

Margarida Clara Oliveira Neves

**Feeding practices in childhood and their association with the child's body weight –
a literature review**

Faculdade de Ciências da Saúde

Universidade Fernando Pessoa

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Declaro, para os devidos efeitos, ter atuado com total integridade na elaboração deste Trabalho de Projeto. Atesto a originalidade do trabalho, confirmo que não incorri em plágio e que todas as frases que retirei de textos de outros autores foram devidamente citadas ou redigidas por outras palavras e convenientemente referenciadas na bibliografia.

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(Margarida Clara Oliveira Neves)

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LIST OF ACRONYMS AND ABBREVIATION

BLW	<i>Baby Led-Weaning</i> (do português Desmame Conduzido pelo Bebê)
TSF	<i>Traditional Spoon Feeding</i> (do português Alimentação Tradicional à Colher)
FITS	<i>Feeding Infants and Toddler Study</i> (do português Estudo sobre Alimentação de Bebês e Crianças Pequenas)
BMI	<i>Body Mass Index</i>
mg	<i>Milligram</i>
OR	<i>Odds Ratio</i>
RR	<i>Relative Risk</i>
ug	<i>Microgram</i>
US	<i>United States</i>
vs	<i>Versus</i> (do português Contra)
WHO	<i>World Health Organization</i> (do português Organização Mundial de Saúde)
ESPGHAN	<i>Enteral Society for Paediatric Gastroenterology Hepatology and Nutrition</i> (do português Sociedade Europeia de Gastroenterologia, Hepatologia e Nutrição Pediátrica)

TITLE/ AUTHORS/ ACADEMIC AFFILIATION

Title – Feeding practices in childhood and their association with the child’s body weight

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RESUMO

Introdução: Nos últimos anos tem havido uma preocupação com o aumento substancial da obesidade infantil e, conseqüentemente com a sua prevalência na vida adulta. Tem também surgido um interesse crescente sobre o melhor método de desmame, de forma a potenciar o desenvolvimento adequado da criança e prevenir possíveis problemas futuros.

Objetivo: O objetivo desta revisão bibliográfica é analisar a literatura científica referente ao momento de introdução da alimentação complementar, comparando os métodos, identificando os riscos e os benefícios e a sua associação com a obesidade infantil.

Metodologia: Como fonte de dados utilizou-se a US National Library of Medicine (PubMed) e a pesquisa foi realizada em setembro de 2023, referente aos últimos 15 anos. Excluíram-se cartas ao editor, livros bem como os artigos que se encontravam fora do tema.

Resultados: Os métodos de introdução da alimentação complementar podem influenciar resultados posteriores na vida das crianças como as preferências alimentares, o apetite e o comportamento alimentar. O método de introdução alimentar tradicional é recomendado pela OMS, e baseia-se em apresentar ao bebé refeições com textura cremosa e à colher, transitando gradualmente para texturas menos homogêneas. Apresentam menos carências nutricionais, mas por outro lado, podem comprometer o desenvolvimento da autorregulação da ingestão uma vez que o controlo é dos pais. O desmame conduzido pelo bebé (BLW) mostra-se promissor no que diz respeito ao desenvolvimento da criança e na aceitação de novos alimentos, mas apresenta como preocupação o risco de engasgo e carências nutricionais e energéticas.

Conclusões: Investigar estas questões é desafiador, devido à complexidade das práticas de alimentação complementar, que limitam a viabilidade e a generalização de estudos. Não foi encontrada evidência consistente entre qual o melhor método de introdução da alimentação complementar para reduzir a probabilidade de desenvolver obesidade, mas, foi amplamente sugerido que deve ser adaptado às necessidades individuais de cada criança, com a inclusão de uma variedade de alimentos e texturas e evitando-se a introdução de alimentos sólidos antes dos 4 meses de idade.

Palavras-chave: amamentação, alimentação complementar, desmame conduzido pelo bebê, alimentação tradicional à colher, obesidade infantil.

ABSTRACT

Introduction: In recent years there has been concern about the substantial increase in childhood obesity and, consequently, its prevalence in adult life. There has also been a growing interest in the best weaning method, in order to promote the child's adequate development and prevent possible future problems.

Objective: The objective of this review is to analyze the scientific literature regarding the introduction of complementary foods, comparing existing methods, their benefits and risks, and their association with childhood obesity,

Methodology: The US National Library of Medicine (PubMed) was used as data source and the search was carried out in September 2023, covering the last 15 years. Letters to the editor, books and off-topic articles were excluded.

Results: The methods used to introduce complementary feeding can influence later outcomes in children's lives, such as food preferences, appetite and eating behavior. The traditional method of introducing food is recommended by the WHO and is based on introducing babies to meals with a creamy texture and by spoon, gradually moving on to less homogeneous textures. These have fewer nutritional deficiencies, but on the other hand, they can compromise the development of self-regulation of intake as the parents are in the control. Baby-led weaning is promising in terms of the child's development and acceptance of new foods, but there are concerns about the risk of choking and nutritional and energy deficiencies.

Conclusions: Investigating these issues is challenging due to the complexity of complementary feeding practices, which limits the feasibility and generalizability of studies. No consistent evidence has been found on the best method of introducing complementary feeding to reduce the likelihood of developing obesity, but it has been widely suggested that it should be adapted to the individual needs of each child, including a variety of foods and textures and avoiding the introduction of solids foods before 4 months of age.

Keywords: breastfeeding, complementary feeding, traditional spoon feeding, baby led weaning, childhood obesity.

I. INTRODUCTION

Childhood is an extremely important period for the development of each child's full human potential and it is also crucial for the prevention of future chronic diseases such as obesity. It is already known that the period from conception to two years of age is a "critical window" for the promotion of optimal growth and health good development (1).

According to the World Health Organization (WHO), in 2019, about 38 million children under the age of 5 had overweight or obesity, which used to come from high-income countries and now there is also a substantial increase in low and middle-income countries, especially in urban settings (3). Children who are overweight or obese have an increased risk of maintaining this condition into adulthood and are therefore they are more likely to suffer from metabolic, cardiovascular, and respiratory diseases than normal-weight children, as well as have mental and motor delayed thus increasing morbidity and mortality (2). The cause of childhood obesity is multifactorial, these factors being genetic, environmental and/or sociocultural (1).

The period of food introduction has been seen by scientific community as an essential point to study in relation to childhood obesity, since dietary habits and preferences in early life will have a special impact on adult life, and may severely condition it (4).

