MED (-251.2 kcal/d, $p=0.045$) and the MyPyramid (-437.5 kcal/d, $p=0.003$) diet groups reported reduced total energy intake compared to baseline. Participants in both diet groups demonstrated reductions ($p<0.001$) in body weight from baseline (-2.3 ± 3.4 kg and -3.1 ± 3.4 kg for the MED and comparison diets, respectively).³¹ However, PPWL between the two groups did not differ significantly, which is not surprising given that both diets would be considered “healthy” diets, and are composed of similar food groups.

Frequency of eating also may influence PPWL, though only 1 study on this question was identified. This study³² enrolled 60 lactating Swedish women who intended to breastfeed for 6 months. The study did not show a significant relationship between eating frequency and postpartum weight change in a 12-week intervention between 10 to 14 weeks and 22 to 26 weeks postpartum.

Future studies of PPWL during lactation should include careful assessment of dietary practices (using validated methods) and eating frequency (using the criteria described in **Part D. Chapter 13: Frequency of Eating**), and should take into account several potential confounders, including physical activity, eating away from home, exclusivity and duration of breastfeeding, sleep patterns, and psychosocial factors, including mental health status, race/ethnicity, maternal age, prepregnancy BMI, GWG, and SES. In addition, future studies should include information on food insecurity to distinguish between voluntary versus involuntary eating frequency behavior or restricted diets.

Maternal Micronutrient Status

The Committee evaluated the relationship between folic acid from supplements and/or fortified foods consumed before and during pregnancy and lactation and maternal health outcomes. No evidence was available to examine folic acid from fortified foods. The folate RDA is higher for women who are lactating than for women who are not, as the secretion of folate into breast milk increases the folate requirement.⁷⁰ The Committee did not evaluate any other supplement during lactation on maternal micronutrient status. Outcomes related to supplementation before and during pregnancy are summarized in **Part D. Chapter 2: Food, Beverage, and Nutrient Consumption During Pregnancy**. Four studies (5 articles) were included in the evidence portfolio for supplementation during lactation alone.

Three studies were RCTs conducted in the United States⁶⁰ and Canada,^{57,61} 1 PCS was conducted in Canada,⁵⁸ and 1 uncontrolled before-and-after study was conducted in Japan⁵⁹ with the primary outcomes of plasma or serum folate, hematological outcomes, and serum vitamin B₁₂. All studied folic acid supplements in the range of 300 to 1,000 µg/d and Houghton et al.⁵⁷ also included a group receiving 400 µg/d 5-MTHF. Duration of exposure varied (4 weeks, 12 weeks, or 16 weeks), and all were conducted within the first 25 weeks postpartum. Based on this evidence, the Committee concluded that moderate evidence indicated that folic acid supplementation during lactation is positively associated with maternal RBC folate and may be positively associated with maternal serum or plasma folate. The evidence was insufficient to

determine the relationship between folic acid from supplements consumed during lactation and maternal hemoglobin, MCV, and serum or plasma vitamin B₁₂. No evidence was available for the outcome of maternal red cell distribution width.

Human Milk Composition and Quantity

Maternal Dietary Patterns

As noted in the Introduction, only some of the components in human milk are affected by maternal dietary intake.²⁴ The Committee sought to determine the relationship between patterns of maternal dietary intake consumed during lactation and components of human milk. The evidence base included 3 RCTs that investigated maternal diets with a macronutrient distribution outside of the AMDR and 2 cross-sectional studies that investigated maternal dietary patterns.

Based on this body of evidence, the Committee drew two conclusions relative to fat and fatty acid composition of human milk. First, maternal consumption of diets higher in fat (>35 percent fat) and lower in carbohydrate during lactation is related to higher total fat in human milk collected in the maternal postprandial state, a conclusion supported by 3 RCTs. In addition, certain maternal dietary patterns during lactation, including maternal diets based on macronutrient distributions, may be related to the relative proportions of saturated fat and monounsaturated fat in human milk, and of polyunsaturated fat in human milk collected in the maternal postprandial period, a finding that was supported by 3 RCTs and 2 cross-sectional studies. These conclusions were graded as limited due to concerns about randomization (for RCTs), minimal information on maternal dietary intake and supplement use, variability in stage of lactation, and variability in timing of milk sample collection.

The 3 RCTs reported that total human milk fat was higher after the women consumed a higher fat diet or full-fat dairy diet. However, the specific fatty acids that differed depending upon whether the milk samples were collected in a fed or fasted state, which likely reflects differences in the physiological sources of milk fatty acids. For example, using stable isotopes, Hachey demonstrated that a delay of about 6 hours occurred between ingestion of a fat and its appearance in human milk.⁷¹ Medium-chain fatty acids (MCFA) (e.g., C:6 to C12:0) are synthesized in the mammary gland through *de novo* fatty acid synthesis,⁷² whereas *de novo* synthesis of long-chain fatty acids (LCFA) (e.g., C16:0 and C18:0) in the human mammary gland is limited, even on a low-fat diet.⁷³ The long chain polyunsaturated fatty acids, DHA,

