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Complementary Food and Obesity

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Key Messages

- The introduction of solid foods during early life significantly influences obesity risk. Timing and content are crucial factors in shaping long-term eating habits.
- Childhood overweight and obesity often persist into adulthood, leading to serious long-term health complications such as hyperglycemia, dyslipidemia, and hypertension.
- Early prevention programs that educate parents about responsive feeding and dietary choices show promise in reducing obesity risk. These programs emphasize the need to consider parents' perceptions and motivations for effective interventions.

Keywords

Complementary feeding · Infants · Obesity · Solid foods · Protein intake

Abstract

Background: Early infant feeding is essential for children's development and future health, particularly in preventing obesity, which is the most common nutrition-related disorder in children worldwide. ***Summary:*** Obesity, characterized by excess body fat and numerous complications, arises from a combination of genetic susceptibility and an obesogenic environment, including lifestyle behaviors related to energy balance. Eating habits start to be shaped early in life, making the introduction of solid foods a critical period. Given the high prevalence of obesity, its long-term health consequences, and social implications, prevention is crucial. This narrative review aimed to identify factors related to the introduction of solid foods that influence obesity and suggest feeding strategies to prevent it. Tracking studies indicate that overweight and obesity during childhood often persist into adulthood, with associated complications such as hyperglycemia, dyslipidemia, hypertension, and nonalcoholic fatty liver disease. Complementary feeding involves introducing solid foods besides breast milk or formula. The timing and content of complementary feeding are crucial in influencing obesity risk. Introduction of solid foods before 4 months is associated with higher BMI in childhood. The method of introducing complementary feeding, such as baby-led weaning, has been proposed to predict later obesity risk, though findings are currently inconclusive. Parental feeding practices and socioeconomic factors significantly influence complementary feeding and obesity risk. Early prevention programs, especially those involving parental education on responsive feeding and diet, are promising for reducing obesity risk. Future programs should incorporate parents' perceptions and motivations to improve intervention effectiveness.

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Introduction

Early infant feeding is crucial for the adequate development of children and their future health during childhood and adult life. This is especially relevant when trying to prevent the

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development of obesity [1]. Worldwide, obesity is the most common nutrition-related disorder in childhood [2]. Obesity is characterized not only by an excess of body fat, but also by a plethora of associated complications already present during childhood [3]. Obesity develops because of a combination of genetic susceptibility and exposure to an obesogenic environment, including energy-balance-related lifestyle behaviors [4]. Eating habits develop from early ages, and the period of introduction of the first solid foods is critical in this development.

Worldwide, obesity is the most common nutrition-related disorder in childhood

Given the high obesity prevalence, its long-term health consequences, its social implications, and the difficulties for treating the condition once it is established, the ideal approach to deal with this chronic disease is to try to prevent it. Prevention should start as soon as possible, and early introduction of solid foods is recognized as one of the most adequate periods [5]. Therefore, the aims of this narrative review were to identify factors related to introduction of solid foods as determinants of obesity and to suggest potential feeding strategies to prevent the development of obesity later in life. This review does not consider the impact of different aspects of complementary feeding introduction on other health outcomes.

Epidemiology of Childhood Obesity

Obesity Prevalence and Trends

The worldwide prevalence of overweight and obesity in children and adolescents in the period 2000 to 2023 was recently reported from a systematic review. In the included studies, diagnosis was based on body mass index (BMI) cut-offs proposed by accepted references and was performed in the general population between January 2000 and March 2023. Two thousand thirty-three studies from 154 different countries or regions were included. In children and adolescents, combined overweight and obesity prevalences were 14.8% (95% CI: 14.5–15.1) and 22.2% (95% CI: 21.6–22.8), respectively. The overall prevalence of obesity in children and adolescents was 8.5% (95% CI: 8.2–8.8). The prevalence varied between countries, from 0.4% (Vanuatu) to 28.4% (Puerto Rico) [6].

In the fifth round of the World Health Organization (WHO) European Childhood Obesity Surveillance Initiative (COSI), 2018–2020, in the 33 countries of the WHO European Region that collected data, 29% of children aged 7–9 years were living with overweight (including obesity), according to WHO definitions. Prevalence among boys was 31%, while among girls it was 28%. The highest prevalence of overweight among children (both genders) was observed in Cyprus, Greece, Spain, and Italy. Prevalence was lowest in Tajikistan, Denmark, Israel, and Kazakhstan. Prevalence of obesity was 12%: 14% among boys and 10% among girls. Country-specific prevalence of obesity among children ranged from 1% in Tajikistan to 19% in Cyprus. Prevalence among children (both genders) was highest in Cyprus, Italy, Greece, and Spain, and lowest in Tajikistan, Denmark, Kazakhstan, and Israel [7].

