The period of infancy and young childhood is characterized by special needs in nutrition, which not only must maintain the body but also support a rapid rate of growth and the appropriate synthesis and deposition of body tissue. This growth leads to a doubling of the body weight at the age of 3–4 months and to a tripling at the age of 12 months. Moreover, the quantity and quality of nutrient supply during infancy and young childhood has been shown to be associated with long-term health effects, some of which being the consequences of ‘programming’ [1].

A special feature of young infancy is that one liquid food is the sole source of nutrition. Breast milk is the optimal food for all healthy infants and provides an adequate supply of nutrients to support a healthy growth and development (with the exception of vitamin K during the first weeks of life and of vitamin D), besides providing anti-infective protection and immunostimulatory components. Studies performed in affluent countries have shown important advantages of breastfeeding over formula feeding, such as lower incidence rates of gastrointestinal and respiratory infections and a lower risk of obesity. Breast milk is the model for the composition of infant formula taking into account that a breast milk substitute should not only imitate the composition of breast milk but also aim at achieving similar health effects [2].

This chapter of the Yearbook on Nutrition and Growth reviews the key articles that have appeared between 1 July 2012 and 30 June 2013 in the area of neonatal and infant nutrition, including breastfeeding. All studies were human observational or clinical trials. Comments are included following the summaries of papers. References used in the introduction and in the comments are listed at the end of the chapter.
Randomized trial of exclusive human milk versus preterm formula diet in extremely premature infants

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Background: Own mother’s milk is the preferred choice to feed premature infants enterally. Second choice is donor human milk, while preterm formula might be the alternative. While the use of human milk is associated with a reduction in nosocomial sepsis and necrotizing enterocolitis, large controlled studies of donor human milk on objective outcome criteria are lacking. The objective of this multicenter, randomized controlled trial was to compare the duration of parenteral nutrition, growth, and morbidity in extremely premature infants fed exclusive diets of either bovine milk-based preterm formula (BOV) or donor human milk and human milk-based human milk fortifier (HUM) of formula vs. human milk.

Methods: The study randomized 53 infants with a birth weight of 500–1,250 g whose mothers did not intend to provide milk, who received parenteral nutrition within 48 h after birth and enteral feedings before 21 days of age. Intervention consisted of an exclusive human milk diet of pasteurized donor human milk and human milk-based fortifier, compared to a bovine-based preterm formula. Study participation ended at the earliest of the following milestones: 91 days of age, discharge from the hospital (to home or to another hospital), or attainment of 50% oral feedings (i.e. 4 complete oral feedings per day). The major outcome was duration of parenteral nutrition. Secondary outcomes were growth, respiratory support, and necrotizing enterocolitis (NEC).

Results: This relatively small group of infants did not differ in birth weight (approx. 1,000 g) or gestational age (27–28 weeks). There was a significant difference in median parenteral nutrition days: 36 vs. 27 in formula-fed infants vs. donor human milk-fed infants, respectively (p = 0.04). The incidence of NEC in the formula-fed group was not significantly different but tended to be higher than in the donor human milk group (21% (5 cases) vs. 3% (1 case), p = 0.08). Surgical NEC was significantly higher in the formula-fed group (4 cases) than in the donor human milk group (0 cases), p = 0.04.