eicosapentaenoic acid (EPA), and arachidonic acid (AA) in human milk, are acquired from the maternal diet.²³ Mohammed et al.³⁴ conducted a crossover study, and reported data from the same women in the fed and fasted state. They showed that primarily MCFAs were higher in the milk when the women were fed a low-fat (25 percent of energy as fat) vs a high-fat (55 percent) diet, in both the fed and fasted state. These findings suggested enhanced *de novo* fatty acid synthesis of MCFAs when maternal dietary fat is restricted. For fatty acids with limited mammary synthesis (e.g., C16:0 to C18:3), milk concentrations were higher in the milk when women were consuming the high-fat diet, but only in the fed state.³⁴ Nasser et al.³⁶ compared the milk fatty acid composition of women fed low-fat (14 percent of energy as fat) vs high-fat (40.2 percent of energy as fat) diets, but did not report whether milk was collected when women were in a fed or fasted state. Consistent with Mohammed et al., milk monounsaturated fat (C:6 to C:12) concentrations were higher when women were on the low-fat diet. Some of the longer chain fatty acids, such as stearic acids (C18:0), α -linolenic acid (C18:3n:3), arachidic acid (C20:0) and eicosenoic acid (C20:1n-9), were higher in milk when women were consuming the high-fat diet.³⁶ Lastly, Yahvah³⁸ compared the human milk fat composition when women were consuming a lower fat (24 percent of energy as fat) vs a higher fat diet (36 percent of energy as fat) as a result of consuming low-fat vs high-fat dairy foods. Monounsaturated fat content was unaffected by the maternal diet, and some, but not all, fatty acids of chain length longer than C12 were higher during the high fat dairy diet, reflecting dietary fat intake.

Two cross-sectional studies assessed dietary patterns. Perrin et al.³³ compared human milk fat composition of U.S. women consuming vegan, vegetarian, or omnivore dietary patterns. The milk of vegan women had significantly higher unsaturated fatty acids and total omega-3 fatty acids, and lower saturated fats, trans fat, omega-6 to omega-3 fatty acid ratios, and linoleic acid to α -linoleic acid ratios than did milk produced by vegetarian or omnivore women. However, maternal DHA/EPA supplement usage differed between the groups (vegan: 26.9 percent, vegetarian: 9.1 percent, omnivore: 3.9 percent), which confounded the analysis. Tian³⁵ reported human milk fat concentration in Chinese women categorized into four dietary patterns using factor analysis. Differences in milk total saturated, total polyunsaturated fat, and n-6 content were observed among women in these groups, but these maternal dietary patterns may not be generalizable to diets consumed in the United States.

Insufficient or no evidence was available to assess the association between maternal dietary patterns and human milk quantity and human milk composition of total protein, water-soluble vitamins (B, C, and choline), fat-soluble vitamins (A, D, E, and K), minerals (iodine and

selenium), human milk oligosaccharides, and bioactive proteins. Pawlak³⁹ measured vitamin B₁₂ in the milk samples of U.S. omnivore, vegetarian, or vegan women studied by Perrin.³³ Although about 20 percent of human milk samples had low vitamin B₁₂ concentrations, they did not differ by maternal dietary pattern. These findings contrast older reports of reduced human milk vitamin B₁₂ content in vegan women and B₁₂ deficiency in infants of vegan women.^{74,75} However, vitamin B₁₂ supplement use was low at the time of those studies and analytical methods did not account for matrix effects of human milk on the measurement of B₁₂ concentrations. Similar to the situation regarding DHA/EPA supplementation, more vegan (46 percent) and vegetarian (27 percent) women who were lactating reported consuming a B₁₂ supplement than did omnivorous women (4 percent), which was not accounted for in the analysis. In addition, about 55 percent of the women in all 3 groups continued to take a prenatal supplement. Thus, the high prevalence of supplement use likely attenuated differences by maternal dietary pattern.

Maternal Folic Acid Supplementation

The Committee investigated the relationship between folic acid from supplements consumed before and during pregnancy and lactation and human milk composition. Three RCTs conducted in the United States⁶⁰ and Canada,^{57,61} and one uncontrolled before-and-after study conducted in Japan⁵⁹ reported human milk folate concentrations. All four studies reported human milk folate concentrations and Mackey also reported unmetabolized human milk folic acid and soluble human milk folate binding protein concentrations. None of the studies found an association between folic acid supplementation in women who were lactating and milk folate levels. Thus, the Committee concluded that consumption of folic acid supplements during lactation does not influence folate levels in human milk. This finding is consistent with the categorization of folate as one of the nutrients (i.e., calcium, copper, folate, iron, zinc) in human milk that are generally independent of maternal status and for which maternal supplementation does not increase milk concentrations.²⁴ The overall grade for the evidence was moderate. The RCTs were graded as strong for consistency, precision and directness, but generalizability was graded as limited, as 75 percent of the studies were in White females, a majority held college degrees, and most participants were of relatively high SES.

Child Health Outcomes

Maternal Diet and Child Food Allergy and Atopic Allergic Diseases

The Committee evaluated how maternal diet during pregnancy and/or lactation is related to the risk of child food allergy and atopic allergic diseases, including atopic dermatitis, allergic rhinitis, and asthma. Conclusion statements for exposures during pregnancy alone or both pregnancy and lactation are summarized in **Part D. Chapter 2**. Of the 8 articles included in the review that were conducted during both pregnancy and lactation, or lactation alone, only 1 RCT⁴⁴ and 1 PCS study⁴⁵ were identified that studied the lactation period alone.

