



A major developmental task during the first years of life is for the child to learn both how and what to eat, as well as to develop preferences for a wide array of healthy foods

Ann Nutr Metab 2017;70(suppl 3):8–15

Does Breastfeeding Shape Food Preferences? Links to Obesity

by Alison K. Ventura

Key insights

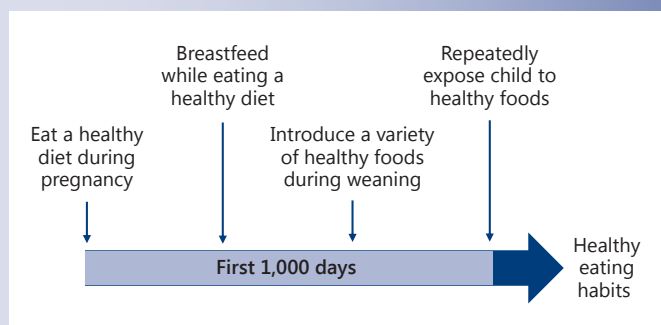
The first 1,000 days of life – between conception and 2 years of age – are a key window of time during which an infant's flavor and food preferences develop. Maturation of smell and taste is a continuum that begins during fetal development and lasts throughout the life-course. Although human innate taste preferences are driven by an attraction to sweet and salty tastes, amniotic fluid and breastmilk provide the vehicle through which infants can learn to prefer the tastes and flavors of different foods.

Current knowledge

Research on infants' flavor and food preferences during the weaning period has identified 3 mechanisms by which preferences emerge: repeated exposure, variety exposure, and associative conditioning. Infants who are repeatedly exposed to a novel food show increased intake and positive behavioral responses to that food. However, infants who are repeatedly exposed to a variety of foods show increased acceptance of the foods to which they are exposed, as well as to other novel foods. Finally, infants show greater acceptance of a novel food when it is paired with a familiar, preferred flavor or food. These 3 key components of preference development characterize the experience afforded by human milk.

Practical implications

Rapid weight gain during infancy is one of the earliest risk factors for the development of obesity and metabolic disease in later life. The first 1,000 days are therefore a critical window for



The first 1,000 days of life are a critical window of time during which an infant's flavor and food preferences develop.

targeting obesity prevention efforts. Breastfed children have a head start in developing preferences for a wider variety of healthy foods compared to formula-fed children. Breastfeeding exposes infants to a spectrum of novel flavors that are paired with the familiar flavors already contained in milk, leading children to be more accepting of different foods during weaning. Encouraging breastfeeding and healthy diets in pregnant and lactating women is key towards building the foundation for healthy eating in the next generation.

Recommended reading

Mennella JA, Jagnow CP, Beauchamp GK: Prenatal and postnatal flavor learning by human infants. *Pediatrics* 2001;107:E88.

Does Breastfeeding Shape Food Preferences? Links to Obesity

Alison K. Ventura

Department of Kinesiology, California Polytechnic State University, San Luis Obispo, CA, USA

Key Messages

- The first 2 years of life are a critical window for the development of flavor and food preferences.
- The flavors of the mothers' diet are transmitted through the amniotic fluid and breast milk, and young infants develop preferences for flavors to which they are repeatedly exposed within familiar contexts.
- Breastfeeding plays a role in promoting infants' acceptance of and preference for healthy foods during weaning, which is an important foundation for efforts to promote healthier dietary intakes and growth trajectories during childhood.

Keywords

Breastfeeding · Food preferences · Flavor preferences · Formula feeding · Obesity · Infant

Abstract

The first 2 years of life have been recognized as a critical window for obesity prevention efforts. This period is characterized by rapid growth and development and, in a relatively short period of time, a child transitions from a purely milk-based diet to a more varied solid-food diet. Much learning about food and eating occurs during this critical window, and it is well-documented that early feeding and dietary

exposures predict later food preferences, eating behaviors, and dietary patterns. The focus of this review will be on the earliest feeding experiences – breast- and formula-feeding – and the unique role of breastfeeding in shaping children's food preferences. Epidemiological data illustrate that children who were breastfed have healthier dietary patterns compared to children who were formula-fed, even after controlling for relevant sociodemographic characteristics associated with healthier dietary and lifestyle patterns. These dietary differences are underlined, in part, by early differences in the opportunities for flavor learning and preference development afforded by breast- versus formula-feeding. In particular, the flavors of the mothers' diet are transmitted from mother to child through the amniotic fluid and breast-milk. The flavors experienced in these mediums shape later food preferences and acceptance of the solid foods of the family and culture onto which the infant is weaned. All infants learn from flavor experiences in utero, but only breastfed infants receive the additional reinforcement and flavor learning provided by continued repeated exposure to a wide variety of flavors that occurs during breastfeeding. Given the numerous benefits of breastfeeding, promotion of breastfeeding during early infancy is an important focus for primary prevention efforts and should be combined with efforts to ensure that mothers consume healthy, varied diets during pregnancy and lactation, and expose their infants to a wide array of foods during weaning and solid-food feeding.