Conclusions: Feeding with exclusive diet of formula compared with human milk in extreme preterm infants resulted in longer duration of parenteral feeding and higher rate of surgical NEC. These findings support a greater need for enhanced lactation or use of exclusive human milk diet of preterm infants in the neonatal intensive care units.
Comments
The use of a human milk-based diet in the neonatal intensive care unit has been advocated for some time. The present study shows that an important outcome, i.e. days on parenteral nutrition is significantly reduced when fed commercially available pasteurized donor human milk only. In an earlier study, an exclusively human milk-based diet, but including approximately 80% of own mother’s milk, the same authors reported a significant reduction in NEC as well [3]. That study was severely criticized because of the high incidence of NEC in the control group. Again in this study the authors describe an incidence of 21%, much higher than in other studies reported in infants receiving formula only. The present study was powered to detect a reduction in parenteral nutrition days, which were significantly lower in the human milk group. The claim on NEC reduction is not appropriate as this was not the primary outcome. The results can only be seen as hypothesis-generating. Furthermore, the incidence of nosocomial infections is extremely high (55–79%), which is not discussed. However, there seemed to be such a trend. Many previous studies describe an association with reduced nosocomial infections when fed a human milk-based diet. That growth rates are low, which is associated with a less favorable neurocognitive outcome, might be overcome with a more appropriate fortification of the human milk-based fortifier. Nonetheless, the data are encouraging and warrant a large independent trial powered to detect a significant reduction in NEC. Preferably, such a study should be conducted without investigators who receive a fee for conducting the study, employees of the company or paid consultants. If such a study shows positive results, it might also reduce the price of the product, as the costs of providing infants commercial available pasteurized human milk up to discharge is at present at least USD 10,000–15,000 per child.

Pasteurization of mother’s own milk for preterm infants does not reduce the incidence of late-onset sepsis

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Background: Human milk benefits preterm very low birth weight (VLBW) infants and may lower their risk for late-onset sepsis. Due to lack of microbiological standards, practices such as pasteurization of mother’s own milk differ widely among neonatal intensive care units worldwide. Several neonatal units have a policy to pasteurize own mother’s milk before administering the milk to the infants to reduce the risk of providing contaminated milk, whereas others provide unpasteurized own mother’s milk. The objective of this randomized controlled trial was to investigate whether pasteurization of mother’s own milk for very-low-birth-weight (VLBW) infants influences the incidence and severity of infection-related outcomes.

Methods: Infants whose mothers intended to breastfeed were randomly assigned to receive either raw or pasteurized mother’s own milk. The duration of the study was from birth to 8 weeks of age or to discharge from the NICU, whichever occurred first. The primary outcome was the incidence of proven nosocomial infection.

Results: The study randomized 303 preterm infants (mean birth weight 1,276 g, mean gestational age 29 weeks). The findings of the study demonstrated that the incidence of laboratory-confirmed
sepsis was not statistically different in infants fed raw milk compared to infants who received pasteurized milk: 22/151 (0.15; CI 0.08–0.20) and 31/152 (0.20; CI 0.14–0.27), respectively (RR 0.71; 95% CI 0.43–1.17).

**Conclusion:** Pasteurization of mother’s own milk given to VLBW infants during hospitalization in the NICU is an intervention that does not improve infection-related outcomes, such as late-onset sepsis.

**Comments**

Holder pasteurization is an effective method in eliminating pathogens from human milk, but has the disadvantage to reduce the immunological capacity and negatively affects the nutrient quality [4]. This study was initially powered to detect a difference in the incidence of proven nosocomial infection, but no statistical significant difference was detected. Consequently, the authors suggest that pasteurization of own mother’s milk does not reduce the incidence of nosocomial infections. That is the appropriate way of concluding the results. The authors suggest that the lack of power was related to the higher rate of sepsis in their retrospective data (40%), on which they performed the power calculation, as compared to the actual incidence (17.5%). A bias in their results might be that whenever the milk of the infants in the ‘raw milk’ group contained specific bacteria, own mother’s milk was pasteurized before administration, which happened in 16% of the infants. This might underestimate the reduction in infection incidence, and is a practice which is not frequently used around the world. In addition, the study was not blinded, although culture-proven sepsis is an outcome that is hard to influence. Despite these disadvantages, primary and several secondary outcomes tended towards slightly better outcomes in the raw milk group. No negative effects were observed by not pasteurizing own mother’s milk. These results do not support the practice that own mother’s milk should be pasteurized, although the final verdict is still out.

**Infant Nutrition**

*Lactobacillus reuteri* DSM 17938 for the management of infantile colic in breastfed infants: a randomized, double-blind, placebo-controlled trial

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**Background:** Infantile colic is common during the first 3–4 months of life. Depending on the definition used, colic affects 3–28% of infants, causing considerable stress and concern for parents. The pathogenesis of the condition remains elusive and many causes and/or risk factors have been suggested including the microbiota that are known to interfere with gut motor function and gas production. The objective of this study was to determine whether administration of *Lactobacillus reuteri* DSM 17938 is beneficial in breastfed infants with infantile colic.