Literature has reported that there is a link between a child's feeding practices in the first two years of life, which includes breastfeeding and introduction of other types of food. Complementary feeding is defined as the process of initiating the introduction of solid and liquid foods when breast milk alone is no longer sufficient to meet nutritional needs (5).

The WHO recommends exclusive breastfeeding for the first 6 months of life, since breast milk provides all the energy and nutrients that infants need for proper growth. After 6 months of age, food introduction and diversification should be started (3).

Food introduction can be accomplished by two different methods: traditional food introduction in which food is crushed or mashed using a spoon, and adapting its texture over time. The other method of introducing food is baby-led weaning, developed by Gill Rapley in 2008, which consists in presenting the baby with a variety of whole foods, and the baby feeds itself, stimulating independence, and developing motor and sensory skills

(6). Although it is gaining much popularity due to its benefits, such as obesity prevention and greater food acceptance, some health professionals are still not very receptive to this new approach, since it presents a choking risk and a higher probability of low energy and micro nutrient intake (7).

Therefore, this literature review analyzes the scientific literature regarding the introduction of complementary foods, comparing existing methods, their benefits and risks, and their association with childhood obesity.

II. METHODOLOGY

A literature review was prepared using the electronic search engines PubMed (National Center for Biotechnology Information, US National Library of Medicine, Bethesda, Maryland). The keywords used for the research were: “breastfeeding”, “complementary feeding”, “baby led weaning” and “childhood obesity”.

Clinical trials, systematic reviews and meta-analyses published in the last 15 years were selected. Articles that addressed risk conditions for childhood obesity were also included. Articles written in Portuguese and English were considered.

From the articles gathered, the titles and the abstracts were read, excluding those that were outside the scope of the research and those that were duplicated. According to the search strategy, 1028 articles were found in the database. Among these, 287 were duplicate articles that were excluded, as well as 662 articles that were also excluded once after reading the titles and abstracts, as they were completely out of topic. Other reasons for excluding the articles were mainly the inadequacy of the study objectives, as they were not completely within the topic under study or did not evaluate the methods of introducing complementary foods and their relationship with overweight and future obesity. Lastly, the full text of 78 articles was read. Among these, review articles, systematic reviews and meta-analyses were excluded. Only experimental studies and observational analytical studies were included, giving a total of 6 articles. Subsequently two studies that were considered relevant was added by the snowball process.

Furthermore, other references were used to describe the methods of complementary feeding, their benefits and risks, totaling 44 references.

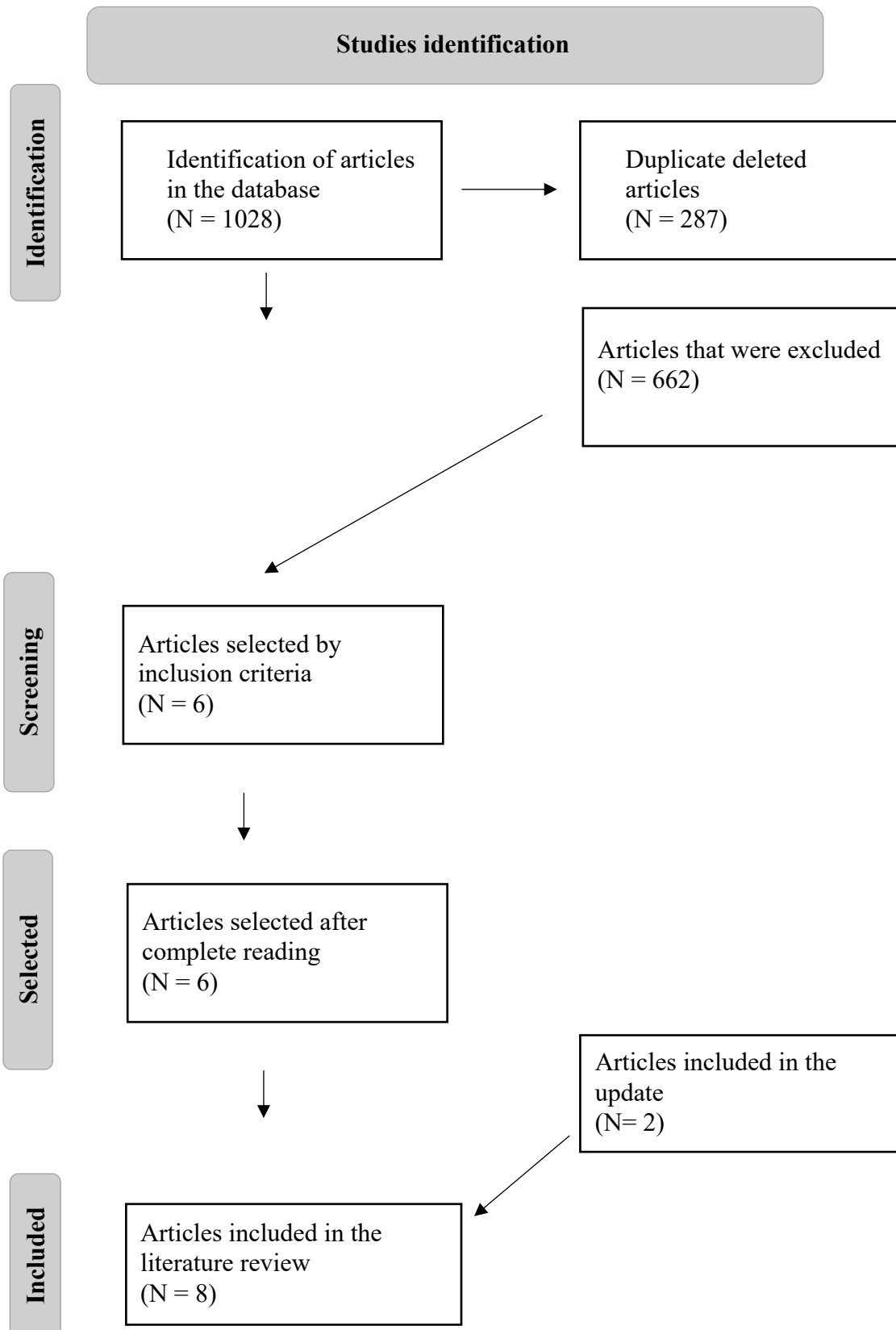


Figure 1. Study selection flowchart for studies assessing the association between complementary feeding and child's body weight.