© 2017 S. Karger AG, Basel

Introduction

The American Academy of Pediatrics recommends infants be exclusively breastfed for about the first 6 months, followed by the introduction of complementary foods and beverages, and continued breastfeeding through at least the first year [1]. This recommendation reflects that the first year of life is characterized by rapid growth and development during which infants transition from a purely milk-based diet to a more varied solid-food diet over a relatively short period of time [2]. Dietary patterns emerge during this period and track from infancy into later childhood [3] and adulthood [4], and it is widely recommended that both children and adults consume diets high in fruits, vegetables, whole grains, low-fat dairy, and lean protein sources, and low in added sugar, saturated fats, and sodium [5].

Many families are not meeting recommendations for early feeding practices and dietary patterns. Eighty-one percent of mothers initiate breastfeeding at birth, but only 22% of infants are exclusively breastfed through 6 months of age [6]. An additional 30% of infants are fed a mix of breast milk and formula by 6 months, with the remaining 48% of 6-month-old infants exclusively formula-fed [6]. Adherence to recommendations does not improve once infants are fed a predominantly solid-food diet. Data from the Feeding Infants and Toddlers Study (FITS) illustrate that 26% of young children fail to consume at least 1 serving of fruit on a given day and 28% do not consume at least 1 serving of vegetables [7]. Only 11–24% of young children consume at least 1 serving of nutrient-dense, dark green or deep yellow vegetables per day. In contrast, over 30% of young children consume white or fried potatoes daily, and 63% consume at least 1 serving of desserts, sweets, or sweetened beverages daily. These dietary patterns continue to worsen throughout later childhood and adolescence [7, 8].

Given the importance of high-quality, nutrient-dense diets for promoting healthy developmental and cardiometabolic outcomes, improvement of young children's dietary patterns is a critical focus for health promotion and primary prevention efforts. Parents and caregivers are largely in charge of which foods are offered to young children, but children's food preferences are a major driver of the types of foods offered, as well as the types of foods that are actually consumed. Thus, the focus of this review will be on how these preferences develop during infancy to highlight possible targets for health promotion efforts. As will be discussed below, young children's preferences are initially hedonically driven, but can be shaped by early exposures and experiences. This review will focus on

the earliest feeding experiences – breast- and formula-feeding – and the unique role of breastfeeding in shaping children's food preferences.

Preference Development during the Prenatal Period

The development of sensory preferences begins in utero; gustatory and olfactory systems emerge during the first trimester and these systems achieve functional maturity by the end of gestation [9]. The functional capacity of these systems in utero provides the opportunity for early sensory learning that prepares the fetus to be attracted to tastes, flavors, and foods that are safe, will promote growth, and are available within the postnatal environment.

It is well-established that gustatory and olfactory stimuli are transferred from mother to fetus through the amniotic fluid [10], and this experience is an initial step in the development of later flavor and food preferences. The fetus can detect chemosensory stimuli present in the amniotic fluid, and repeated exposure to these stimuli influences neonates' later behavioral responses to those same stimuli. For example, during the first few days after birth, neonates show preference for the odor of their own mother's amniotic fluid when compared to the odor of distilled water [11] or the amniotic fluid of another parturient mother [12]. Additionally, mothers who regularly consumed garlic [13] or anise [14] during the third trimester of pregnancy had neonates who showed greater preference for the odor of garlic or anise, respectively, compared to neonates of mothers who did not regularly consume those foods. Experimental work has illustrated that prenatal exposure to carrot flavor leads infants to prefer carrot-flavored to plain cereal during weaning, indicating that prenatal exposures impact later food preferences [15].

An early benefit of prenatal sensory learning was demonstrated in a series of studies by Marlier and colleagues [12, 16]. They noted that 2-day-old newborns could not discriminate between the odor of their mothers' amniotic fluid and colostrum, which suggests continuity exists for the chemosensory properties of amniotic and lacteal fluids [12]. This continuity likely supports the infant's attraction to breast milk as a nutrient source in the early postpartum period. By day 4, infants showed a preference for the odor of their mothers' transitional milk over the odor of their mothers' amniotic fluid, likely due to the repeated exposure to the lacteal fluids and changing properties of these fluids as they transition from colostrum to

mature breast milk [12]. In contrast, infants who were formula-fed at birth showed preference for the odor of their mothers' amniotic fluid compared to the odor of the formula they were fed, and this preference persisted through the first 4 days postpartum [16]. Four-day-old newborns showed clear preferences for the odor of human milk (whether from their own mother or not) compared to formula [17]. Thus, neonates prefer stimuli of biological origins and significance (e.g., breast milk) to those of synthetic origin or without immediate biological significance (e.g., synthetic milk).