**Methods:** Infants aged <5 months (n = 80) with infantile colic (crying episodes lasting ≥3 h/day and occurring at least 3 days/week within 7 days prior to enrollment) who were exclusively or pre-
dominantly (>50%) breastfed were randomly assigned to receive orally *L. reuteri* DSM 17938 [10^8 colony-forming units (CFU)] (n = 40) or identically appearing and tasting placebo (n = 40), in 5 drops, once a day, for 21 days. The primary outcome measures were the treatment success, defined as the percentage of children achieving a reduction in the daily average crying time ≥50%, and the duration of crying (minutes per day) at 7, 14, 21, and 28 days after randomization.

**Results:** The rate of responders to treatment was significantly higher in the probiotic group compared with the placebo group at day 7 (p = 0.026), at day 14 [relative risk (RR) 4.3; 95% CI 2.3–8.7], at day 21 [RR 2.7; 95% CI 1.85–4.1], and at day 28 [RR 2.5; 95% CI 1.8–3.75]. Throughout the study period, the median crying time was significantly reduced in the probiotic group compared with the control group. Additionally, a significant reduction in the parental perception of colic severity and an improved parental/family quality of life were found in the probiotic group compared with the placebo group. No adverse events associated with the probiotic therapy were observed.

**Conclusion:** The lack of effective therapy for predominately breastfed infants with infantile colic and the good safety profile of probiotics (*L. reuteri* DSM 17938) are in favor of this treatment.

**Comments**

Many experimental studies show that several probiotics have positive effects on mucosal immune function and have directly or indirectly anti-inflammatory properties. However, data on clinical benefits of probiotics in infancy are scarce. This study confirms the results of a study published in 2010 by Italian investigators showing that *L. reuteri* given orally at the dose of 10^8 CFU to predominantly breastfed infants improved symptoms of infantile colic with no adverse events [5]. To a lesser extent a beneficial effect on infantile colic was also noted in the control group, which may be related to the natural history of infantile colic or a placebo effect. The study also showed an improvement in parental perception of colic severity and quality of life in the group treated with the probiotic strain. It should be kept in mind that both the Italian study and the present Polish study have been performed in breastfed infants. No data are available as to whether the addition of *L. reuteri* DSM 17938 to infant formula may also improve infantile colic in formula-fed infants. Sadly, health claims related to the efficiency of *L. reuteri* DSM 17938 can be found on the labeling of infant formulae available on the market in some European countries.

**Timing of the introduction of complementary feeding and risk of childhood obesity: a systematic review**

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**Background:** In 2007, the Committee on Nutrition of the European Society for Paediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN) recommended that in all infants, in consideration of their nutritional needs and developmental abilities, the complementary foods introduction should not be before 17 weeks and should not be delayed beyond 26 weeks [6]. In practice, complementary feeding is often introduced earlier than recommended. In developed countries, early introduction of complementary feeding has been associated with gastrointestinal problems, respiratory tract infections and an increased risk for allergy. The relationship to growth and body compo-
The timing of introduction of complementary foods has no clear association with childhood obesity, although very early introduction of solid foods (≤4 months of age) may result in increased childhood BMI.

The types of food introduced during complementary feeding and risk of childhood obesity: a systematic review

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**Background:** The determinants of childhood overweight and obesity are multiple and complex, but infant feeding and the early diet are important contributing factors. The objective of this review was to investigate whether the type of foods given during the complementary feeding period had an impact on BMI and body composition in children aged 4–12 years.

**Methods:** A systematic review of the literature investigated the relationship between the types of food consumed by infants during the complementary feeding period and overweight or obesity during childhood. Electronic databases were searched from inception until June 2012. Following the application of strict inclusion/exclusion criteria, 10 studies were identified and reviewed by two independent reviewers. Studies were categorized into three groups: macronutrient intake, food type/group and adherence to dietary guidelines.