Recently, the worldwide trends in obesity were also reported. In 2022, school-aged children and adolescents showed an age-standardized prevalence of obesity higher than 20% in girls in 21 countries (11%) and boys in 35 countries (18%). These countries were mainly in Polynesia and Micronesia, Latin America and the Caribbean, and the Middle East and North Africa. From 1990 to 2022, age-standardized prevalence of obesity increased in girls in 186 countries (93%) and in boys in 195 countries (98%). In most countries, obesity has more than doubled. The largest increases were in countries from Polynesia and Micronesia and the Caribbean, Brunei, and Chile [8].

The combined prevalence of obesity and thinness (double burden) was also reported. In 2022, the countries with highest combined prevalence in school-aged children and adolescents were in Polynesia and Micronesia and the Caribbean for both sexes, and Chile and Qatar for boys. Combined prevalence was also high in some South Asian countries, such as India and Pakistan, where thinness is still highly prevalent. In almost all countries, the increases in double burden were driven by increases in obesity and decreases in double burden, by declining in underweight or thinness [8].

Tracking of Obesity

The majority of studies assessing obesity tracking have shown that child BMI or weight status tracks over time. In a systematic review published in 2008, 25 publications were selected and 13 studies were considered to be of high quality. All included studies consistently reported an increased risk for children with overweight and obesity of having overweight as adults, suggesting that the likelihood of tracking of overweight into adulthood is moderate for children with overweight and obesity [9]. Another systematic review, including fifteen cohort studies in a meta-analysis of 200,777 participants, reported that children with obesity were five times more likely to have

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obesity in adulthood as compared with children not having obesity; moreover, around 55% of children with obesity will have obesity in adolescence, around 80% of adolescents with obesity will still have obesity in adulthood, and around 70% will have obesity over the age of 30 years [10].

Concerning tracking of severe obesity, in a longitudinal study including 11,591 schoolchildren, 3,096 of whom were examined as adults, it was observed that 78% of children with severe obesity at one examination had severe obesity at the next examination after a mean period of 2.7 years [11]. In relation to tracking determinants, this issue was investigated in two cohorts of Australian children with follow-up to age 12/13 and 16/17 years. Children of lower socioeconomic status, those from culturally diverse backgrounds and girls, were more likely to move into overweight and less likely to resolve their overweight during childhood. Persistence of weight status was not significantly affected by rurality or Indigenous status [12].

Short- and Long-Term Health Consequences

Obesity in children and adolescents is associated with several complications. In children and adolescents aged 5 to 18 years, a systematic review including nineteen studies reported the prevalence of more than one comorbidity; comorbidities were grouped in eight types: (1) hyperglycemia, (2) dyslipidemia, (3) hypertension, (4) nonalcoholic fatty liver disease (currently named as metabolic dysfunction-associated steatotic liver disease), (5) cardiovascular risk, (6) pulmonary disorder, (7) psychological comorbidities, and (8) other comorbidities. In children with obesity, prevalence of prediabetes (fasting glucose ≥100 mg/dL) was 10.5%, high blood pressure (>90th percentile) 19.5%, and nonalcoholic fatty liver disease (ultrasound) 46.7%. Studies for psychological comorbidities were lacking to draw conclusions [13].

The most harmful long-term consequences of childhood obesity are cardiometabolic complications

The most harmful long-term consequences of childhood obesity are cardiometabolic complications. In a systematic review, considering the prevalence of metabolic syndrome in the majority of the countries in the world, it was observed that in 2020, the global prevalence of metabolic syndrome was 28% (95% uncertainty interval: 1.4–6.7) for children and 48% (2.9–8.5) for adolescents, estimating around 25.8 (12.6–61.0) million children and 35.5 (21.3–63.0) million adolescents having metabolic syndrome. The three countries with the highest prevalence in children were Nicaragua (5.2%, 2.8–10.4), Iran (8.8%, 8.0–9.6), and Mexico (12.3%, 11.0–13.7); the three countries with the highest prevalence in adolescents were Iran (9.0%, 8.4–9.7), United Arab Emirates (9.8%, 8.5–10.3), and Spain (9.9%, 9.1–10.8) [14].

Concerning long-term consequences, persistent overweight trajectories from childhood to adulthood were associated with a higher risk of hypertension (RR: 2.49; 95% CI: 1.9, 3.28) and type 2 diabetes (RR: 4.62; 95% CI: 2.36, 9.04) compared with a trajectory characterized by a normal BMI throughout childhood and adulthood. The risk of hypertension (RR: 2.38; 95% CI: 1.70, 3.33) and type 2 diabetes (RR: 3.66; 95% CI: 2.57, 5.19) was also higher in those with normal to overweight trajectory compared with participants with a permanent normal weight trajectory [15]. In addition, there is also an intergenerational transmission of obesity, as children, especially girls, who become adults with obesity are at risk of having children with obesity [16].