The RCT randomized 62 Thai lactating women with a history of allergy to a diet that restricted dairy products (vs usual diet) from birth to 4 months postpartum. Infants in the intervention group had a significantly lower incidence of atopic dermatitis (6.67 percent) at age 4 months than did infants in the control group (25 percent).⁴⁴ Based on this single study, the Committee concluded that insufficient evidence was available to determine the relationship between maternal dietary patterns or maternal consumption of any of the food components studied and the risk of atopic dermatitis/eczema, food allergy, or allergic rhinitis in the child.

Lumia et al. explored the association between maternal dietary intake during month 3 of lactation and asthma risk in the child at age 5 years.⁴⁵ Of the 6 dietary components assessed, only 1, maternal use of margarines, was found to have a weak association with increased asthma risk in the child at age 5 years. Therefore, the Committee concluded evidence was insufficient to determine the relationship between maternal consumption of fish, cow milk products, meat, and meat products, and fats such as margarine, oil, and butter, with risk of asthma in the child. In addition, no evidence was available to assess maternal dietary patterns or consumption of eggs, peanuts, tree nuts, seeds, and soybeans on asthma risk. These findings support the conclusions of the AAP⁷⁶ and the European Academy of Allergy and Clinical Immunology⁷⁷ that maternal dietary restrictions during lactation do not prevent the development of atopic disease in the infant and child.

Maternal Diet and Neurocognitive Development

Maternal Dietary Patterns

No studies examining the relationship between maternal dietary patterns during lactation and neurocognitive development of the child met inclusion criteria. Further research is needed on maternal dietary patterns during lactation that emphasize foods rich in certain key nutrients, namely those that are important for brain development, and for which a relationship between maternal intake and human milk composition exists. Nutrients meeting both of these criteria include omega-3 polyunsaturated fatty acids, choline, iodine, and the B vitamins.^{21,78}

Maternal Seafood Consumption

No studies examining the relationship between seafood consumption during lactation and neurocognitive development in the child met inclusion criteria. All the seafood reviews by recent Dietary Guidelines Advisory Committees (see **Part D. Chapter 9: Dietary Fats and Seafood** for discussion on previous Committees' reviews of seafood) found a notable lack of data to inform decisions and recommendations for women who are lactating. Despite this, the totality of existing evidence supports consumption during lactation of fish and seafood that are known to be higher in DHA and EPA and lower in methylmercury as part of an overall healthy dietary pattern, as has been previously recommended in the *2015-2020 Dietary Guidelines for Americans*⁴⁸

Maternal Omega-3 Fatty Acid Supplementation

The Committee examined whether omega-3 fatty acid supplementation during pregnancy and/or lactation is related to neurocognitive development of the child. Much less evidence was available for lactation than for pregnancy (see **Part D. Chapter 2: Food, Beverage, and Nutrient Consumption During Pregnancy**, Question 10). The search revealed 4 eligible RCTs (7 articles) that included supplementation during lactation, conducted in Norway,^{49,54,55} the Netherlands,^{53,56} Germany,⁵² and the United States.^{50,51} In 3 of these, supplementation began at 15 to 19 weeks gestation and continued to 3 to 4 months postpartum.^{49,52-56} In the fourth trial, supplementation began at 5 days postpartum and continued to 4 months postpartum.^{50,51} Outcomes were assessed at various ages, from infancy to a maximum age of 18 months,⁵³ 5 years,^{50,52} or 7 years.⁴⁹ The types and dosages of supplements provided were heterogeneous: 1 trial provided cod liver oil,^{49,54,55} 1 provided 220 mg DHA plus 220 mg of AA,^{53,56} 1 provided

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1,020 mg of DHA, 180 mg of EPA, and 9 mg of vitamin E⁵² and 1 provided 200 mg of DHA.^{50,51} The number of women enrolled ranged from 119 to 149.

Cognitive development was assessed in all 4 trials. One study^{49,54} found a favorable effect of supplementation on one measure of intelligence at age 4 years, but no significant effect at age 7 years. Another study^{50,51} reported a favorable effect of supplementation on one measure of sustained attention at age 5 years, but no association with multiple measures of cognitive development at ages 12 months, 2.5 years, and 5 years. The other 2 trials found no significant effect of the intervention.^{52,53} Given the mixed results, the small number of studies, relatively small sample sizes, risk of bias due to several study limitations, and limited information on the generalizability of results to the general U.S. population, the Committee judged that evidence was insufficient to determine the relationship between omega-3 fatty acid supplementation during both pregnancy and lactation, or during lactation alone, and cognitive development in the child.

The evidence base was even more limited, and also mixed, for language development (2 trials), motor development (3 trials), visual development (1 trial), and socio-emotional development (1 trial). For several outcomes (academic performance, anxiety, depression, ADD, ADHD, and ASD), no evidence was available from these trials. Thus, the Committee concluded that either insufficient or no evidence was available to determine the relationship between omega-3 fatty acid supplementation during both pregnancy and lactation, or during lactation alone, and these outcomes.

These conclusions are consistent with those of a Cochrane systematic review and meta-analysis published in 2015,⁷⁹ which stated that “there is inconclusive evidence to support or refute the practice of giving LC-PUFA supplementation to breastfeeding mothers in order to improve neurodevelopment or visual acuity.” A review in 2016⁸⁰ came to a similar conclusion.