Preference Development during the Postnatal Period

At birth, infants exhibit innate preferences for sweet and savory and aversion to bitter and sour [18]; a preference for salt emerges around 4 months [19]. These innate taste preferences are thought to be adaptive, ensuring the infant is attracted to the initial food that will sustain growth (breast milk, which is high in lactose, a source of sweet taste, and free amino acid glutamate, a source of savory taste). Given that poisons are bitter and rancid foods are sour, these taste preferences also ensure that infants are less willing to consume foods that may induce harm.

Consideration of these initial preferences provide some insight into why many children eat diets that are high in desserts, sweets, sweetened beverages, and fried potatoes, and low in nutrient-dense, dark green and other vegetables: these are the diets to which they are innately attracted and readily prefer. However, infants exhibit high levels of plasticity and are responsive to the food-related stimuli to which they are exposed and the social cues that surround food and eating. Thus, a major developmental task during the first years of life is for the child to learn both how and what to eat, as well as to develop preferences for a wide array of healthy foods.

Flavors in breast milk and/or formula are a primary postnatal influence on infants' developing flavor and food preferences. Although formula brands differ in their sensory profiles, formulas provide a more monotonous experience relative to breast milk. In particular, breast milk is similar to the amniotic fluid in that a wide array of flavor compounds that are transferred to and detectable in

human milk, including garlic [20], carrot [21], vanilla [22], tobacco [23], alcohol [24], and lipophilic flavor compounds with molecular structures and sensory properties similar to those found in fruits, vegetables, sweets, and spices [25]. The appearance of these compounds in breast milk peaks approximately 2–3 h after consumption and, in some cases, are detectable for up to 8 h after consumption [25]. Thus, breastfeeding is unique from formula feeding in that it provides a “flavor bridge” between the flavors to which the infant was exposed in the womb and the flavors of the foods to which the infant will eventually be exposed during weaning [26].

Experimental research examining how infants' preferences develop during the introduction of complementary foods and beverages has illustrated 3 mechanisms by which preferences emerge: repeated exposure, variety exposure, and associative conditioning. At the most basic level, infants who are merely repeatedly exposed to a novel food show increased intake and positive behavioral responses (e.g., positive facial expressions) to that food [27]. However, infants who are repeatedly exposed to a variety of foods (e.g., a rotating schedule of peas, potatoes, squash) show increased acceptance of the foods to which they are exposed, as well as to novel foods [28]. Infants also show greater acceptance of a novel food when it is paired with a familiar, preferred flavor or food compared to when it is presented alone [27].

These key components of preference development – repeated exposure, variety exposure, and associative conditioning – characterize the experience afforded by human milk. Because the flavors of the mother's diet are transmitted from mother to child through the milk, the infant is repeatedly exposed to a wide variety of flavors, and novel flavors are paired with the familiar sweetness and flavors already present within the milk. Given this experience, it is no surprise that a large body of research illustrates that infants are responsive to the flavors contained within human milk and these early experiences are associated with later preferences and dietary patterns.

In particular, the varied sensory properties of human milk influence infant behavior, but, in the short term, the way in which the flavor of the milk impacts infant behavior depends on whether the infant has had recent experience with the flavor. For example, when breastfeeding mothers were instructed to consume a bland,

Breastfeeding provides a “flavor bridge” between the flavors to which the infant was exposed in the womb and the flavors of the foods to which the infant will eventually be exposed during weaning

low-garlic diet for 3 days prior to testing, their 4- to 6-month-old infants spent a significantly longer time attached to the nipple and showed an increased number of sucks during a test feeding that occurred 1.5–3 h after their mothers ingested a garlic capsule compared to a control group of infants whose mothers consumed a placebo capsule [20]. Thus, infants are attracted to and stimulated by novel flavors in the milk [15, 20, 29]. In contrast, when breastfeeding mothers consumed a target flavor (e.g., garlic [29], carrot [21], or caraway [30]) in the days prior to testing (i.e., their infants were repeatedly exposed to these flavors in the breast milk), their infants showed no preference for the flavor relative to a plain control during a test feeding, which may be a form of sensory-specific satiety [21, 29]. In contrast to these short-term studies, longer-term studies of both breast- and formula-fed infants illustrate that, during solid-food feeding, infants and young children show greater preferences for the flavors to which they have been exposed through the amniotic fluid [15], breast milk [15], or formula [31].

Effects of early experience on taste and flavor preferences has been shown to last until at least 10 years of age [32, 33].

Although infants learn from their early flavor exposures during milk feeding regardless of whether fed breast milk or formula, the exposure to a wide variety of flavors afforded by breastfeeding appears to be advantageous during later weaning. During the introduction of solid foods (when infants are 4–6 months of age), parents generally report that their infants react positively to the vast majority of foods to which they are introduced [34]. However, reactions to novel foods vary according to the taste of the food, with salted vegetables more accepted than plain vegetables [34] and fruits or sweeter vegetables more readily accepted than more bitter vegetables [35].