Economic Impact

Overweight/obesity has a large impact on national economies, through reduced productivity, increased disability, increased health care costs, and reduced life expectancy. For example, in China between 2000 and 2009, the estimates of increased health care costs associated with obesity grew from 0.56% to 3.13% of China's annual national health care expenditure. In Brazil, obesity-related health care costs are expected to double, from USD 5.8 billion in 2010 to USD 10.1 billion in 2050 [17].

Based on 6 studies, it was estimated that USD 19,000 was the incremental lifetime medical cost of a child having obesity at the age of 10 years, relative to a child of the same age with normal weight, maintaining normal weight throughout adulthood. If the possibility of weight gain among normal weight youth was considered, the incremental lifetime medical cost was USD 12,660 [18].

In a systematic review considering 13 articles with information on health care and productivity costs, the mean total lifetime cost of a child or adolescent with obesity was EUR 149,206 for a boy and EUR 148,196 for a girl. The ratio between costs related with productivity losses and health care costs was 8.19 in boys and 6.55 in girls [19].

Complementary Feeding and Obesity

Complementary feeding, as defined by the ESPGHAN Committee of Nutrition, corresponds to all solid and liquid foods other than breast milk or infant formula that are given to infants when

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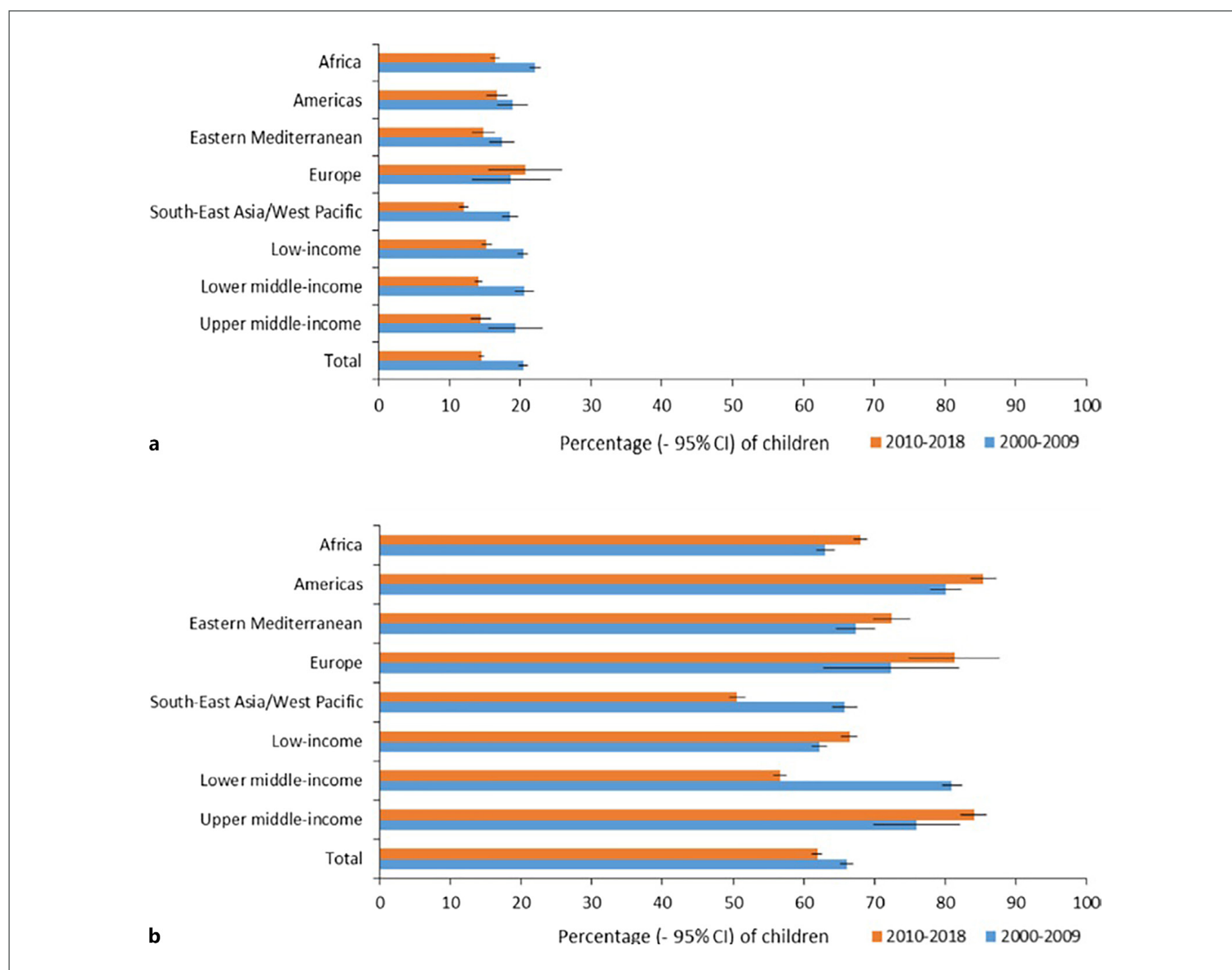