Despite the inconclusive nature of the evidence on this question, it is clear that an adequate supply of LC-PUFA, particularly DHA, to the infant is critical for brain development of the infant and child.^{80,81} Accumulation of DHA in the brain is most rapid during the second half of gestation and the first year after birth. As noted in the findings of the systematic review on maternal dietary patterns and human milk composition, the fatty acid content of the maternal diet affects the concentrations of fatty acids in human milk, including DHA. The effects of omega-3 fatty acid supplements provided to the lactating women on neurocognitive development of the child likely depends on the baseline omega-3 fatty acid adequacy of her diet as well as the ability of the infant and child to produce LC-PUFA from their precursor fatty acids in an amount sufficient to

support optimal development of the central nervous system.⁸² Thus, further evidence is needed from RCTs that are adequately powered and targeted at populations with low intakes of omega-3 fatty acids.

Maternal Folic Acid Supplementation

Folate is naturally present in some foods, added to others, and available as a dietary supplement. Food folates are in the tetrahydrofolate (THF) form and contain different numbers of glutamic acids depending on the type of food. Folic acid is the fully oxidized monoglutamate form of the vitamin that is used in fortified foods and most dietary supplements.⁸³ Folate plays a role in numerous biochemical pathways that affect brain development and function, including neural stem cell proliferation and differentiation, regulation of gene expression, neurotransmitter synthesis, and myelin synthesis and repair.⁸⁴ In particular, folate deficiency due to diet⁸⁵ or genetics⁸⁶ can disrupt myelination in the brain. Myelin is the supportive tissue that surrounds and protects the nerve cells and facilitates communication, and disruptions in myelination can have significant effects on central nervous system functioning by altering the speed of conduction in multiple systems. The acquisition of cognitive skills coincides with the pattern of central nervous system myelination. Therefore, retardation of myelination of the brain in infancy leads to delayed acquisition of cognitive skills.⁸⁷ Genetic polymorphisms in genes for enzymes in the folate-homocysteine pathway also have been associated with behavior in children with ADHD.⁸⁴ However, no studies examining the relationship between maternal folic acid supplementation during lactation and neurocognitive development of the child met inclusion criteria. Given that the systematic review undertaken by the Committee showed no effect of folic acid supplementation on human milk folate, further research in this area is not warranted. Instead, future research should focus on maternal dietary patterns during lactation that emphasize foods rich in certain key nutrients, namely, those that are important for brain development, and for which a relationship between maternal intake and human milk composition exists.

SUMMARY

This is the first Dietary Guidelines Advisory Committee to conduct a series of reviews focused on women who are lactating. However, the 3 most recent editions of the *Dietary Guidelines for Americans* have provided some guidance on specific foods, food components, or nutrients and lactation outcomes, including: alcohol (2005, 2010, 2015)^{48,88,89}; caffeine (2015)⁴⁸; and seafood (2010, 2015)^{48,88}; maintaining energy balance (2010)⁸⁸; healthy weight (2010)⁸⁸; and physical activity (2005)⁸⁹. The 2010 Committee examined several relationships that were not included in the final *Dietary Guidelines for Americans*; these included associations between specific foods, food components, or nutrients (including DHA) and lactation outcomes (including human milk composition), as well as the relationship between lactation and PPWL.

The 2020 Committee re-examined seafood consumption and omega-3 fatty acid supplements, but did not specifically examine alcohol, caffeine, or physical activity. This Committee examined several new relationships of maternal dietary patterns and frequency of eating with PPWL, and of maternal dietary patterns with human milk composition and quantity. In addition, for the first time, the Committee examined relationships between maternal dietary patterns and/or consumption of specific foods and dietary supplements during lactation and food allergy, atopic conditions, and neurodevelopment in children.

Nutrient requirements during lactation are intended to support the nutritional status of the woman and to provide the additional amounts of energy and nutrients associated with milk synthesis and the secretion of nutrients into human milk. A woman's nutritional and metabolic status before and during pregnancy is linked with lactation success and long-term metabolic health. Women who are lactating have a higher average Healthy Eating Index (HEI) Score (i.e., 62 out of 100) than do women of a similar age who are not pregnant or lactating (i.e., 54). The higher mean score is driven by higher HEI component scores for Total Fruits, Greens and Beans, Whole Grains, Fatty Acids, and Seafood and Plant Proteins, combined with higher HEI moderation component scores for Refined Grains, Added Sugars, and Saturated Fats. However, women who are lactating have lower component scores than their peers (women who are pregnant and those who are neither pregnant nor lactating) for Total Vegetables, Dairy, and Sodium. Additionally, nearly 1 in 6 women who are lactating consume Total Protein Foods in amounts less than those recommended in the USDA Food Patterns (**see Part D. Chapter 1: Current Intakes of Foods, Beverages, and Nutrients**, Question 3 for additional information about the HEI).

Mean usual intakes of select underconsumed and overconsumed nutrients by lactating and non-pregnant, non-lactating women in the U.S., based on the What We Eat in America, NHANES 2013-2016 data, are summarized in Table D3.1. The definitions of underconsumed and overconsumed nutrients or food components can be found in **Part D. Chapter 1** and in the footnotes of Table D3.1. Nutrients or food components of public health concern are those that are underconsumed or overconsumed nutrients or food components with supporting evidence through biochemical indices or functional status indicators, if available, plus evidence that the inadequacy or excess is directly related to a specific health condition (**see Part D. Chapter 1**). Food components of public health concern among women who are lactating include those for the entire population older than 1 year, including vitamin D, calcium, dietary fiber and potassium, which are underconsumed and sodium, saturated fat and added sugars, which are overconsumed (Table D3.1). In addition, diet analysis results showed that 5 percent or more of women who are lactating have intakes below the EAR for folate, magnesium, copper, thiamin, vitamin A, and zinc. Vitamin D, folate/folic acid and zinc are unique in that >5 percent of women are not meeting the EAR from foods alone, but the use of dietary supplements by women who are lactating can lead to some women exceeding the UL (Table D3.1). Iron may be overconsumed by women who are lactating, with 29 percent of those taking supplements exceeding the UL compared to <3 percent of women who are lactating who are not taking supplements (Table D3.1). Lastly, choline and magnesium are underconsumed in the diets of women who are lactating and should be considered for further evaluation, given limited availability of biomarker, clinical, or health outcome data (**see Part D. Chapter 1**). These data suggest that, while women apparently seek to improve their diets during lactation, further improvements are needed to better align with dietary recommendations and avoid under- or overconsuming nutrients and food components.