It has also been documented in some [30, 36], but not all [27, 34, 35], studies that breastfed infants are initially more accepting of novel foods and that repeated exposure to a novel food leads to greater increases in intake for breastfed compared to formula-fed infants. Similarly, breastfed infants exhibit a greater response to variety exposure than formula-fed infants [37], and the effect of variety exposure, either through breastfeeding or offering a variety of flavors, is still evident at 3 and 6 years of age [38]. During later childhood, children who were breastfed

exhibit lower levels of neophobia (or fear of new foods) [39] and are less picky [40] compared to children who were formula-fed.

Associations between Breastfeeding and Later Dietary Patterns

Globally, a growing body of epidemiological studies suggest that the early effects of breastfeeding on acceptance of and preferences for healthy foods may translate into healthier dietary patterns during later life. For example, in a cohort of Australian children, longer breastfeeding durations were associated with intakes of greater varieties of healthy foods and greater varieties of fruits and vegetables when children were 2 years old, independent of family demographics [41]. In a recent analysis of 4 European cohorts of children aged 2–4 years living in the United Kingdom, France, Greece, and Portugal, longer breastfeeding durations predicted higher fruit and vegetable intakes during later childhood, even after adjusting for maternal intakes and

relevant sociodemographic variables [42]. Similarly, a study of Canadian children illustrated that 4-year-old children who were exclusively breastfed for 3 or more months had significantly higher adjusted odds of consuming 2 or more servings of vegetables per day when compared to children who were formula-fed or partially breastfed [43]. Other studies of US, Brazilian, and Dutch cohorts have demonstrated similar associations between breastfeeding through the first year [44–46] and/or exclusive breastfeeding for ≥ 3 months [45, 47] and higher consumption of fruits and vegetables when children are 4–7 years old.

Associations between Breastfeeding and Risk for Obesity

The etiology of obesity is multifactorial with a number of important risk factors occurring prior to birth (Fig. 1) [48]. However, during the postnatal period, the first 2 years have been recognized as a critical period for development, especially as it relates to health outcomes and risk for obesity [49] and dietary patterns have been highlighted as important contributors to the development of obesity [50]. Given the evidence for effects of breastfeeding on early food preferences and associations between breastfeeding and later dietary patterns, it is plausible to