III. DEVELOPMENT

1. Feeding in the first semester of life

Ensuring appropriate nutrition during the first years of life and childhood emerges as a fundamental element to initiate the full human potential present in each child. There is a well-established consensus that the time span from conception to two years of age represents a “critical window” in which is important to actively promote optimal growth, appropriate behavioral development, and ensure overall health (8).

Breastfeeding offers infants and mothers unmatched health benefits. The World Health Organization (WHO) recalls that breast milk is the “perfect food” for newborns and recommends that all babies be fed exclusively with breast milk until six months of age and should be maintained alongside complementary appropriate foods up to two years of age or older” (3). On the other hand, the European Society for Paediatric Gastroenterology Hepatology and Nutrition (ESPGHAN) suggests that exclusive or full breastfeeding should be promoted for at least 4 months (17 weeks, beginning of the 5th month of life) and exclusive or predominant breastfeeding for the first 6 months of life (26 weeks, beginning of the 7th month) (9).

ESPGHAN refers to the term exclusive or full breastfeeding for the practice of feeding a baby exclusively with breast milk, without any other type of food or liquid, including water. In the case of exclusive or predominant breastfeeding, breastfeeding is the main source of nutrition, but in addition to breast milk, small supplements or liquids can be introduced in specific cases, if recommended by a health professional. However, breastfeeding remains the baby's main source of nutrition (9).

During the first 180 days of life, if breast milk becomes insufficient, it is recommended that the diet continues to be exclusively dairy-based, with infant formulas being used to complement or as an alternative, given that they are close to human milk in terms of its composition (10). It is important to mention that breastfeeding, even if it occurs partially, or in smaller quantities, or for a shorter period than recommended, maintains beneficial effects when compared to exclusive feeding using infant formulas (11).

Exclusive breastfeeding refers to feeding a baby exclusively from breast milk. This provides the vast majority of infants with adequate and necessary nutrition during the first

6 months of life, however, some babies may require supplementation or complementary foods to support optimal growth and development before the aforementioned 6 months (9).

2. Start of complementary feeding

Complementary feeding or weaning refers to the period in which the infant needs to introduce complementary foods, since breast milk or infant formula alone are no longer sufficient to meet the child's needs. This introduction must be gradual, increasing and diversifying the new foods introduced and gradually decreasing breast milk (12).

The WHO recommends that feeding should be exclusively maternal during the first 6 months of the infant's life, followed by the introduction of complementary foods together with breast milk (14). After 6 months, an exclusive dairy diet alone does not meet the infant's energy needs and of some micro nutrients (iron, zinc, B vitamins) (13).

Offering food during this important stage of life must be based on variety and quality, being that no processed foods or foods with added sugar or salt should be offered, these two additives being prohibited during the first year of life (15).

The ESPGHAN advises that complementary feeding of solids should not be started before 4 months of age, but should not be delayed beyond 6 months either, and continued breastfeeding is recommended alongside complementary feeding. It suggests offering foods with a variety of tastes and textures, including bitter-tasting green vegetables. In addition to these recommendations, it also states that all infants should receive iron-rich complementary feeding, including meat products and/or iron-fortified foods (9).

Choosing the right time for weaning must be determined by the children's nutritional needs, their health status, as well as their physiological maturity, particularly neurological and gastrointestinal maturity, and their interest in food (9).

A randomized clinical trial on 698 mothers concludes that complementary feeding practices that promote self-regulation of intake and the development of healthy food preferences have been positively associated with healthy eating patterns and child's growth (17).

In this regard, parents play a central role during the food introduction process, as they are the decision maker about the method by which the baby will be fed. The way food is presented to the baby, as well as the interaction of guardians during food introduction may, most likely, influence food preferences and the entire appetite regulation system (18).

In the literature it is possible to identify two main methods of complementary feeding. The traditional method of introducing food, in which food is presented to the baby in pureed form and offered through a spoon, with the help of an adult. More recently, baby led-weaning has emerged, which refers to the method in which a variety of foods are offered and the baby feeds alone. This approach can give the baby greater control over their intake.

Therefore, it is important to note that the way babies are fed programs their taste preferences and appetite regulation and also establishes the basis for lifelong eating patterns (17). A study conducted by Ruowei Li *et al.* analyzed whether babies' self-regulation of milk intake is affected by the way they are fed (bottle vs. breast) and the type of milk (formula vs. breast milk). The results of this study show that self-regulation of intake can be affected by the way milk is offered. It concluded that babies who are bottle-fed have poorer regulation of the satiety mechanism than babies who are fed directly at the breast (19). It can be explained by the fact that breast-fed babies can control their milk intake since they decide when to start and stop sucking. On the other hand, babies who are bottle-fed are less likely to control their milk intake. Duration and quantity may depend on caregivers' decisions based on visual clues about the amount of milk left in the bottle. Thus, when babies are encouraged to finish the amount of food in the bottle, even if they are already satiated, their innate abilities to regulate energy intake in the face of internal appetite signals can be interrupted or altered not only by the type of milk but also by the mode of feeding.

It is important to mention the concept of food neophobia, since it is widely mentioned in the literature. It refers to fear or aversion to new or unfamiliar foods, especially present in babies and young children, who are very selective about the foods they consume, avoiding trying foods they are unfamiliar with or that have a different appearance, texture or smell (20). It can lead to a restricted and unbalanced diet, as it tends to avoid a variety of foods, which can impact nutrition and health. Evidence suggests that combining new

foods with foods who are familiar and preferred in taste conditioning rapidly increases liking and intake (21).

Therefore, it is important to encourage children to try different foods to develop a diverse palate from an early age and thus help overcome food neophobia. It should be noted that each baby is unique, and the introduction of complementary foods must be adapted to individual needs.

It is essential to consult a pediatrician or health care professional for specific and personalized guidance on introducing solid foods based on the baby's age, health and needs. Consequently, the introduction of complementary foods should be a gradual and pleasant process that promotes the child's healthy development.

2.1 Traditional complementary feeding

The traditional food introduction method is the complementary feeding method that the WHO recommends the most (30). This method is based on presenting the baby with meals with a creamy texture and with a spoon, gradually transitioning to less homogeneous and more granular textures as the infant demonstrates good chewing and swallowing control, until the introduction of solid foods, in which the child starts family meals. It is important that different textures and flavors are offered progressively.