Table D3.1 Mean usual intake of select underconsumed and overconsumed nutrients, by lactation status, in the United States, 2013-2016¹

		Lactating		Non-Lactating²	
		Food and Beverages (n=78)	Food, Beverages, and Dietary Supplements (n=77)	Food and Beverages (n=2060)	Food, Beverages, and Dietary Supplements (n=2019)
<u>Potentially underconsumed:</u>					
Choline (mg)	Mean (SE)	366 (21)	370 (18)	290 (4)	293 (4)
	% >AI (SE)	14† (5.1)	6† (2.2)	7 (1.1)	7 (1.0)
Dietary fiber (g)	Mean (SE)	21.2 (1.0)	n/a	15.4 (0.4)	n/a
	% >AI (SE)	20* (4.2)	n/a	7 (1.2)	n/a
Potassium (mg)	Mean (SE)	2773 (135)	n/a	2277 (42)	n/a
	% >AI (SE)	46 (8.0)	n/a	28 (2.6)	n/a
Vitamin E (mg)	Mean (SE)	11.9 (1.0)	n/a	8.6 (0.2)	n/a
	% <EAR (SE)	71 (7.9)	n/a	85 (2.1)	n/a
Vitamin C (mg)	Mean (SE)	86.8 (7.6)	155.5 (12.6)	72.5 (2.5)	122.3 (6.9)
	% <EAR (SE)	53 (6.8)	34 (4.5)	46 (2.5)	37 (1.9)
Vitamin A (µg RAE)	Mean (SE)	845 (52)	n/a	559 (15)	n/a
	% <EAR (SE)	40 (8.0)	n/a	46 (2.3)	n/a
Magnesium (mg)	Mean (SE)	363 (14)	378 (18)	270 (4)	284 (5)
	% <EAR (SE)	14† (3.2)	13† (3.0)	49 (2.2)	46 (2.1)
Calcium (mg)	Mean (SE)	1163 (72)	1361 (84)	869 (11)	948 (13)
	% <EAR (SE)	13† (4.6)	8† (2.8)	44 (1.8)	38 (1.8)
Copper (mg)	Mean (SE)	1.5 (0.09)	1.9 (0.18)	1.1 (0.02)	1.3 (0.03)
	% <EAR (SE)	7† (2.9)	11† (3.3)	11 (1.1)	10 (1.0)
Thiamin (mg)	Mean (SE)	1.80 (0.10)	2.77 (0.16)	1.41 (0.02)	3.01 (0.23)
	% <EAR (SE)	5† (2.4)	4† (2.2)	8 (1.6)	7 (1.3)
<u>Potentially underconsumed and overconsumed:</u>					
Vitamin D (µg)	Mean (SE)	6.3 (0.8)	23.4† (9.0)	4.0 (0.1)	13.2 (1.3)

	% <EAR (SE)	89† (5.5)	38 (6.2)	>97	73 (1.4)
	% >UL (SE)	<3	7† (6.3)	<3	<3
Folate (µg DFE)	Mean (SE)	665 (61)	1408 (86)	466 (8)	640 (15)
	% <EAR (SE)	9† (4.4)	7† (2.8)	18 (1.9)	14 (1.6)
Folic acid (µg)	Mean (SE)	224 (27)	660 (51)	158 (4)	261 (8)
	% >UL (SE)	<3	24 (6.2)	<3	<3
Zinc (mg)	Mean (SE)	12.8 (0.9)	24.5 (1.8)	9.6 (0.1)	12.0 (0.3)
	% <EAR (SE)	13† (6.0)	12† (5.1)	14 (1.9)	12 (2.1)
	% >UL (SE)	<3	11† (4.5)	<3	<3
<u>Potentially overconsumed:</u>					
Iron (mg)	Mean (SE)	17.0 (1.2)	35.9 (2.5)	12.4 (0.2)	16.2 (0.5)
	% >UL (SE)	<3	29† (5.3)	<3	<3
Sodium (mg)	Mean (SE)	3880 (167)	n/a	3191 (41)	n/a
	% >AI (SE)	>97	n/a	>97	n/a
	% >CDRR (SE)	97† (2.1)	n/a	85 (1.8)	n/a

AI=Adequate Intake; CDRR=Chronic Disease Risk Reduction; EAR=Estimated Average Requirement; UL=Tolerable Upper Intake Level

Underconsumed=A nutrient that is underconsumed by 5 percent or more of the population or specific groups relative to the EAR, AI, or other quantitative authoritative recommendations from the diet alone. Overconsumed=A nutrient that is consumed in potential excess of the UL, CDRR, or other quantitative authoritative recommendations by 5 percent or more of the population or in specific groups from the diet alone. For more information see: Table D 1.1 Framework to Begin the Process of Identifying Nutrients and Other Food Components as Underconsumed, Overconsumed, or of Potential Public Health Concern