*Infants are attracted to
and stimulated by novel flavors
in the milk*

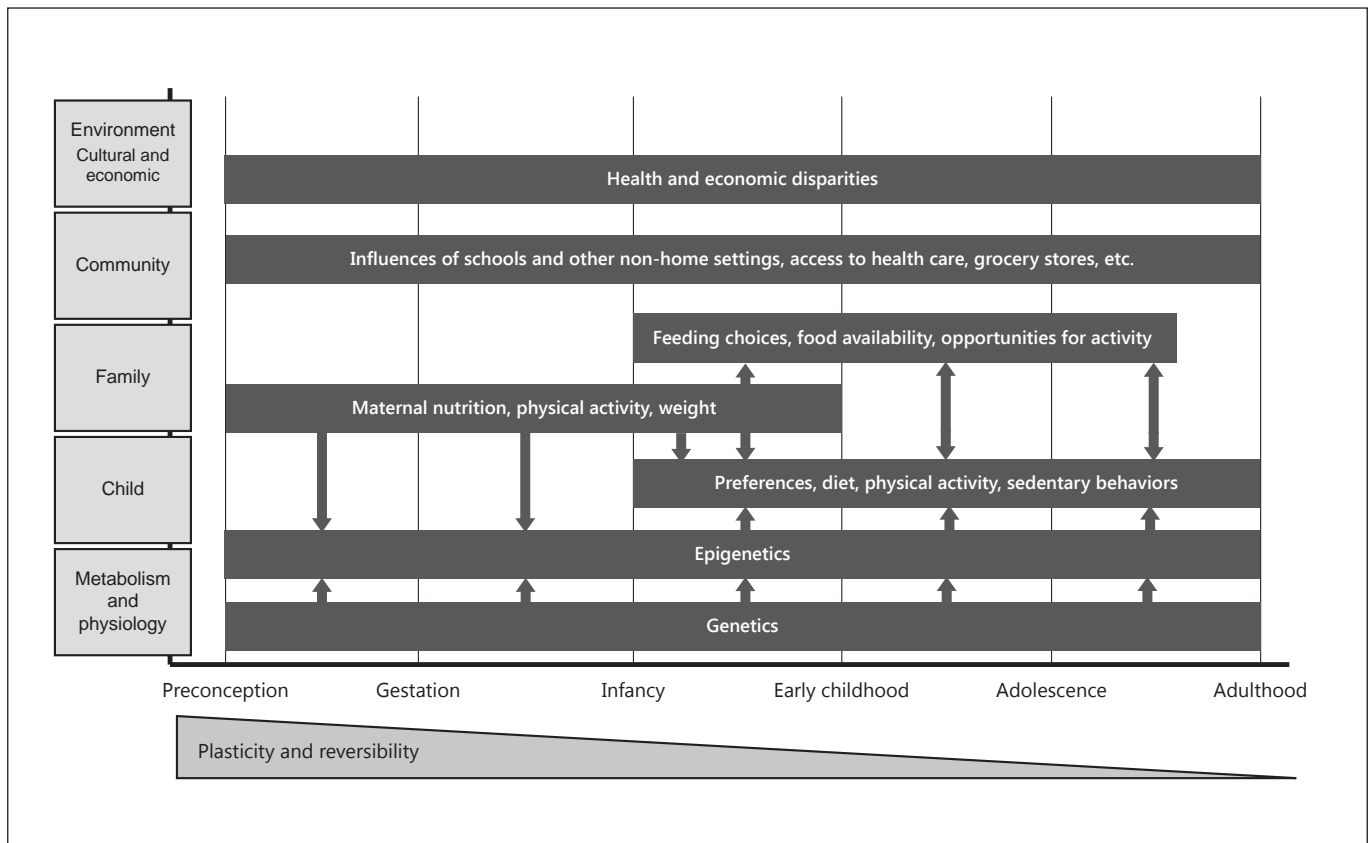


Fig. 1. Early origins of obesity. Factors at multiple levels (ranging from genetics to environments) interact to influence a child's risk for obesity. Note that this is not a complete representation of all factors influencing obesity, but it illustrates how influences begin during the preconception period and continue throughout the life

course. Children exhibit high levels of plasticity – or abilities to change – during early life, but exposures during this period also have more significant impacts of long-term health outcomes. Adapted from Pray et al. [48].

consider promotion of breastfeeding as a component of obesity prevention efforts and examine possible effects of breastfeeding on later growth patterns and obesity risk.

During early infancy, breastfeeding is associated with healthier growth patterns. Breastfed infants consume a lesser volume during each feeding and over the course of a day compared to formula-fed infants [51] and infants fed breast milk are significantly lighter by 9 months of age [52]. Breastfed infants also gain healthier amounts of weight during the first year postpartum and are less likely to show patterns of rapid weight gain during infancy compared to their formula-fed peers [53]. Excess weight gain among formula-fed infants is not offset by equally greater gains in length and appears to be attributable to higher levels of fat mass (as opposed to fat-free mass) in formula-fed infants [54].

Whether these early growth differences translate to later weight outcomes is unclear given somewhat equivocal findings for associations between breastfeeding and later risk for obesity. Some studies suggest that the effects of breastfeeding on promoting healthy weight gain trajectories and weight status are long lasting, extending into later childhood, adolescence, and adulthood, even after controlling for sociodemographic characteristics. Indeed, several meta-analyses of published research have consistently illustrated modest associations between breastfeeding (when compared to formula-feeding) and reduced risk of obesity later in life [55–60], as well as a significant dose-response effect of breastfeeding duration on reduced risk for later obesity [55, 59]. However, a recent cluster-randomized trial (the Promotion of Breastfeeding Intervention Trial [PROBIT]), within which mothers who initiated breastfeeding participated in a

breastfeeding promotion intervention or standard care, did not find differences in the prevalence of obesity for children of mothers in the intervention versus control groups, despite significant effects of the intervention on increasing the duration and exclusivity of breastfeeding [61, 62]. These findings may suggest that the links between breastfeeding and obesity are due to confounding factors, but this conclusion is limited by the fact that all mothers in this sample initiated breastfeeding and a comparison of outcomes for infants who were breastfed versus those who were exclusively formula-fed was not possible.

Implications and Recommendations

A child's first 1,000 days – defined as the period from conception to the age of 2 years – are a critical period for obesity prevention efforts [49]. Although the etiology of obesity is complex, rapid weight gain during infancy has been highlighted as one of the earliest postnatal risk factors for the development of later obesity and metabolic dysfunction [63] and has been recognized as a prime target for prevention and intervention efforts [64]. Early feeding exposures are central when considering influences on risk for rapid weight gain and obesity, and it is well-documented that these early feeding and dietary exposures are significant predictors of later food preferences, eating behaviors, and dietary patterns.

Although breastfeeding is not a panacea, a large body of research illustrates that breastfeeding can facilitate the development of preferences for healthy foods during a critical period of development. Specifically, it appears that children who are breastfed get a “jump start” on developing preferences for a wide array of healthy foods when compared to children who are formula-fed, mainly because breastfeeding allows children to be repeatedly exposed to a wide array of novel flavors that are paired with the familiar flavors already contained within the milk. This experience may lead infants to be more accepting of foods during weaning, because they are already familiar with and have developed a preference for the flavors of these foods well before they experience them in solid-food form. Given the numerous benefits of breastfeeding, promotion of breastfeeding during early infancy is an important focus for primary prevention efforts and should be combined with efforts to ensure mothers consume healthy, varied diets during pregnancy and lactation and expose their infants to a wide array of healthy foods during weaning and complementary feeding.