Fig. 1. Trends in regional weighted prevalence of introduction of solid, semisolid, or soft foods under 6 months (**a**) and at 6–8 months (**b**) in 44 selected LMICs, by WHO regions and World Bank income [18].

breast milk or formulas are no longer sufficient to meet their nutritional requirements [5]. The prevalence of complementary feeding at different ages, in some low- and middle-income countries, is displayed in Figure 1. For the introduction of solid, semisolid, or soft foods under 6 months, the prevalence decreased from 2000–2009 to 2010–2018, in all the considered regions, except in Europe; in 2010–2018, the prevalence was in general around 15%, except in Europe where it was around 20%. For the introduction of solid, semisolid, or soft foods at 6–8 months, the prevalence in 2010–2018 ranged from around 50% in South East Asia/West Pacific, to higher than 80% in Europe and the Americas [20]. In this section, the main determinants of obesity development related to different complementary feeding characteristics are reviewed.

Content of Complementary Feeding and Obesity

In terms of energy, it was observed that high consumption of energy-dense complementary feeding may induce excessive weight gain in infants that was also associated with a 2- to 3-fold higher risk of obesity during childhood [21, 22]. In relation to total protein intake, some studies showed that a high proportion of energy from protein during complementary feeding was associated with either body weight or BMI in later childhood [23, 24]. The most controversial aspect is related to the different protein sources. In this regard, a systematic review showed that there was not enough evidence on the association between animal protein sources, especially dairy products and growth, when compared with vegetable protein sources; however, a direct association between a high intake

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of milk and serum insulin-like growth factor 1 concentrations was suggested as a mechanism for the potential role of dairy products [25].

More recently, some studies have investigated the impact of different protein sources such as meat, dairy, and vegetables on growth and body composition in infants. In a study including infants born at term and receiving formula feeding, they were randomly allocated to a group consuming meat or another group consuming dairy foods, from 5 to 12 months of age. In both groups, total protein intake was similar, 3 g/kg body weight/day. Consumption of the rest of the foods, infant formula, cereals, fruits, and vegetables was ad libitum. The increase in mean total protein intake was similar in both groups. During the follow-up, length-for-age *z* score increased in the meat group (0.33 ± 0.09, p = 0.001) and decreased in the dairy group (−0.30 ± 0.10, p = 0.0002). Weight-for-length showed a higher increase in the dairy group (0.76 ± 0.21, p = 0.000002) as compared with the meat group (0.30 ± 0.17, p = 0.55) [26].

In the same trial, at 24 months of age, weight-for-age *z* score and weight-for-length *z* score were similar in both groups and also similar to the values observed at 12 months. In addition, serum insulin-like growth factor 1 concentrations increased significantly from 12 to 24 months in both groups. At the end of the follow-up, length-for-age *z* score still was significantly higher in the meat group as compared with the dairy group [27].

Vegetables are traditionally one of the first food groups that are introduced as complementary feeding. It is also a food group showing difficulties for their consumption during childhood. For this reason, it seems important to promote their intake. Exposure to vegetables during the first 4 weeks of complementary feeding as compared with a combination of fruits and vegetables (control group) was associated with increased vegetable consumption (broccoli and spinach provided by the study) at the age of 9 months [28].

In contrast, in a 4-arm randomized controlled trial including 246 first-time mothers and their infants, an intervention promoting repeated exposure to a variety of vegetables or an intervention promoting responding sensitively to child signals during mealtime (separately or combined with an attention control condition) showed that no intervention was effective in increasing vegetable consumption [29]. Vegetarian and vegan diets have been proposed to be consumed even during the complementary feeding period; however, there is some evidence of being associated with a high risk of micronutrient deficiencies or insufficiencies and growth retardation, when compared with omnivorous diets or even diets with high vegetable content such as the Mediterranean diet [30].