¹Adapted from What We Eat in America, NHANES 2013-2016 Usual Nutrient Intake from Food and Beverages, and Total Usual Nutrient Intake from Food, Beverages, and Dietary Supplements, by Pregnancy and Lactation Status for Females 20 to 44 years of age ^{90,91}

²Includes all women who are not lactating and are not pregnant

†Estimate may be less reliable due to small sample size and/or large relative standard error

Maternal Dietary Patterns and Frequency of Eating

As stated in the 2015 Committee report, “foods are generally not consumed in isolation, but rather in various combinations over time. In addition, dietary components of an eating pattern can have interactive, synergistic, and potentially cumulative relationships, such that the eating pattern may be more predictive of overall health status and disease risk than individual foods or nutrients”.⁹²

The 2020 Committee was unable to draw conclusions regarding maternal dietary patterns or frequency of eating during lactation and PPWL due to a lack of evidence. In addition, either insufficient or no evidence was available to determine the relationship between overall maternal dietary patterns and any component of human milk composition. Intervention studies that experimentally manipulated dietary fat content showed differences in milk fat content and composition. Diets containing more than 35 percent of energy from fat and that were lower in carbohydrate during lactation were related to higher total fat in human milk when milk was collected in the maternal postprandial period. In addition, diets based on different macronutrient distributions were related to the relative proportions of saturated fat and MCFAs in human milk, and of polyunsaturated fatty acids in human milk collected in the maternal postprandial period. The 2010 Committee investigated the association between maternal dietary intake of omega-3 fatty acids from seafood and breast milk composition and health outcomes in infants.⁹³ They concluded that moderate evidence indicates that increased maternal dietary intake of long-chain omega-3 fatty acids, in particular DHA, from at least 2 servings of seafood per week during pregnancy and lactation is associated with increased DHA levels in human milk (results for infant outcomes will be described below). These findings are consistent with systematic reviews showing that human milk fat composition is related to maternal dietary intake⁹⁴ and that maternal fish consumption is associated with DHA concentration in human milk.⁹⁵ Taken together, evidence indicates that maternal diet influences human milk fat content and composition and that women who are lactating can increase the DHA content of their milk by consuming seafood.

In terms of infant outcomes, no evidence was available to determine a relationship between dietary patterns during lactation and child developmental outcomes. In addition, evidence was lacking or insufficient to determine whether dietary patterns or consumption or avoidance of specific foods, even common allergens, are related to any of the four outcomes investigated (food allergy, atopic dermatitis, allergic rhinitis, or asthma). These findings are similar to those of the AAP Committee on Nutrition and Section on Allergy and Immunology,⁷⁶ which published a

clinical report that does not recommend maternal restriction during lactation as an atopy prevention strategy. Given current AAP recommendations and the systematic review results of this report, the Committee does not support restriction of potential allergens in maternal diets during lactation, unless the woman is allergic to the foods. Rather, the findings of the Committee support the need for women who are lactating to consume an overall healthy dietary pattern that includes these foods, as they are important sources of potentially underconsumed nutrients, such as calcium, choline, magnesium, and vitamin D.

While the Committee was unable to establish relationships between maternal dietary patterns during lactation and the outcomes investigated, the Committee did find evidence to recommend certain dietary patterns during *pregnancy* (see **Part D. Chapter 2: Food, Beverage, and Nutrient Consumption During Pregnancy**). The beneficial dietary patterns were higher in vegetables, fruits, whole grains, nuts, legumes, fish, and vegetable oils, and lower in processed meat and refined grains. These foods are consistent with those present in dietary patterns associated with lower overall chronic disease risk in women who are *not pregnant or lactating* (see **Part D. Chapter 1: Current Intakes of Foods, Beverages, and Nutrients** and **Part D. Chapter 8: Dietary Patterns**). Taken together, these findings support relatively consistent dietary patterns associated with healthy outcomes in women of reproductive age.

Food Pattern Modeling exercises showed that each of the 3 Food Patterns styles (**Healthy U.S.; Healthy Vegetarian or Healthy Mediterranean**) described in **Chapter 14: USDA Food Patterns for Individuals Ages 2 Years and Older** is expected to meet nutrient needs for women who are lactating with the possible exception of choline and vitamins A, D and E. Thus, these patterns will provide many of the nutrients that are commonly underconsumed by women who are lactating. Therefore, the Committee recommends that women who are lactating choose foods consistent with these dietary patterns and specifically incorporate foods that are rich in choline and vitamins A, D and E, such as seafood, eggs, fortified milk, nuts, seeds and vegetable oils (see **Part D. Chapter 1: Current Intakes of Foods, Beverages, and Nutrients**).