Disclosure Statement

The writing of this article was supported by Nestlé Nutrition Institute. The author has no other disclosures.

References

- 1 Section on Breastfeeding: Breastfeeding and the use of human milk. *Pediatrics* 2012;129:e827–e841.
- 2 Grummer-Strawn LM, Scanlon KS, Fein SB: Infant feeding and feeding transitions during the first year of life. *Pediatrics* 2008; 122(suppl 2):S36–S42.
- 3 Lioret S, Betoko A, Forhan A, Charles MA, Heude B, de Lauzon-Guillain B; Eden Mother-Child Cohort Study Group: Dietary patterns track from infancy to preschool age: cross-sectional and longitudinal perspectives. *J Nutr* 2015;145:775–782.
- 4 Mikkilä V, Rasanen L, Raitakari OT, Pietinen P, Viikari J: Consistent dietary patterns identified from childhood to adulthood: the cardiovascular risk in Young Finns Study. *Br J Nutr* 2005;93:923–931.
- 5 US Department of Health and Human Services and US Department of Agriculture: 2015–2020 Dietary Guidelines for Americans, ed 8. December 2015. Available at <http://health.gov/dietaryguidelines/2015/guidelines/>.
- 6 Centers for Disease Control and Prevention: Breastfeeding Report Card: Progressing Toward National Breastfeeding Goals. Atlanta, National Center for Chronic Disease Prevention and Health Promotion, Division of Nutrition, Physical Activity and Obesity, 2016.
- 7 Siega-Riz AM, Deming DM, Reidy KC, Fox MK, Condon E, Briefel RR: Food consumption patterns of infants and toddlers: where are we now? *J Am Diet Assoc* 2010;110:S38–S51.
- 8 Reedy J, Krebs-Smith SM: Dietary sources of energy, solid fats, and added sugars among children and adolescents in the United States. *J Am Diet Assoc* 2010;110:1477–1484.
- 9 Bradley RM: Development of the taste bud and gustatory papillae in human fetuses; in Bosma JF (ed): *Oral Sensation and Perception*. Springfield, Charles C Thomas, 1972, pp 137–162.
- 10 Mennella JA, Johnson A, Beauchamp GK: Garlic ingestion by pregnant women alters the odor of amniotic fluid. *Chem Senses* 1995;20:207–209.
- 11 Schaal B, Marlier L, Soussignan R: Responsiveness to the odour of amniotic fluid in the human neonate. *Biol Neonate* 1995;67:397–406.
- 12 Marlier L, Schaal B, Soussignan R: Neonatal responsiveness to the odor of amniotic and lacteal fluids: a test of perinatal chemosensory continuity. *Child Dev* 1998;69:611–623.
- 13 Hepper PG: Human fetal “olfactory” learning. *Int J Prenat Perinat Psychol Med* 1995;7: 147–151.
- 14 Schaal B, Marlier L, Soussignan R: Human fetuses learn odours from their pregnant mother's diet. *Chem Senses* 2000;25:729–737.
- 15 Mennella JA, Jagnow CP, Beauchamp GK: Prenatal and postnatal flavor learning by human infants. *Pediatrics* 2001;107:E88.
- 16 Marlier L, Schaal B, Soussignan R: Bottle-fed neonates prefer an odor experienced in utero to an odor experienced postnatally in the feeding context. *Dev Psychobiol* 1998;33: 133–145.