Timing of Complementary Feeding Introduction and Obesity

At the age of 4–6 months, breast milk or infant formula alone is no longer adequate to meet an infant's energy and nutrient requirements, and solid foods are recommended to be initiated [31]. The WHO recommends starting to provide solid foods to infants after 6 months of age [32]; however, these recommendations were based on the prevention of infectious diseases, mainly in low- and middle-income countries. In this regard, a Cochrane review showed that the main benefits of exclusive breast-feeding for 6 months as compared with 3–4 months were lower infant morbidity from gastrointestinal and respiratory infections and more rapid maternal weight loss after delivery [33].

At the age of 4–6 months, breast milk or infant formula alone is no longer adequate to meet an infant's energy and nutrient requirements

Two systematic reviews showed no clear association between complementary feeding introduction with children's obesity risk, with the exception of solid food introduction before 4 months, which has been associated with greater obesity risk [31, 34]. Another systematic review showed that the majority of studies, including the only randomized controlled trial and 5 high-quality studies with adequate adjustment for confounders, showed no association between age at introduction of solids and later anthropometry or risk of obesity [35].

More recent studies showed that introduction of solid foods before 4 months or after 6 months was associated with a greater BMI later during childhood [36, 37]. In terms of recommendations by scientific societies, the American Academy of Pediatrics [38] and the Canadian Paediatric Society [39] recommend that solid foods should be introduced around 6 months of age. Introduction of infant cereals at 4 vs. 6 months was associated with higher BMI *z* score, increased risk of obesity, and less favorable eating behavior, supporting the recommendation for introducing solid foods around 6 months of age [40].

The European Society for Paediatric Gastroenterology, Hepatology, and Nutrition [5] recommends that solid foods should be introduced between 4 and 6 months of age. Supporting this recommendation, some cohort studies did not observe a protective effect of delaying complementary

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feeding after 6 months, as compared to introducing solid foods from 4 to 6 months [41–44]. A randomized control study allocating infants to 4 or 6 months of exclusive breast-feeding also reported no significant difference in the risk of overweight or obesity between groups [45]. In the EAT randomized trial comparing early introduction of six foods (peanut, cooked egg, cow's milk, sesame, whitefish, and wheat) with exclusive breast-feeding to approximately 6 months, there was higher BMI in the intervention than in the control group at 12 months, but no difference at the age of 3 years [46].

Breast-feeding could attenuate the impact of the timing of solid food introduction on weight-related outcomes. This factor was not considered in the majority of studies. In a Dutch birth cohort, the association between complementary feeding introduction before 4 months and overweight until the age of 17 years was observed in both formula- and breast-fed infants; the duration of breast-feeding shorter than 4 months had an additional effect on overweight [47]. In another cohort, complementary feeding started at 4 months was associated with higher adiposity during childhood, but only in breast-fed infants; however, these associations persisted at adolescence for waist circumference, truncal fat, and the sum of triceps and subscapular skinfolds, but mainly in formula-fed infants [37].

Methods of Introduction of Complementary Feeding and Obesity

Complementary feeding is usually started with baby cereals together with formula milk and fruits, vegetables, meat, poultry, or fish in the form of purées. These purées progressively evolve from a thin to a thicker texture, until family foods are offered to the child. International recommendations suggest that children should not be given finger foods until the age of 8 months, these should not replace baby cereals or purées, and they should eat family foods at the age of 12 months [48].

Baby-led weaning (BLW), auto-weaning, or regulated self-nutrition is an emergent way of infant feeding that could influence children's health. BLW is based on the observation that from 6 months, infants join the family at meal times, they are able to select what they wish to eat, and they may feed themselves. Infants use their hands firstly, and then they use cutlery. Infants decide what, how much, and how fast they eat. Adults decide what to offer, being just a facilitator or passive player in the feeding process [49].

A study in 6,355 Spanish women showed that 38.6% of them had heard about BLW and the overall prevalence of BLW was 14%. Exclusive BLW was reported in 2.1% of the cases. Infants fed with BLW had higher likelihood of previously having exclusive breast-feeding (OR: 4.1 [95% CI: 3.3–5.0]), living in a urban environment (OR: 1.6 [1.2–2.2]), and having higher maternal education (OR: 1.3 [1.1–1.5]) [50].

In a systematic review about the potential association between BLW and obesity, including 8 articles (6 observational studies and 2 randomized control trials), results were inconclusive, with some studies showing lower weight gain in those fed by BLW, but other not [51]. In the Baby-Led Introduction to Solids (BLISS) randomized control trial, including 206 women in late pregnancy, after 12 and 24 months, BMI *z* score was not significantly different between control and intervention (BLW) groups. At 12 months, those infants in the BLW group showed less food fussiness and greater enjoyment of food. At 24 months, those in the BLW group showed lower satiety responsiveness [52]. In fact, the negative influence of BLW on eating behavior development could be the pathway to develop obesity later in life. In a cohort study, it was also observed that BLW or using a mixed approach was associated with higher enjoyment of food and lower food fussiness at the age of 3 to 6 years [53]. In a systematic review on the association between eating behaviors and adiposity, it was observed, in cross-sectional and longitudinal studies, that higher enjoyment of food and food responsiveness were directly associated with BMI *z* score [54].