**Results:** In some studies, an association was found between high protein intakes at 2–12 months of age and higher BMI or body fatness in childhood. Higher BMI in childhood was associated with higher energy intake during complementary feeding. Adherence to dietary guidelines during weaning was associated with a higher lean mass, but consuming specific foods or food groups made no difference to children’s BMI.

**Conclusion:** In very early infancy, a high energy intake, particularly dairy protein, may lead to higher BMI and higher body fatness during childhood. Further research is needed to establish this relationship. However, adherence to dietary guidelines during infancy may represent a greater likelihood of a healthy family diet, which leads to increased lean mass.
Weight change before and after the introduction of solids: results from a longitudinal birth cohort

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Background: One mechanism underlying the higher prevalence of obesity in children is the early introduction to solids that has been described in some studies as an accelerator of infant weight gain. Intake of fatty and sugary foods has been reported to be higher at 12 months in children with early introduction to solids. Another explanation is that infant weight gain precedes the introduction of solids. Indeed, a study showed that one of the reasons for parents to introduce solids earlier than recommended is that their infant was big for their age. The objective of this study was to examine the association between the very early (0–3 months), early (between 3 and 6 months) and timely (beyond 6 months) introduction of solids and weight change in infancy and early childhood. The authors hypothesized that infants that were introduced to solids very early and early were already heavier before introduction than infants who were introduced to solids after the age of 6 months.

Methods: Data from 3,184 children were used. The association, and its direction, between the introduction of solids and weight-for-height (WFH) change between birth and 45 months of age were studied. Pregnant women were asked to participate in a birth cohort (Generation R Study) during their first antenatal visit. The timing of the introduction of solids was reported by the mother from a questionnaire at 12 months postpartum and categorized into timing of solids introduction. Anthropometric data were collected during standardized child health center visits. Repeated-measurements analyses with splines positioned according to the time of solid introduction were used to obtain estimates for WFH change before and after the introduction of solids. Analyses were adjusted for educational level, ethnicity, smoking during pregnancy, mother’s BMI, breastfeeding, history of food allergy and infant’s hospital admission.

Results: Relative to mothers who introduced solids early, mothers who introduced solids after the age of 6 months were more often highly educated, non-smokers, breastfeeding for at least 6 months, and had more often an infant with a history of food allergy. Before solids were introduced, weight gain was significantly higher in children introduced to solids early (z-score = 0.65; 95% CI 0.34, 0.95) than in children introduced to solids very early (z-score = 0.02; 95% CI –0.03, 0.08) and timely (z-score = 0.04; 95% CI –0.05, –0.03). Shortly after the introduction of solids, children introduced to solids very early and early showed a relative decrease in WFH. No difference was found in WFH change between the solid introduction groups after 12 months, and at that time, weight change was as expected.

Conclusion: Children introduced early to solid foods had a higher increase in WFH before the introduction of solids than children introduced timely to solids. However, no evidence was found that early introduction of solids increases WFH.
The timely introduction of complementary foods during infancy is necessary for both nutritional and developmental reasons, and to enable the transition from milk feeding to family foods [6]. The ability of breast milk or infant/follow-on formula alone to meet requirements for macro- and micronutrients becomes limited with increasing age of the infant. Furthermore, infants gradually develop the ability to chew, and start to show an interest in foods other than milk. Complementary feeding, i.e. solid foods and liquids other than breast milk or infant/follow-on formula, is associated with major changes in both macro- and micronutrient intake. In contrast to the large literature on breast and formula feeding, little attention has been paid to the complementary feeding period, the nature of the foods given, or whether this period of significant dietary change influences later health and development. The limited scientific evidence base is reflected in considerable variation in complementary feeding recommendations between countries.

The two systematic reviews and the observational study described above increase our knowledge in the complex area of complementary feeding. We are still not able to confirm whether the timing of complementary feeding or the type of foods ingested play a role in the occurrence of overweight and obesity later in childhood. However, the observational study showed that adherence to dietary guidelines may represent a greater likelihood of a healthy family diet, which in turn leads to an increased lean mass. This highlights the need for a healthy balanced diet during childhood, rather than a focus on specific foods given or not during the complementary feeding period.