By using the traditional complementary feeding, the control of caregivers is bigger and they play an active role in the baby's nutrition, as they guide the type and consistency of food, the speed and quantity with which the child ingests it (31). Despite being the oldest complementary feeding method used throughout the world, there are some limitations such as the association and the risk of developing obesity, based on the fact that the caregiver controls the amount of food ingested. The presented benefits are the parents total control over the baby's nutrition, they represent a more active role in the child's nutrition and, it is also important to highlight that they present fewer nutritional deficiencies compared to the led-weaning method of introducing food (27).

One study demonstrates that traditional feeding practices include offering food as a first response to the baby's crying and distress, “feeding to calm”. It also states that babies and young children will eat more when they receive larger portions and therefore manipulate

their satiety stimulus (21).

It can be predicted that traditional eating practices may compromise the development of self-regulation on intake, in which eating is initiated in response to hunger and terminated in response to satiety signals.

2.2 Baby Led-Weaning food introduction method

As the name indicates, the BLW food introduction method refers to *Baby Led Weaning*. This practice of food introduction has gained a lot of notoriety over the last 15 years due to being a promising method in food introduction and child development, however it also presents some concerns.

As previously mentioned, in this practice the baby leads the introduction of food. Starting from the age of 6 months, the infant should start ingesting solid foods, and as such, the basis of this method is precisely to introduce solid foods from the beginning of complementary feeding (7).

In BLW, the adult decides which foods to offer, they can be cooked or raw, and in an initial phase the foods should be offered well-cooked or raw if they have a soft consistency in larger cuts and should gradually be presented in smaller cuts as the baby grows and increases the ability to hold and chew more easily. The child should also be part of the family's meals from the beginning, with the same meal time and place, instead of having their meal before or after. Once the meal is placed in front of the child, they have complete autonomy to choose what to eat, the quantity and the timing (32).

Several advantages stand out, such as the child's tendency to accept food better, and in the long term consume more of these foods; the ability to differentiate the flavor of different foods; it is a complete sensory experience, it develops vision, touch, taste and motor skills; there is better use of fiber in foods, since they are offered whole or in pieces and therefore, there is not as much loss of fiber; encourages autonomy from an early age; awakens social skills because the child eat meals together with the family (7,33).

One of the premises of *Baby Led Weaning* is, precisely, that the child eats the main meals with the family from the moment complementary food is introduced and, therefore, it is

expected to assume that it can improve the eating style of the rest of the family since the baby is present and there is the intention that the baby acquires good eating habits. However, in counterpart, a pilot study found that this method did not improve the family's eating style (34).

An article from the *British Medical Journal* suggests that there is a much lower tendency towards obesity because the child receives the stimulus of satiety and decides when to stop eating, whereas in traditional eating there is a greater incentive to finish the amount of food prepared (35).

On the other hand, the disadvantages observed with this method of food introduction are based on the increased risk of airway obstruction and suffocation (gag reflex), decreased iron intake, which can lead to delays in cognitive function (18), vitamin B12 deficiency, since it is difficult to eat meat in the first months of food introduction through BLW and zinc deficiency (7). There are also concerns about the risk of not meeting energy needs following BLW as they may not yet have the motor skills or motivation to ingest the required amount, and this is particularly relevant if foods with low energy value such as fruit and vegetables predominate (36).

In this method of introduction of complementary feeding, parents or guardians play a more passive role, in which they must only observe and supervise the child during the meal, but without interfering in the feeding process.

2.3 Responsive Feeding

Responsive feeding does not refer to a method of introducing complementary feeding, however, it is an approach widely mentioned in the existing literature on the topic of introducing complementary feeding. It refers to a more attentive approach, which can be taken regardless of the method chosen by tutors. Also known as “sensitive feeding”, it is an approach to children's nutrition that focuses on understanding children's dietary needs and promoting a positive relationship with food from the beginning of complementary feeding (37).

It is defined as a strategy for introducing food that is based on not forcing or controlling

children's eating and, instead, respecting signs of hunger and satiety, offering a variety of healthy foods and creating a food environment that is positive and safe. This complementary feeding approach is suggested to promote and reinforce young children's ability to self-regulate their energy intake as well as create a good relationship with food and mealtimes (38).

To promote healthy food preferences, parents need to encourage their children to eat without pressure and sensitively to the needs and behaviors related to the child's autonomy (39).

Studies show that excessive food restriction, i.e. pressuring a child to eat certain foods, can lead to a negative reaction towards the food and generally has a counterproductive effect that will make the child like those foods less. Likewise, coercing children to eat the amount of food proposed by their guardians reduces their ability to self-regulate their energy intake and, therefore, is associated with an increased risk of obesity (37).

A randomized study that evaluates the effects of sensitive feeding and the acceptance of vegetables argues that, for better acceptance of vegetables, they should be introduced before fruits or with other sweet flavors during complementary feeding since babies inherent preference for sweet flavors will interfere with the acceptance of vegetables. However, the beneficial effects on vegetable acceptance do not appear to last as children grow older, because there is a tendency to become more selective about their diet as they grow (20).

Although promoting responsive eating alone is not a guarantee against childhood obesity, this approach has been shown to be associated with a reduced risk of being overweight during the first few years of life (38). In contrast, this method is insufficient to promote healthy food preferences, especially as the child grows (38).

3. Association between early feeding practices and childhood obesity

Global childhood obesity rates have risen wildly, becoming a real public health concern (3). According to the World Health Organization (WHO), in 2019, about 38 million children under the age of 5 had overweight or obesity (3).

From the beginning of the child's development, parents play a crucial role, contributing through genetic factors and shaping the environment in which children grow up. Genes are expressed in family contexts that differ in available foods, eating routines and eating practices. The combination of these factors can jointly increase the risk of developing obesity (24).

Evidence suggests that in utero exposure to maternal obesity appears to contribute to this problem. Children born from mothers with obesity during pregnancy are more likely to develop obesity and metabolic problems compared to children not exposed to maternal obesity in utero (22). Furthermore, the presence of obesity in parents is considered a significant indicator for the development of childhood obesity, and when both parents are obese, this risk appears to be even higher (23).