Infants should not only receive essential nutrients but also learn important habits that affect how they will eat

Theories behind the Effects of Complementary Feeding Introduction on Obesity

In this section, factors related to complementary feeding that may potentially modulate later obesity risk are briefly discussed; they should be considered in the design of complementary feeding recommendations. Infants should not only receive essential nutrients but also learn important habits that affect how they will eat. Complementary feeding is influenced by their family and social environment, which can either increase or decrease their risk of developing obesity. Understanding how these factors work together is crucial for creating effective ways to prevent obesity (Fig. 2) [55].

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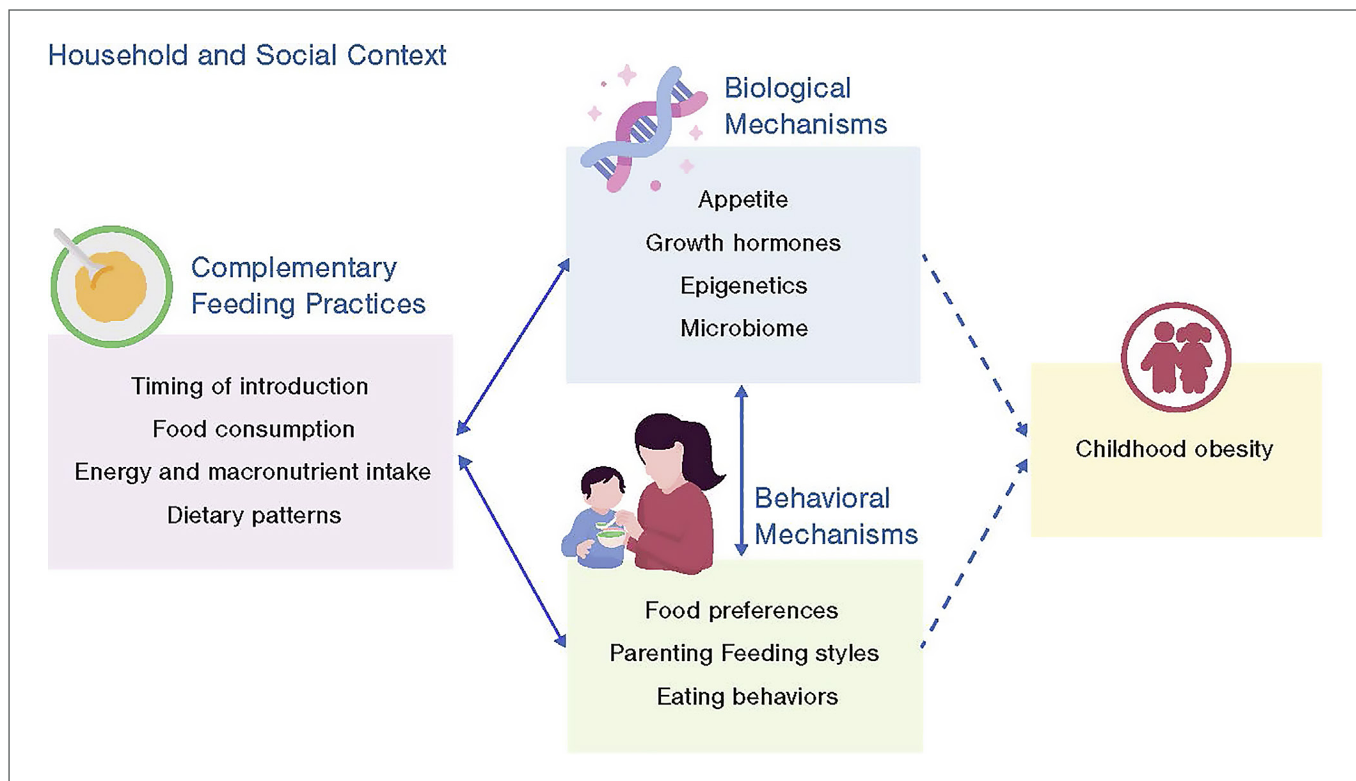

Fig. 2. Pathways linking complementary feeding practices to pediatric obesity. Adapted from Thompson [55].