- 17 Marlier L, Schaal B: Human newborns prefer human milk: conspecific milk odor is attractive without postnatal exposure. *Child Dev* 2005;76:155–168.
- 18 Steiner JE: Human facial expressions in response to taste and smell stimulation. *Adv Child Dev Behav* 1979;13:257–295.
- 19 Beauchamp GK, Cowart BJ, Moran M: Developmental changes in salt acceptability in human infants. *Dev Psychobiol* 1986;19:17–25.
- 20 Mennella JA, Beauchamp GK: Maternal diet alters the sensory qualities of human milk and the nursing's behavior. *Pediatrics* 1991;88:737–744.
- 21 Mennella JA, Beauchamp GK: Experience with a flavor in mother's milk modifies the infant's acceptance of flavored cereal. *Dev Psychobiol* 1999;35:197–203.
- 22 Mennella JA, Beauchamp GK: The human infants' responses to vanilla in human milk and formula. *Infant Behav Dev* 1996;19:13–19.
- 23 Mennella JA, Beauchamp GK: Smoking and the flavor of breast milk. *N Engl J Med* 1998;339:1559–1560.
- 24 Mennella JA, Beauchamp GK: The transfer of alcohol to human milk. Effects on flavor and the infant's behavior. *N Engl J Med* 1991;325:981–985.
- 25 Hausner H, Bredie WL, Molgaard C, Petersen MA, Moller P: Differential transfer of dietary flavour compounds into human breast milk. *Physiol Behav* 2008;95:118–124.
- 26 Mennella JA: Flavour programming during breast-feeding. *Adv Exp Med Biol* 2009;639:113–120.
- 27 Forestell CA, Mennella JA: Early determinants of fruit and vegetable acceptance. *Pediatrics* 2007;120:1247–1254.
- 28 Maier AS, Chabanet C, Schaal B, Leathwood PD, Issanchou SN: Breastfeeding and experience with variety early in weaning increase infants' acceptance of new foods for up to two months. *Clin Nutr* 2008;27:849–857.
- 29 Mennella JA, Beauchamp GK: The effects of repeated exposure to garlic-flavored milk on the nursing's behavior. *Pediatr Res* 1993;34:805–808.
- 30 Hausner H, Nicklaus S, Issanchou S, Molgaard C, Moller P: Breastfeeding facilitates acceptance of a novel dietary flavour compound. *Clin Nutr* 2010;29:141–148.
- 31 Mennella JA, Beauchamp GK: Understanding the origin of flavor preferences. *Chem Senses* 2005;30(suppl 1):i242–i243.
- 32 Liem DG, Mennella JA: Sweet and sour preferences during childhood: role of early experiences. *Dev Psychobiol* 2002;41:388–395.
- 33 Sausenthaler S, Koletzko S, Koletzko B, Reinhardt D, Kramer U, von Berg A, Berdel D, Bauer CP, Grubl A, Wichmann HE, Heinrich J; group GIs: Effect of hydrolysed formula feeding on taste preferences at 10 years. Data from the German Infant Nutritional Intervention Program Plus Study. *Clin Nutr* 2010;29:304–306.
- 34 Schwartz C, Chabanet C, Lange C, Issanchou S, Nicklaus S: The role of taste in food acceptance at the beginning of complementary feeding. *Physiol Behav* 2011;104:646–652.
- 35 Barends C, de Vries JH, Mojet J, De Graaf C: Effects of repeated exposure to either vegetables or fruits on infant's vegetable and fruit acceptance at the beginning of weaning. *Food Qual Prefer* 2013;29:157–165.
- 36 Sullivan SA, Birch LL: Infant dietary experience and acceptance of solid foods. *Pediatrics* 1994;93:271–277.
- 37 Maier AS, Chabanet C, Schaal B, Leathwood PD, Issanchou SN: Breastfeeding and experience with variety early in weaning increase infants' acceptance of new foods for up to two months. *Clin Nutr* 2008;27:849–857.
- 38 Maier-Noth A, Schaal B, Leathwood P, Issanchou S: The lasting influences of early food-related variety experience: a longitudinal study of vegetable acceptance from 5 months to 6 years in two populations. *PLoS One* 2016;11:e0151356.
- 39 Cooke LJ, Wardle J, Gibson EL, Sapochnik M, Sheiham A, Lawson M: Demographic, familial and trait predictors of fruit and vegetable consumption by pre-school children. *Public Health Nutr* 2004;7:295–302.
- 40 Galloway AT, Lee Y, Birch LL: Predictors and consequences of food neophobia and pickiness in young girls. *J Am Diet Assoc* 2003;103:692–698.
- 41 Scott JA, Chih TY, Oddy WH: Food variety at 2 years of age is related to duration of breastfeeding. *Nutrients* 2012;4:1464–1474.
- 42 de Lauzon-Guillain B, Jones L, Oliveira A, Moschonis G, Betoko A, Lopes C, Moreira P, Manios Y, Papadopoulos NG, Emmett P, Charles MA: The influence of early feeding practices on fruit and vegetable intake among preschool children in 4 European birth cohorts. *Am J Clin Nutr* 2013;98:804–812.
- 43 Burnier D, Dubois L, Girard M: Exclusive breastfeeding duration and later intake of vegetables in preschool children. *Eur J Clin Nutr* 2011;65:196–202.
- 44 Soldateli B, Vigo A, Giugliani ER: Effect of pattern and duration of breastfeeding on the consumption of fruits and vegetables among preschool children. *PLoS One* 2016;11:e0148357.
- 45 Perrine CG, Galuska DA, Thompson FE, Scanlon KS: Breastfeeding duration is associated with child diet at 6 years. *Pediatrics* 2014;134 Suppl 1:S50–55.
- 46 Moller LM, de Hoog ML, van Eijnsden M, Gemke RJ, Vrijkotte TG: Infant nutrition in relation to eating behaviour and fruit and vegetable intake at age 5 years. *Br J Nutr* 2013;109:564–571.
- 47 Scholtens S, Brunekreef B, Smit HA, Gast GC, Hoekstra MO, de Jongste JC, Postma DS, Gerritsen J, Seidell JC, Wijga AH: Do differences in childhood diet explain the reduced overweight risk in breastfed children? *Obesity (Silver Spring)* 2008;16:2498–2503.
- 48 Pray LA, Food and Nutrition Board, Board on Children Youth and Families, Institute of Medicine, National Research Council: Examining a Developmental Approach to Childhood Obesity: The Fetal and Early Childhood Years – Workshop in Brief. Washington, Institute of Medicine and National Research Council of the National Academies, 2015.
- 49 Woo Baidal JA, Locks LM, Cheng ER, Blake-Lamb TL, Perkins ME, Taveras EM: Risk factors for childhood obesity in the first 1,000 days: a systematic review. *Am J Prev Med* 2016;50:761–779.
- 50 Funtikova AN, Navarro E, Bawaked RA, Fito M, Schroder H: Impact of diet on cardiometabolic health in children and adolescents. *Nutr J* 2015;14:118.
- 51 Heinig MJ, Nommsen LA, Peerson JM, Lonnerdal B, Dewey KG: Intake and growth of breast-fed and formula-fed infants in relation to the timing of introduction of complementary foods: the DARLING study. *Davis Area Research on Lactation, Infant Nutrition and Growth. Acta Paediatr* 1993;82:999–1006.
- 52 Michaelsen KF, Petersen S, Greisen G, Thomsen BL: Weight, length, head circumference, and growth velocity in a longitudinal study of Danish infants. *Dan Med Bull* 1994;41:577–585.
- 53 Mihrshahi S, Battistutta D, Magarey A, Daniels LA: Determinants of rapid weight gain during infancy: baseline results from the NOURISH randomised controlled trial. *BMC Pediatr* 2011;11:99.
- 54 Dewey KG, Heinig MJ, Nommsen LA, Peerson JM, Lonnerdal B: Breast-fed infants are leaner than formula-fed infants at 1 y of age: the DARLING study. *Am J Clin Nutr* 1993;57:140–145.
- 55 Harder T, Bergmann R, Kallischnigg G, Plagemann A: Duration of breastfeeding and risk of overweight: a meta-analysis. *Am J Epidemiol* 2005;162:397–403.
- 56 Owen CG, Martin RM, Whincup PH, Davey-Smith G, Gillman MW, Cook DG: The effect of breastfeeding on mean body mass index throughout life: a quantitative review of published and unpublished observational evidence. *Am J Clin Nutr* 2005;82:1298–1307.
- 57 Owen CG, Martin RM, Whincup PH, Smith GD, Cook DG: Effect of infant feeding on the risk of obesity across the life course: a quantitative review of published evidence. *Pediatrics* 2005;115:1367–1377.