Seafood and Omega-3 Fatty Acid Supplements

The 2020 Committee evaluated the evidence as to whether maternal seafood consumption or omega-3 fatty acid supplementation, are related to neurocognitive outcomes in the child. The Committee concluded that no evidence is available to determine relationships between seafood consumption during lactation and any measure of neurocognitive development the Committee

assessed. The Committee also concluded that moderate evidence suggested that seafood intake *during pregnancy* may be associated favorably with measures of cognitive, language, and communication development in the child (see **Part D. Chapter 2**, Question 9). Although the Committee's systematic review did not identify evidence for associations between seafood consumption during lactation and neurocognitive outcomes in the child, seafood choices, particularly those that are low in methylmercury content, are important components of a healthy dietary pattern for women who are not pregnant as well as for those who are pregnant. Seafood may increase the DHA content of human milk and provides potential underconsumed nutrients for women who are lactating. Therefore, the Committee concurs with recommendations from the *2015-2020 Dietary Guidelines for Americans*,⁴⁸ the Food and Drug Administration, and the Environmental Protection Agency,⁹⁶ which are that women who are lactating should consume at least 8 and up to 12 ounces of a variety of seafood per week, from choices that are lower in methylmercury and higher in omega-3 fatty acids. Women who are lactating should limit intake of seafood choices that may be high in environmental contaminants.⁹⁷

In terms of omega-3 fatty acids from supplements during both pregnancy and lactation, or lactation alone, and neurocognitive outcomes in the child, the Committee evaluated the evidence from a total of 4 RCTs and 1 PCS, but only 1 RCT investigated supplementation during lactation alone. Findings were mixed, both within and between studies, and an insufficient number of studies were available to investigate the relationship between omega-3 fatty acid supplementation and developmental milestones in the child for many exposure-outcome pairs. Therefore, the Committee concluded that evidence was insufficient for cognitive, language, motor, and visual development outcomes and evidence was lacking for any other outcome investigated. As a result, the Committee is unable to make a specific recommendation about routine supplementation with omega-3 fatty acids during lactation.

Folic Acid Supplements

The Committee evaluated the associations between maternal folic acid intake from supplements and maternal folate status, human milk composition, and child neurodevelopmental outcomes. Moderate evidence indicated that in women who are lactating, consuming folate supplements resulted in higher serum and RBC folate concentrations, but no difference in human milk folate concentrations, compared to non-supplement users. No evidence was available for effects of folic acid from supplements on child neurodevelopmental outcomes.

Dietary intakes of folate are generally low and folate status may be compromised in some groups of women (see **Part D. Chapter 1**), so continued attention to intake is warranted. However, the RDA for folate is lower during lactation than during pregnancy. Based on maternal dietary intake data, 9 percent of women who are lactating have folate intakes less than the Estimated Average Requirement (EAR), which is reduced to 7 percent in those taking supplements. Conversely, 24 percent of women who are lactating and taking folic acid supplements have folate intakes exceeding the Tolerable Upper Intake Level (UL) (see **Part D. Chapter 1**).

These findings are in agreement with the analysis of nutrient intakes of women who are pregnant or lactating using NHANES 1999-2014 data.¹⁸ Supplement use among women who are lactating was high (70 percent) and more than half continued to use prenatal supplements. The folate and iron intake from supplements alone exceeded the RDA for these micronutrients by 2.4-fold and 3.7-fold, respectively.¹⁸ The Committee encourages women who are lactating to consume foods high in folate, including those fortified with folic acid, as part of a healthy dietary pattern. These foods may include fortified foods, dark green and leafy vegetables, and legumes. However, caution is warranted about continued use of prenatal supplements during lactation due to their high levels of folic acid and iron.

Other Nutrients from Supplements and/or Fortified Foods

This Committee did not study questions related to dietary supplements and/or fortified food sources of vitamins B₁₂ and D, iron, and iodine. Vitamin D is considered a nutrient of public health concern for women who are lactating (see **Part D. Chapter 1**). Over supplementation with iron and folic acid is a potential concern for women who are lactating. Including nutrients from dietary supplements, 29 percent and 24 percent of women who are lactating are exceeding recommendations for iron and folic acid, respectively (see **Part D. Chapter 1**). Given that these high intakes have not been directly linked with clinical outcomes, these are not designated of public health concern but warrant monitoring.

Less than 3 percent of women in who are lactating have vitamin B₁₂ intakes below the EAR.⁹⁸ However, low concentrations of vitamin B₁₂ have been reported in the serum and human milk of mothers consuming vegan dietary patterns without B₁₂ supplementation.⁷⁵

Iodine and vitamin D are nutrients that have few dietary sources, in the absence of fortification. Thus, consumption of fortified foods and supplements may be the primary way to achieve adequate intakes of these nutrients, though the addition of seafood to the diet (for

iodine) and some sunlight exposure (for vitamin D) will also help meet requirements. The current EAR for vitamin D for women who are lactating is 400 IU (10 µg).⁹⁹ Currently 89 percent of women in this population are consuming less than the EAR from food. When food and supplements are both considered, 38 percent of women who are lactating are still consuming less than the EAR.⁹⁸ Vitamin D supplementation in the 400 to 2,000 IU (10 to 50 µg) range is not sufficient to produce human milk concentrations that are adequate to meet the vitamin requirement of an exclusively breastfed infant. Daily maternal vitamin D supplementation at 6,400 IU was required to achieve milk concentrations high enough to meet the infant AI of 400 IU (10 µg).¹⁰⁰ Given the importance of these nutrients to achieve optimal maternal nutrient status and human milk composition for the recipient infant, and the fact that they are all nutrients of concern among females of reproductive age, additional attention should be given to these nutrients during the development of future Dietary Guidelines.