Studying the association between the early introduction of complementary foods and overweight and obesity later in life is a methodological challenge: (1) the association between early introduction of solids and weight gain may be related to reverse causality: infants experiencing rapid weight gain may be earlier, or later, introduced to solids; (2) there are many confounding factors that may influence the timing of complementary feeding, including educational level, socio-economic class, cultural background, smoking during pregnancy, mother’s BMI, breastfeeding, history of food allergy and infant’s hospital admissions. Even if the associations were adjusted for the most important confounders in the observational study, no information was available on the exclusivity of breastfeeding and on the intake of infant formula and complementary foods; (3) the age at introduction of complementary feeding is a simple exposure measure and ignores the complex dynamics of nutrition during the first 2–3 years of life; (4) the increasing prevalence of overweight and obesity is likely to be the result of a complex mixture of genetic, environmental, social, and nutritional factors. Therefore, identifying a single risk factor among so many variables is very difficult. Randomized clinical trials on complementary feeding patterns are urgently needed.

**Comparison of complementary feeding strategies to meet zinc requirements of older breastfed infants**

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**Background:** Because zinc concentration in breast milk (HM) declines over the early months of lactation, the zinc intake of an exclusively breastfed infant also declines. The Institute of Medicine
(IoM) set the estimated average requirement for zinc dietary intake at 2.5 mg/day. To meet physiologic requirements for zinc, the infant is progressively more dependent on complementary foods (CF). Previous studies from the same group in Denver showed that zinc intake from CF, including non-zinc-fortified infant cereal was about 0.5 mg/day at 7 months, with an additional 0.5 mg/day contributed by HM [7]. Therefore, traditional complementary feeding practices for older breastfed infants would not be able to meet zinc requirements for many infants. The primary objective of this study was to compare total daily zinc absorption and zinc status in older breastfed-only infants randomly assigned at 5 months of age (while exclusively breastfed) to different complementary feeding regimens. A secondary objective was to compare biomarkers of zinc status in the feeding groups.

**Methods:** Exclusively breastfed 5-month-old infants (n = 45) were randomly assigned to receive commercially available pureed meats, iron- and zinc-fortified infant cereal (IZFC), or whole-grain, iron-only-fortified infant cereal (IFC) as the first and primary CF until completion of zinc metabolic studies between 9 and 10 months of age. Measurement of the fractional absorption of zinc (FAZ) in human milk and CF was performed by using a zinc stable-isotope methodology with dual isotope ratios in urine. Calculated variables included the dietary intake from duplicate diets and 4-day test weighing, the total absorbed zinc (TAZ) from FAZ × diet zinc, and the exchangeable zinc pool size (EZP) from isotope enrichment in urine.

**Results:** Mean daily zinc intakes were significantly greater for the meat and IZFC groups than for the IFC group (p < 0.001); only intakes in meat and IZFC groups met estimated average requirements. Mean (±SEM) TAZ amounts were 0.80 ± 0.08, 0.71 ± 0.09, and 0.52 ± 0.05 mg/day for the meat, IZFC, and IFC groups, respectively (p = 0.027). Zinc from human milk contributed <25% of TAZ for all groups. The EZP correlated with both zinc intake (r = 0.43, p < 0.01) and TAZ (r = 0.54, p < 0.001).

**Conclusion:** The incorporation of meats into the dietary regimen at the time of initiation of complementary feeding is well accepted and provides an intake of zinc that meets estimated dietary requirements in a well-absorbed form. Zinc-fortified commercial infant cereals provide zinc intake and daily absorbed zinc similar to that of the meat group. Zinc requirements for older breastfed-only infants are met only with the regular consumption of either meats or zinc-fortified foods.