Introduction of solid foods may influence how infants regulate their appetite by affecting the hormonal control of hunger and satiety; in this way, high protein intakes during complementary feeding seem to enhance insulin and insulin-like growth factor secretion leading to increased fat deposition and adipocyte differentiation [56]. Epigenetic programming in infants may also be modulated during the complementary feeding period by the intake of high-energy diets or high consumption of some nutrients such as dietary fats; however, the great majority of studies showing these results were conducted in animal models [57].

Complementary feeding also influences the colonization of the gut microbiota. The introduction of solid foods has been associated with increased bacterial diversity [58, 59]. In the LISS study, high consumption of fruits and vegetables, breads and cereals, and dietary fiber at 7 months was associated with an increase in alpha diversity at 12 months and decreased relative abundance of bacteria associated with milk consumption, as Bifidobacteriaceae and Veillonellaceae and increased Lachnospiraceae and Ruminococcaceae; their relative increases have been attributed to the introduction of solid foods, as both Lachnospiraceae and Ruminococcaceae have species that are known to play a role in polysaccharide degradation [59]. In a randomized clinical trial in infants 5 months of age receiving meats or micronutrient-fortified cereals as the primary complementary food until 9 months, a more abundant butyrate-producing Clostridium group XIVa in the meat group was observed; Clostridium group XIVa, of the phylum Firmicutes, comprises a number of beneficial species capable of producing butyrate, a short-chain fatty acid that is metabolized by enterocytes [60]. In Danish infants, it was observed that microbiota composition was associated with adipose deposition; body mass increase from 9 to 36 months was positively associated with changes in the relative abundance of Firmicutes, Clostridium, and Eubacteria species, and negatively associated with bacterial strains of the Enterobacteriaceae family [61], emphasizing the relevance of high consumption of fruits and vegetables, breads and cereals, and dietary fiber during the complementary feeding period [59]. In Finnish children, overweight at the age of 7 years was also associated with microbiota colonization at 6 and 12 months [62]. A potential strategy to reduce weight gain could be to add probiotics to complementary feeding foods. However, one study providing *Lactobacillus paracasei* ssp. paracasei F19 (LF19) did not affect BMI *z* score, sagittal abdominal diameter, fat-free mass, fat mass index, truncal fat %, android or gynoid fat % [63].

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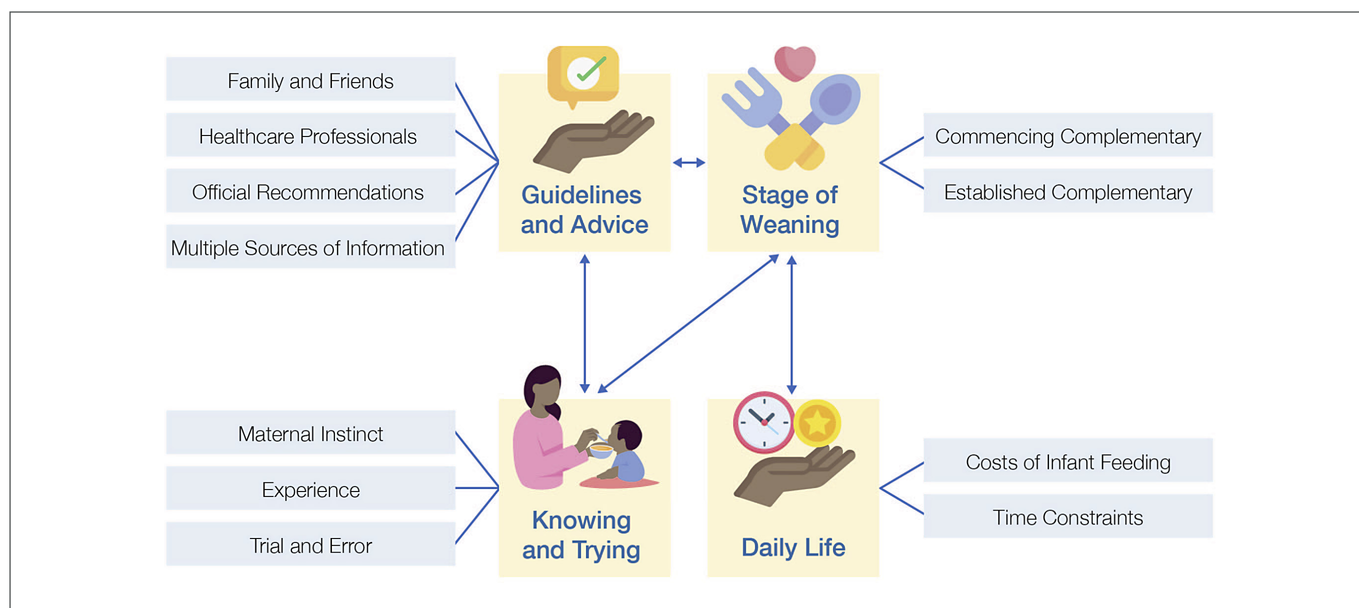

Fig. 3. Visual representation of themes and subthemes. Bidirectional arrows represent reciprocal relationships between themes, where aspects of one theme influence aspects of the other. Stages of weaning, for instance, had a reciprocal relationship with all other themes, with different experiences and perceptions emerging at different stages. Adapted from Hennessy et al. [70].