The timing of the introduction of complementary foods is crucial for the child development and can be a predictor of childhood obesity. However, there is plenty of information showing inconsistent associations. A study indicates that children who begin to introduce food before 6 months of age generally exceed their caloric needs and, therefore, have a tendency to become overweight in childhood (16). Schack-nielsen *et al.* found that the introduction of complementary feeding before 4 months of age was associated with an increased risk of overweight and obesity [OR] 0.94; 95% CI [0.86 – 1.02], however, showed a negative association with adult waist circumference index [OR] 0.25; 95% CI [0.10 – 0.49]. These results suggest that the early introduction of complementary foods may be related to a greater risk of overweight and obesity in adulthood, but the association with waist circumference is negative (41). A systematic review corroborated that there is a relationship between the introduction of early complementary feeding (before 4 months) and childhood obesity (25). In a specific study, including data from four different cohorts from Europe, including Portugal (Generation XXI), introduction of complementary foods earlier than 4 months was positively associated with fat mass levels in 5-year-old French children, but not in the other three countries (44), supporting the inconsistency of results.

One possible explanation for the association between early feeding practices and child's obesity is through the growth velocity of the child. Some studies suggest that rapid weight gain may have a contribution to obesity. In a meta-analysis, the odds ratio for overweight and obesity was 3.66 [95% CI 2.59-5.17] in the presence of rapid weight gain before 2

years of age. The odds were even higher when rapid weight gain occurred before 1 year of age (26).

Another study states that the way liquid and solid foods are offered to the infant, that is, the way they were prepared, prepared and presented to the child, as well as the selection of foods that were made to constitute the meal, can be important for results later, thus influencing the child's food preferences, behaviors and appetite (25), with a subsequent impact in child's body weight.

Hereupon, the most recent findings support current guidelines, which recommends not to introduce complementary foods before 4 months, as associations have been found between early food introduction and measures of adiposity in children from middle childhood to beginning of adolescence, these associations being more relevant in formula-fed children (27). On the other hand, the same study states that the late (8 months or more) introduction of complementary foods is also harmful in preventing obesity in children fed infant formula (27).

A systematic review suggests an enhancing agent of childhood obesity, which is the food environment, which is characterized by the availability of cheap food, rich in energy, sugar and salt, in which babies and young children will accept these foods and drinks the first time they're offered, even without repeated exposure (21). Conditioning their food preferences and thus making it difficult for them to accept foods with less palatability, smell and appearance, such as vegetables. The Feeding Infants and Toddler Study (FITS) claims that children consume high amounts of high-calorie foods and drinks, such as fruit juices, drinks with added sugar and dairy desserts (28).

It can, therefore, be concluded that early eating habits are determined in early childhood, as well as the length of exclusive breastfeeding and the timing of introduction of complementary foods.

IV. DISCUSSION

This literature review aims to describe the evidence on the relationship between methods of introducing complementary foods and childhood obesity. To this end, methodologies were used to ensure the selection of studies currently available in the aforementioned database.

The choice of food introduction method can influence food preferences, appetite self-regulation as well as the child's eating behaviors, as mediators for the child's weight status. Some results suggest that baby led weaning may be associated with a greater ability to self-regulate appetite, while the traditional method may be associated with greater energy intake. It is important to highlight that the family's social and nutritional environment, parental literacy, socioeconomic capacity, and genetics are factors influencing the development of childhood obesity (24).

It should be noted that both methods have advantages and disadvantages, and it should be noted that the method of introducing traditional complementary feeding is the oldest and most widely accepted as it offers a high level of control on the part of parents allowing them to carefully monitor the amount that babies ingest. On the other hand, the baby led weaning method promotes the baby's autonomy and can help develop motor skills and a good relationship with food from the beginning of food introduction. Contrastingly, parents who preferred following the traditional method report that the main fears regarding BLW include the fear of the baby choking (55.3%), concern about the baby's ability to eat enough (44.2%), babies not yet having the motor skills to feed themselves (27.6%) and in contrast, they also report that since the traditional method worked well, they did not feel the need to change (27.1%) (40).

In fact, Morison *et al.* states that babies using the BLW method suffer from choking more frequently at 6 months of age, presenting a relative risk [RR] 1.56; 95% CI (1.13-2.17) when compared with the group of babies under the traditional feeding method. However, at 8 months the result shows a 40% lower risk of choking [RR] 0.60; 95%CI (0.42-0.87) (35).

Regarding energy intake, no difference was observed, but babies following the BLW method seem to consume more total fat (48% vs 42% of energy, $p < 0.001$) and saturated fat (22% vs 18% of energy, $p < 0.001$) and lower iron (1.6mg vs 3.6mg, $p < 0.001$), zinc

(3.0mg vs 3.7mg, $p=0.001$) and vitamin B12 (0.2ug vs 0.5ug, $p<0.001$) than babies who follow the traditional method (35).

In other words, babies who followed BLW had similar energy intakes to those who followed the traditional method and also ate family meals more regularly, but they appeared to have a higher intake of total and saturated fat, and lower intakes of iron, zinc and vitamin B12. In opposition, children who followed the BLW method were more likely to receive fruits and vegetables as first foods rather than iron-fortified cereals, which assumes that first foods were poor sources of iron and, despite fruits and vegetables being foods rich in nutrients, they are not sufficient for the needs of babies when starting complementary feeding. In particular, and regardless of the method, babies should receive complementary foods rich in iron (40).

On the other hand, babies who follow BLW eat meals with their family more frequently, and eat the same foods as their family, which increases the likelihood of eating a greater variety of foods rich in iron. Also, the iron bioavailability of these foods is much higher than that of iron-fortified cereals, commonly offered when introducing traditional complementary foods.

Jones *et al.* through an observational study deduced that babies who followed BLW started complementary feeding at a significantly later age (average of 26 weeks), while babies who followed the traditional method introduced complementary feeding at an average of 23.5 weeks (42). Several pieces of evidence indicate that parents who follow BLW take greater care in complying with WHO dietary recommendations, which makes them wait until 6 months, that is considered the most appropriate age to start complementary feeding (14).

As has been analyzed throughout this study, the practices used to introduce complementary feeding have an influence on growth in the first months and year of life, which presupposes their influence on future BMI. The literature revealed that rapid weight gain in childhood may also be an important factor in the prevalence of obesity and overweight. A community cohort study developed by Sutharsan *et al.* (43) concluded that rapid weight gain in the first 5 years of life is associated with excess weight in adults, while slow weight gain during this period shows an inverse association.

Throughout this literature review, it was possible to verify that no consistent evidence

was found regarding the best method of introducing complementary foods to prevent the prevalence of obesity in early childhood. However, Cameron *et al.* concluded that families who followed BLW reported that they would recommend the method, but more than half (59.3%) would recommend the use of BLW method in combination with the traditional method. Approximately 46% of parents who chose the traditional method would be willing to try BLW if they had another child (40).