**Comments**

This is an important study, not only for older exclusively breastfed infants living in underprivileged parts of the world but also for those living in affluent countries. It provides information on intestinal absorption of zinc from different complementary feeding regimens. The results of the study clearly show that the daily absorbed zinc of fully breastfed infants is well below the requirements without consumption of either foods naturally high in zinc, such as meats, or micronutrient-fortified products. The mean plasma zinc concentration tended to be higher for the meat group, but the low sensitivity of this biomarker, small sample sizes in each group, and substantial variability support conclusions that plasma zinc concentrations are primarily useful for assessment of risk of zinc deficiency of populations [8]. For clinical settings, these results confirmed the value of a good diet history to judge risk of deficiency for older infants and toddlers who are predominantly breastfed. The results of this study also support complementary feeding recommendations by the WHO for settings with low resources where deficiencies of zinc and iron in infants and young children toddlers are widespread.
Timing of the introduction of complementary foods in infancy: a randomized controlled trial

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Background: In 2001, WHO changed the recommended duration of exclusive breastfeeding from the first 4–6 months to the first 6 months of life [9]. WHO stated that ‘the available evidence demonstrates no apparent evident risks in recommending, as a general policy, exclusive breastfeeding for the first 6 months of life in both developing and developed country settings’. The principle reason for this change was to provide optimal nutrition to young infants in low-resource countries where available water and complementary foods may be nutritionally inadequate or contaminated. However, there is still some controversy as to whether the iron intake of infants exclusively breastfed for 6 months in these low-income countries is sufficient to cover their needs at the end of the first semester of life. In high-income countries, no data are available on the iron status after 4 or 6 months of exclusive breastfeeding. One systematic review of the optimal age for the introduction of complementary foods concluded that there was inadequate evidence in high-income countries to increase the duration of exclusive breastfeeding from 4 to 6 months of age. WHO has requested randomized controlled trials to be done to guide policy decisions in this regard. The objective of the study was to examine the optimal duration of exclusive breastfeeding concerning the iron status and growth rate of infants in Iceland.

Methods: In this randomized, controlled trial, healthy term (≥37 weeks) singleton infants (n = 119) were randomly assigned to receive either complementary foods in addition to breast milk from the age of 4 months (CF) or to exclusive breastfeeding for 6 months (EBF). Data were collected regarding diet by 3-day weighed food records, iron status and growth.

Results: Infants in the CF group had higher mean serum ferritin (SF) levels at 6 months (70.0 ± 73.3 vs. 44.0 ± 53.8 μg/l, p = 0.02), which remained significant when adjusted for baseline characteristics. However, there was no difference between groups in the prevalence of iron deficiency anemia (Hb <10.5 g/l, MCV <74 fl, SF <12 g/l), iron deficiency (MCV <74 fl, SF <12 μg/l), or iron depletion (SF <12 μg/l). Infants in both groups grew at the same rate between 4 and 6 months of age. Mean energy intake from complementary foods at 5 months was 8.8 kcal/kg/day, which is approximately 10% of the average daily energy requirements for infants 6–11 months of age. The mean daily intake of iron from complementary foods was 0.6 mg, which is 8% of an infant’s average daily iron requirements at age 6–11 months.

Conclusion: In a high-income country, infants who receive a small amount of complementary food in addition to breast milk from 4 months of age had higher iron stores at 6 months compared with those exclusively breastfed for 6 months. However, no effect was found on the growth rate between 4 and 6 months.
This important study is the first one to examine the effects of exclusive breastfeeding for 4 vs. 6 months on iron status and growth in a high-income study. With respect to growth, the study confirms the conclusion of the systematic review which was the basis for the WHO recommendation regarding the optimal duration of exclusive breastfeeding. Whereas infants in the CF group had higher iron stores at 6 months compared with those in the EBF group, both groups had adequate stores as determined by SF levels and no significant differences were seen between groups in the prevalence of iron deficiency with or without anemia. Taking into account these results it is very unlikely that an infant exclusively breastfed for 6 months from a healthy mother in a high-income country will present iron deficiency/iron deficiency anemia or an impaired growth. Nevertheless, the growth pattern should be closely monitored using the WHO Child Growth Standards published in 2006 [10].