Strategies for Women Who Are Lactating

A variety of strategies can help women who are lactating achieve food and nutrient intakes that promote optimal outcomes for them and their children. These strategies include:

1. Encourage women who are lactating to consume a wide variety of foods that are consistent with the dietary patterns described in **Chapter 14: USDA Food Patterns for Individuals Ages 2 Years and Older**
2. Encourage consumption of foods and beverages that are good sources of potentially underconsumed nutrients identified in **Part D. Chapter 1** or that are lower than recommended for women who are lactating in the USDA Food Patterns, including choline, magnesium, protein, fiber, and vitamins A, D, and E.
3. Encourage women to discontinue the use of prenatal high iron dose supplements during lactation unless they are medically indicated, as these supplements are usually formulated to meet the high iron requirements of pregnant women, not to meet the nutritional requirements for lactating women and can therefore result in iron intakes above the UL.
4. Encourage women to not avoid potential allergenic foods during lactation, unless it is medically indicated to protect the mother's health.
5. Encourage women to follow guidance from the 2015 Dietary Guidelines Advisory Committee⁹² and the AAP¹⁰¹ that, "women who are breastfeeding should consult with

their health care provider regarding alcohol consumption.” This Committee did not review evidence regarding alcoholic beverage consumption by lactating women, but supports this prior guidance.

6. Encourage women to follow guidance from the 2015 Dietary Guidelines Advisory Committee⁹² that “...those who are breastfeeding should consult their health care providers for advice concerning caffeine consumption.” This Committee did not review evidence regarding caffeine consumption. Insufficient high-quality data are available to make evidence-based recommendations on safe maternal caffeine consumption.¹⁰² Lactating women who are consuming caffeine in foods or beverages may want to monitor the behavior of their infant for fussiness, jitteriness, or poor sleep patterns and adjust their caffeine intake accordingly. The Committee supports this guidance.
7. Encourage women who are breastfeeding to consume seafood in accordance with recommendations by the *2015-2020 Dietary Guidelines for Americans*,⁴⁸ the Food and Drug Administration, and the Environmental Protection Agency: at least 8 and up to 12 ounces of a variety of seafood per week, from choices that are lower in methylmercury and higher in omega-3 fatty acids.
8. Encourage women to maintain a healthy pre-pregnancy weight, achieve appropriate weight gain during pregnancy, initiate and maintain breastfeeding throughout their child’s infancy, and return to a healthy weight during the postpartum period. This Committee did not review evidence regarding relationships of maternal BMI or GWG to lactation success; however, existing evidence shows that high prepregnancy BMI and excess GWG are risk factors for suboptimal breastfeeding outcomes.¹⁰³⁻¹⁰⁵ The *2010 Dietary Guidelines for Americans* stated⁸⁸: “The development of standardized approaches to promote healthy pre-pregnancy weight, appropriate weight gain during pregnancy, the initiation and maintenance of breastfeeding during infancy, and a return to healthy weight status postpartum can help prevent overweight and obesity throughout the life span.” This Committee supports these recommendations.

Support for Federal Programs

1. The Committee supports efforts by Federal programs, such as the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), that serve women who are lactating should encourage participants to take advantage of available nutrition

counseling services. In addition, policy, systems, and environmental change strategies and competitive pricing of healthy food and beverage choices can help ensure that women of all economic strata can afford them. Similar healthy foods and beverages should be routinely stocked and distributed by food pantries and other food assistance venues and recommended by food assistance programs.

2. Given the documented health benefits for the mother and infant, the Committee supports broader implementation of Federal programs that promote, protect and support breastfeeding.¹⁰ While this Committee did not review evidence regarding relationships of lactation to maternal health benefits, existing evidence shows that lactation confers short- and long-term maternal health benefits, which can be influenced by the duration of lactation.¹⁰ The 2010 Dietary Guidelines Advisory Committee investigated the relationship between breastfeeding and postpartum weight change and concluded that a moderate body of consistent evidence shows that breastfeeding may be associated with maternal PPWL.⁹³
3. The Committee supports further development of surveillance systems and databases to report food and beverage intakes of women who are lactating. These systems and databases should represent diverse subgroups of women. They also should include food and beverage composition and supplement data that can show how fortified foods and supplemental sources of nutrients contribute to overall nutrient intake and dietary quality during lactation, and should contain data on nutrient composition of human milk. In addition, the ability to link maternal dietary intake data to that of their children would strengthen the ability to determine how maternal dietary patterns and intakes affect child health and development. The Committee encourages implementation of surveillance systems to gather more information about the contextual aspects of diet, such as the frequency and/or timing of food and beverage consumption and the impacts of food security and economic status on food intake. This information is important to fully understand how and why women consume specific foods and beverages before and during lactation.

Need for Future Research

Despite the importance of the questions examined in this chapter for the long-term health of the mother and child, the available evidence for most questions was insufficient to form

conclusion statements. Many questions remain to be answered regarding the content and pattern of the diet of women during lactation and the influence on PPWL, human milk composition and quantity, and child outcomes, in addition to other questions that the Committee was not asked to address. The Committee supports ongoing Federal initiatives to fill these gaps in the literature. These initiatives began with a 2017 workshop on “Human Milk Composition: Biological, Environmental, Nutritional, and Methodological Considerations.” The consensus of the workshop attendees was that the “limited scope of Human Milk (HM) research initiatives has led to a lack of robust estimates of the composition and volume of HM consumed and, consequently, missed opportunities to improve maternal and infant health.¹⁰⁶” Additional research in this area is essential, and a number of recommendations for research on these important topics are discussed in **Part E. Future Directions**.

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