There are several factors to take into account when analyzing the risk of childhood obesity. On this literature review, we evaluated methods for introducing complementary foods, but timing and type of food can also play a fundamental role in preventing childhood obesity. Breastfeeding and the surrounding environment as well as other confounding factors must be taken into consideration.

The results of this literature review on methods of introducing complementary foods that protect against the risk of obesity are inconclusive, possibly due to the fact that there are few studies. It is important to mention that more consistent studies, more clinical trials and longer prospective studies should be carried out, using confounders such as birth weight and including variables such as speed of weight gain and body composition and the way in which foods are offered to the child, in order to provide concise results on the best method of introducing complementary foods to reduce the risk of childhood obesity.

The advantage of this study is that, although there are several descriptive studies already published on each of the approaches applied to the introduction of complementary feeding, few actually relate the association with childhood obesity.

Although this could be an advantage, it could also be a disadvantage in that we have had access to a limited number of studies that specifically address this association. It can be determined that it is essential to carry out more studies, more research needs to be done in order to reach a clear conclusion on the subject under study. In this way, it is clear that this study is important in order to understand the most recent updates to the literature published to date.

It is a difficult assessment to implement in practice, both in experimental and observational studies. Since families and children have to be monitored over a long period of time, which can lead to loss of follow-up and the information is most often based on mothers self-reporting and is therefore subject to a lot of confounding.

It is important to note that it is also a limitation that none of the articles covered in this paper refer to the food and nutritional quantification of each of the babies under study. It must be made clear that none of the methods guarantees that the child will be healthier and maintain adequate growth and development, since many factors can influence the child's weight, such as the quantity and content of the food itself, as well as many other factors.

Future studies should overcome these limitations and benefit from the implementation of a multi-informant (e.g. mothers and fathers), multi-method (e.g. self-reported and observational measures) and multi-context (e.g. families and schools) approach.

It is possible that no single method is feasible or suitable for all children at all times, and to be a responsive caregiver is also to be able to choose or seek information about what is best and what best suits the child's characteristics and needs.

V. CONCLUSION

To prevent childhood obesity, it is essential to adopt a holistic approach that takes into account several factors such as promoting a healthy eating environment at home, offering a variety of foods and textures, without pressure, in order to promote a good relationship with food in the child. These are important additional measures to prevent childhood obesity. The age for introducing solid foods must be defined individually, however, as aforementioned, introduction before 4 months of age and after 6 months of age is not suggested.

In this literature review, no consistent evidence was found regarding the best method of introducing complementary foods to reduce the probability of developing obesity. All studies found show inconclusive results. It can be concluded that the choice of approach to adopt for the introduction of complementary foods must take into account numerous factors, and mainly that each infant is unique, and the introduction of complementary foods as well as the method adopted must be adapted to individual needs.

BIBLIOGRAPHY

1. 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 Jun;50(6):761-779.
2. Martínón-Torres N, Carreira N, Picáns-Leis R, Pérez-Ferreirós A, Kalén A, Leis R. Baby-Led weaning: what role does it play in obesity risk during the first years? A systematic review. *Nutrients.* 2021 Mar 21;13(3):1009.
3. WHO. Breastfeeding. World Health Organization. [2023] Disponível em: <https://www.who.int/health-topics/breastfeeding#tab=tab_1>.
4. Weihrauch-Blüher S, Kromeyer-Hauschild K, Graf C, Widhalm K, Korsten-Reck U, Jödicke B, et al. Current guidelines for obesity prevention in childhood and adolescence. *Obesity facts.* 2018 Jul 4;11(3):263-76.
5. Araújo CS, de Farias Costa PR, de Oliveira Queiroz VA, de Santana ML, Miranda EP, Pitangueira JC, et al. Age of introduction of complementary feeding and overweight in adolescence and adulthood: a systematic review. *Maternal & Child Nutrition.* 2019 Jul;15(3):e12796.
6. Gomez MS, Novaes AP, Silva JP, Guerra LM, Possobon RD. Baby-led weaning, an overview of the new approach to food introduction: integrative literature review. *Revista Paulista de Pediatria.* 2020 Jan 13;38.
7. Daniels L, Heath AL, Williams SM, Cameron SL, Fleming EA, Taylor BJ, et al. Baby-Led Introduction to Solids (BLISS) study: a randomised controlled trial of a baby-led approach to complementary feeding. *BMC pediatrics.* 2015 Dec;15(1):1-5.
8. Dewey, K. Guiding principles for complementary feeding of the breastfed child. WHO Americas: Maternal, Newborn, Child & Adolescent Health & Ageing, Nutrition and Food Safety; 2008.

9. Fewtrell M, Bronsky J, Campoy C, Domellöf M, Embleton N, Mis NF, et al. Complementary feeding: a position paper by the European Society for Paediatric Gastroenterology, Hepatology, and Nutrition (ESPGHAN) Committee on Nutrition. *Journal of pediatric gastroenterology and nutrition*. 2017 Jan 1;64(1):119-32.
10. Van Dellen SA, Wisse B, Mobach MP, Dijkstra A. The effect of a breastfeeding support programme on breastfeeding duration and exclusivity: a quasi-experiment. *BMC public health*. 2019 Dec;19(1):1-2.
11. Ballard O, Morrow AL. Human milk composition: nutrients and bioactive factors. *Pediatric Clinics*. 2013 Feb 1;60(1):49-74.
12. WHO, UNICEF. Global strategy for infant and young child feeding. World Health Organization & United Nations Children's Fund; 2003.
13. Agosti M, Tandoi F, Morlacchi L, Bossi A. Nutritional and metabolic programming during the first thousand days of life. *La Pediatria Medica e Chirurgica*. 2017 Jun 28;39(2).
14. WHO. Complementary feeding. World Health Organization. [2023] Disponível em: < https://www.who.int/health-topics/complementary-feeding#tab=tab_1>.
15. Grote V, Verduci E, Scaglioni S, Vecchi F, Contarini G, Giovannini M, et al. Breast milk composition and infant nutrient intakes during the first 12 months of life. *European journal of clinical nutrition*. 2016 Feb;70(2):250-6.
16. Ardic C, Usta O, Omar E, Yıldız C, Memis E. Effects of infant feeding practices and maternal characteristics on early childhood obesity. *Archivos argentinos de pediatria*. 2019 Feb 1;117(1):26-33.
17. Daniels LA, Mallan KM, Nicholson JM, Thorpe K, Nambiar S, Mauch CE, et al. An early feeding practices intervention for obesity prevention. *Pediatrics*. 2015 Jul 1;136(1):e40-9.