Food preferences and eating habits develop early in life, and acceptance of new foods is associated with early food variety, food frequency exposure, and the sensory properties of the foods [64]. This is relevant mainly for foods that are difficult to have accepted; for instance, infants consuming fruits and vegetables at 6 months showed greater intakes of fruits and vegetables at the age of 7 years [65]. At the opposite, high exposure to commercial foods for infants was associated with high early sugar intake also contributing to children's sugar preferences and intake [66]. Not only taste, but also texture play an important role in food acceptance [67].

Parental feeding practices during complementary feeding may also contribute to obesity development. Feeding practices characterized by higher maternal control, such as restrictive and pressuring styles, were associated with higher energy intake; restriction was associated with better feeding practices and higher infant weight-for-age z score, and pressuring was associated with inadequate feeding practices and lower infant weight-for-age z score [68].

Socioeconomic factors are also associated with complementary food consumption and timing of their introduction. Low maternal education and income were associated with early introduction of complementary foods [69]. Parental diets also influence infant's dietary patterns characterized by low fruit and vegetable consumption and high snack and sugar-sweetened beverage consumption [16].

Successful Programs for Early Obesity Prevention

Early prevention of childhood obesity, during the first 2 years, has been suggested as the most promising period. Interventions delivered by health professionals during this period showed that four studies were effective in terms of adiposity/weight and at least one behavioral outcome; however, twenty-two were effective only at the level of behavioral outcomes [70]. In a systematic review of randomized control trials aiming to reduce the risk of overweight and obesity before 2 years of age, the most effective interventions were those focusing on diet and responsive feeding, including education of parents and caregivers on issues related to hunger and satiety cues and infant eating behaviors [71].

In a trial including 468 Italian newborns, pediatricians provided an educational program from birth until the age of 2 years. Intervention infants benefited of promotion of breastfeeding, feeding on demand, responsive feeding, timely complementary feeding, food portions based on child's appetite, providing varied protein sources, and playing active games. At 3 months of age, higher proportion of infants from the intervention group were fed on demand as compared with the control group (93% vs. 80%, $p < 0.001$). At the age of 2 years, obesity prevalence was 35% lower in the intervention as compared with the control group; however, this difference was not statistically significant (13.4% vs. 8.7%; $p = 0.10$) [72].

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Failure of interventions to show significant results in terms of obesity prevention effectiveness should be analyzed. The majority of the interventions are completely defined by health professionals and researchers without considering the perceptions and motivations of the families. In general, parents wish to be involved in improving their infant's feeding process. In a thematic synthesis of studies on parental experiences and perceptions of infant complementary feeding, four main topics were identified: guidelines and advice; stage of weaning; daily life; and knowing and trying (Fig. 3) [73]. All these areas should be considered when designing intervention studies and programs in infants.

To fill the research gaps on obesity prevention during the complementary feeding period, more clinical trials should be performed using different feeding strategies and timing of provision of different complementary feeding foods. To be more successful, parental perceptions, attitudes, wishes, and motivations should be previously assessed.

Conclusions

Early introduction of energy-dense foods and high protein intake, mainly from animal sources, is associated with an increased risk of childhood obesity. Introduction of solid foods before 4 months of age is also associated with an increased risk of obesity later during childhood. The introduction of solids around 6 months appears to be the optimal period. The BLW approach for infant feeding, where infants self-feed from the family's meals, has shown mixed results in terms of obesity prevention; however, some studies suggest BLW might promote healthier eating behaviors. Complementary feeding affects the hormonal control of hunger and satiety and influences the gut microbiota composition. High protein intakes can increase insulin and insulin-like growth factors, promoting fat deposition. The diversity of the gut microbiota, shaped by early diet, can also impact weight gain and obesity risk. Parental feeding practices, such as restrictive or pressuring feeding styles, and socioeconomic factors, including maternal education and income, significantly influence the timing and content of complementary feeding. Provision of clear, consistent information and guidance from trusted sources on when, what, and how to feed infants during the complementary feeding period is essential to improve infant's future optimal eating behaviors and health.

Conflict of Interest Statement

The author has no conflicts of interest to declare.

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Author Contributions

L.A.M. conceived and wrote the review.

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