- 58 Arenz S, Von Kries R: Protective effect of breast-feeding against obesity in childhood: can a meta-analysis of published observational studies help to validate the hypothesis? *Adv Exp Med Biol* 2009;639:145–152.
- 59 Yan J, Liu L, Huang G, Wang PP: The association between breastfeeding and childhood obesity: a meta-analysis. *BMC Public Health* 2014;14:1267–1278.
- 60 Horta BL, Loret de Mola C, Victora CG: Long-term consequences of breastfeeding on cholesterol, obesity, systolic blood pressure and type 2 diabetes: a systematic review and meta-analysis. *Acta Paediatr* 2015;104:30–37.
- 61 Kramer MS, Matush L, Vanilovich I, Platt RW, Bogdanovich N, Sevkovskaya Z, Dzikovich I, Shishko G, Collet JP, Martin RM, Smith GD, Gillman MW, Chalmers B, Hodnett E, Shapiro S: A randomized breast-feeding promotion intervention did not reduce child obesity in Belarus. *J Nutr* 2009;139:417S–421S.
- 62 Martin RM, Kramer MS, Patel R, Rifas-Shiman SL, Thompson J, Yang S, Vilchuck K, Bogdanovich N, Hameza M, Tilling K, Oken E: Effects of promoting long-term, exclusive breastfeeding on adolescent adiposity, blood pressure, and growth trajectories: a secondary analysis of a randomized clinical trial. *JAMA Pediatr* 2017;171:e170698.
- 63 Sacco MR, de Castro NP, Euclides VL, Souza JM, Rondo PH: Birth weight, rapid weight gain in infancy and markers of overweight and obesity in childhood. *Eur J Clin Nutr* 2013;67:1147–1153.
- 64 Baird J, Fisher D, Lucas P, Kleijnen J, Roberts H, Law C: Being big or growing fast: systematic review of size and growth in infancy and later obesity. *Br Med J* 2005;331:929–934.