18. Cameron SL, Taylor RW, Heath AL. Development and pilot testing of Baby-Led Introduction to SolidsS-a version of Baby-Led Weaning modified to address concerns about iron deficiency, growth faltering and choking. *BMC pediatrics*. 2015 Dec;15(1):1-1.
19. Li R, Fein SB, Grummer-Strawn LM. Do infants fed from bottles lack self-regulation of milk intake compared with directly breastfed infants?. *Pediatrics*. 2010;125(6):e1386-e1393.
20. van der Veek SM, de Graaf C, de Vries JH, Jager G, Vereijken CM, Weenen H, et al. Baby's first bites: a randomized controlled trial to assess the effects of vegetable-exposure and sensitive feeding on vegetable acceptance, eating behavior and weight gain in infants and toddlers. *BMC pediatrics*. 2019 Dec;19(1):1-7.
21. Birch LL, Doub AE. Learning to eat: birth to age 2 y. *The American journal of clinical nutrition*. 2014 Mar 1;99(3):723S-8S.
22. Godfrey KM, Reynolds RM, Prescott SL, Nyirenda M, Jaddoe VW, Eriksson JG, et al. Influence of maternal obesity on the long-term health of offspring. *The lancet Diabetes & endocrinology*. 2017 Jan 1;5(1):53-64.
23. Whitaker KL, Jarvis MJ, Beeken RJ, Boniface D, Wardle J. Comparing maternal and paternal intergenerational transmission of obesity risk in a large population-based sample. *The American journal of clinical nutrition*. 2010 Jun 1;91(6):1560-7.
24. May AL, Dietz WH. The Feeding Infants and Toddlers Study 2008: opportunities to assess parental, cultural, and environmental influences on dietary behaviors and obesity prevention among young children. *Journal of the American Dietetic Association*. 2010;12(110):S11-5.
25. Fewtrell MS. Can optimal complementary feeding improve later health and development?. *Preventive Aspects of Early Nutrition*. 2016;85:113-23.
26. Zheng M, Lamb KE, Grimes C, Laws R, Bolton K, Ong KK, et al. Rapid weight gain during infancy and subsequent adiposity: a systematic review and meta-analysis of evidence. *Obesity reviews*. 2018 Mar;19(3):321-32.

27. Gingras V, Aris IM, Rifas-Shiman SL, Switkowski KM, Oken E, Hivert MF. Timing of complementary feeding introduction and adiposity throughout childhood. *Pediatrics*. 2019 Dec 1;144(6).
28. Stallings VA. Feeding infants and toddlers study (FITS) 2016: findings and thoughts on the third data cycle. *The Journal of Nutrition*. 2018 Sep 1;148(suppl_3):1513S-5S..
29. Tahir MJ, Michels KB, Willett WC, Forman MR. Age at introduction of solid food and obesity throughout the life course. *Obesity*. 2018 Oct;26(10):1611-8.
30. WHO. Infant and young child feeding: model chapter for textbooks for medical students and allied health professionals. World Health Organization; 2009.
31. Komninou S, Halford JC, Harrold JA. Differences in parental feeding styles and practices and toddler eating behaviour across complementary feeding methods: Managing expectations through consideration of effect size. *Appetite*. 2019 Jun 1;137:198-206.
32. Brown A, Jones SW, Rowan H. Baby-led weaning: the evidence to date. *Current nutrition reports*. 2017 Jun;6:148-56.
33. Fernandes C, Martins F, Santos AF, Fernandes M, Veríssimo M. Complementary Feeding Methods: Associations with Feeding and Emotional Responsiveness. *Children*. 2023 Feb 26;10(3):464.
34. Rowan H, Harris C. Baby-led weaning and the family diet. A pilot study. *Appetite*. 2012 Jun 1;58(3):1046-9.
35. Morison BJ, Taylor RW, Haszard JJ, Schramm CJ, Erickson LW, Fangupo LJ, et al. How different are baby-led weaning and conventional complementary feeding? A cross-sectional study of infants aged 6–8 months. *BMJ open*. 2016 May 1;6(5):e010665.
36. Embleton ND, Moltu SJ, Lapillonne A, Van Den Akker CH, Carnielli V, Fusch C, et al. Enteral nutrition in preterm infants (2022): a position paper from the ESPGHAN committee on nutrition and invited experts. *Journal of pediatric gastroenterology and nutrition*. 2023 Feb 1;76(2):248-68.

37. Nicklaus S. The role of food experiences during early childhood in food pleasure learning. *Appetite*. 2016 Sep 1;104:3-9.
38. DiSantis KI, Hodges EA, Johnson SL, Fisher JO. The role of responsive feeding in overweight during infancy and toddlerhood: a systematic review. *International journal of obesity*. 2011 Apr;35(4):480-92.
39. Arden MA, Abbott RL. Experiences of baby-led weaning: trust, control and renegotiation. *Maternal & child nutrition*. 2015 Oct;11(4):829-44.
40. Cameron SL, Taylor RW, Heath AL. Parent-led or baby-led? Associations between complementary feeding practices and health-related behaviours in a survey of New Zealand families. *BMJ open*. 2013 Dec 1;3(12):e003946.
41. Schack-Nielsen L, Sørensen TI, Mortensen EL, Michaelsen KF. Late introduction of complementary feeding, rather than duration of breastfeeding, may protect against adult overweight. *AM J Clin Nutr*. 2010 Jul;91(7):619-627.
42. Jones SW, Lee M, Brown A. Spoonfeeding is associated with increased infant weight but only amongst formula-fed infants. *Maternal & child nutrition*. 2020 Jul;16(3):e12941.
43. Sutharsan R, O'Callaghan MJ, Williams G, Najman JM, Mamun AA. Rapid growth in early childhood associated with young adult overweight and obesity—evidence from a community based cohort study. *Journal of Health, Population and Nutrition*. 2015 Dec;33:1-9.
44. Moschonis G, de Lauzon-Guillain B, Jones L, Oliveira A, Lambrinou CP, Damianidi L, et al. The Effect of early feeding practices on growth indices and obesity at preschool children from four European countries and UK schoolchildren and adolescents. *Eur J Pediatr*. 2017 Sep;176(9):1181-1192.