**Breastfeeding duration: influence on taste acceptance over the first year of life**

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**Background:** Among early feeding experiences, those related to milk feeding, whether it is breastfeeding or formula feeding, can have important impact on taste acceptance, which is one of the major determinants of food consumption in children. Compared with exposure to formula, exposure to maternal milk may result in sensory difference in terms of aroma and taste. Concerning aroma, some volatile compounds from the foods ingested by the mother are likely to be transmitted into her milk. Breast milk may bear a distinct flavor component which is likely to have an impact on infant behavior at the age of complementary feeding, as shown in several studies. Concerning taste, breast milk contains some compounds which bear a taste, such as lactose (sweet taste), glutamate (umami taste), Na (salty taste) and urea (bitter taste). Their concentration in breast milk differs from that in infant formula: the concentration of glutamate may be up to 14-fold higher and the concentration of Na is 2- to 4-fold lower. The impact of breastfeeding on later taste acceptance has been rarely assessed. The objective of this study was to examine the impact of exclusive breastfeeding duration (DEB) on the acceptance of sweet, salty, sour, bitter and umami taste solutions at 6 and 12 months.

**Methods:** Participating mothers were recruited before the last trimester of pregnancy. Data were reported for 122 infants (62 males), with a birth weight of 3.31 (SD 0.51) kg and a birth length of 50.0 (SD 2.4) cm. Mothers recorded the DEB. Acceptance of solutions of each of the five basic tastes relative to water was evaluated at 6 and 12 months by the ingestion ratio (IR) [11]. The IR of a taste was defined as the ingested volume of this taste solution relative to the sum of the ingested volumes of this taste solution and of water. This IR is interpreted as follows: ratio at 0.5 indicates indifference to the taste solution; ratio >0.5 indicates a preference for the taste solution over water; ratio <0.5 indicates a rejection of the taste solution over water. Kendall correlations were calculated between the DEB and the IR.

**Results:** Only 16% of infants completed at least 6 months of exclusive breastfeeding; 79% had begun complementary feeding by 6 months. At 6 months, infants preferred sweet, salty and umami solutions over water and were indifferent to sour and bitter solutions. The longer an infant was breastfed, the more the umami solution was accepted at 6 months (p = 0.02). At 12 months, infants pre-
ferred sweet and salty solutions over water and were indifferent to sour, bitter and umami solutions. The relationship between the DEB and acceptance of the umami solution was no more observed at 12 months. No relationship was observed between the DEB and sweet, salty, sour and bitter taste acceptance at 6 or 12 months.

**Conclusion:** This study highlights the role of exclusive breastfeeding in the establishment of taste acceptance, with a positive impact of longer breastfeeding duration on umami taste acceptance at 6 months, maybe related to the higher glutamate content of human milk compared with formula milk. It suggests that prolonged breastfeeding could also be associated with an impact on sensory preference at the beginning of complementary feeding.

**Comments**

As suggested by the authors, the observed association between the DEB and umami taste preference at 6 months, studied using monosodium glutamate, is likely to be related to the effect of exposure to glutamate in breast milk. The interpretation of the results is somewhat limited by the fact that breast milk was neither analyzed for taste compound composition, nor evaluated by a sensory panel to characterize its perceived taste. The impact of exclusive breastfeeding on umami taste acceptance is transient. It was observed at an age close to the beginning of complementary feeding and could favor the initial acceptance of umami-tasting foods. This could constitute a ‘taste bridge’ effect, in the same way that a ‘flavor bridge’ effect was previously described by Mennella et al. [12] regarding flavor transition from breast milk to a solid diet. Concerning salty taste, the results of Schwartz et al. did not confirm previous findings. A specific limitation to any study on breastfeeding is that it is not possible to carry out interventional studies randomizing breastfeeding. Rate and duration of breastfeeding may vary according to several factors, in particular the mother’s social status.

Even with some methodological limitations, this important paper adds more knowledge to the fascinating area of the sensory and behavioral consequences of very early feeding on feeding behavior and feeding patterns later in life. Research in the field of complementary feeding should be encouraged by governments, official bodies and research agencies and not only by the industry.

**References**