Table 1. Summary of studies describing the association between complementary feeding and child's body weight

Reference Author	Location	Year	Type of study	N (sample) Recruitment (date)	Babies age (months)	Objective	Outcome measures	Results and conclusions
Daniels <i>et al.</i> (16)	Australia	2015	Randomized clinical trial (RCT)	698 mothers with healthy full-term babies (control n=346, 4 months old) (intervention n=352, 4 months old)	Start – at 4 months of age and follow-up until 5 years old.	Provide advance guidance to mothers on “protective” complementary feeding practices potentially reducing obesity risk	Baby's weight at 4, 14 months, 2.5 years, 3.5 years and 5 years (WAZ calculation). Length/height (4.14 months, 2.5 years, 3.5 years and 5 years) (HAZ). Waist circumference (2.5 years, 3.5 years and 5 years). Calculation of BMI and BMIZ (WHO reference data)	There were no statistically significant overall effects on anthropometric indicators of obesity risk. (Score Z do BMI: P=0,06) Prevalence of overweight/obesity (control group 13.3% vs intervention 11.4%, P=0.66)
Fernandes <i>et al.</i> (31)	Portugal	2023	Retrospective, comparative cross-sectorial and exploratory study with a small sample	Caregivers of 179 children	Children between 3 and 5 years old	Differences in emotional and feeding responsiveness between caregivers who implemented traditional feeding approaches vs baby led weaning through the comprehensive feeding practices questionnaire (CFPQ)	Data collection in Lisbon schools (26%) and online through Qualtrics (64%). 70.5% used the traditional method of introducing complementary feeding, 16.8% the BLW method and 12.8% both methods.	There were significant differences in the age of parents, being that older parents use the traditional method more frequently. Parents who used the BLW method showed that there was less pressure to eat and more attentive reactions compared to those who followed the traditional method.

Feeding practices in childhood and their association with the child's body weight – a literature review

Morison <i>et al.</i> (33)	New Zealand	2016	Community-based cross-sectorial study	51 babies of the same age and sex (n = 25 BLW e n = 26 TSF)	Between 6 and 8 months of age	Compare the intake of foods, nutrients and “meals”	Obtained through 2 questionnaires, the demographic questionnaire with information on the baby's date of birth, birth weight and gestational age and the nutrition questionnaire that obtains information such as the duration of exclusive breastfeeding, age at which complementary feeding is introduced	Babies who followed the BLW and TSF method showed comparable energy intakes, but BLW babies had higher intakes of fat and saturated fat, as well as lower intakes of iron, zinc and vitamin B12
Sutharsan <i>et al.</i> (41)	Australia	2015	Community cohort study	2077 adults who were born between 1981 and 1984	From birth to 21 years old.	Association between early weight gain in children and their overweight and obesity status in adulthood taking into account factors from mid-childhood..	Anthropometric measurements of weight and height, obtained at birth, 6 months, 5 years, 14 years and 21 years. Calculation of BMI and waist-hip ratio (WHR).	Rapid weight gain in the first 5 years of life was associated with excess weight in adults, while slow weight gain during this period has an inverse association, although it is not statistically significant.
Gingras <i>et al.</i> (25)	USA	2019	Prospective cohort study	1013 children between 4 and 6 months 4 months (19%), 4 to 6 months (68%) and 6 months (14%).	4 to 6 months	Association between the moment of introduction of complementary foods and adiposity throughout childhood.	Data were collected through a questionnaire administered at 6 and 12 months postpartum. Measurements of child adiposity in middle childhood and early adolescence were included. Weight and height, WC, subscapular and triceps skin folds were measured. The DXA examination was performed. BMI, BMI z score and fat percentage were calculated.	The introduction of complementary feeding at 4 months was associated with greater adiposity in middle childhood with persistent effects into adolescence, especially in formula-fed children.

Jones <i>et al.</i> (40)	United Kingdom	2019	Observational study (transverse and longitudinal comparison)	Cross-sectional study: 269 babies (109 BLW and 160 TSF) Longitudinal study: 101 babies (30 BLW and 71 TSF)	3 to 12 months	Impact of different aspects of infant nutrition on the weight and growth of children aged between 3 and 12 months	Anthropometric measurements: weight and length and then 16 weeks later (longitudinal data) Calculation of WAZ, LAZ, BMIZ and WAZV (WHO reference data)	No significant differences in WAZ between BLW regardless of breastfeeding type. Babies on TSF and fully formula fed (both simultaneously) are significantly heavier than those who receive any breastfeeding. Smaller increases in BLW, but not statistically significant
Cameron <i>et al.</i> (38)	New Zealand	2013	The population-based, cross-sectional survey	199 babies (140 TSF, 42 self-identified BLW and 17 adherent BLW)	6 to 12 months	Determine feeding practices and selected health-related behaviours in NZ families following BLW or TSF methods for introducing complementary foods.	The online survey was divided into four main sections: 1 – starting complementary foods; 2 – BLW; 3 – attitudes towards, and experiences of feeding the infant; 4 – demographic information	38% of all participants had not heard of BLW, 76% reported knowing a lot about it and 54.1% knowing a moderate or small amount. 64.1% of TSF group had never heard of BLW; 100% of all BLW groups reported that they would recommend the method, but 59.6% would recommend that BLW be used in combination with TSF; 46% of TSF group would be willing to try BLW if they had another child.
Moschonis <i>et al.</i>	United Kingdom	2017	Four European birth cohorts ALSPAC – UK,	ALSPAC – 13988 children EDEN – 1070	From birth to 13 years	Examine the association of feeding practices	Food-frequency questionnaires (FFQs)	For 5 year-old children in France, the prevalence of overweight/obesity was found to be much

(44)	EDEN – France, EuroPrevall – Greece and Generation XXI – Portugal Generation XXI – 3387 children EuroPrevall – 1084 newborns	children during infancy with growth and adiposity indices in preschool children from four European countries and in UK schoolchildren and adolescents	Anthropometric measurements: weight and length; Fat mass level (BIA), dual energy x-ray absorptiometry (DXA) Overweight/obesity prevalence in 4-5 year-old	lower compared to the 4-year-old children from the other three cohorts (7 vs 20%); For overweight/obesity prevalence as an outcome, 4 and 13 year-old children in ALS PAC that were breastfed between 3 and 6 months of age were less likely to be overweight or obese (P = 0.008 at 4years and p = 0.031 at 13 years) than those breastfed for longer than 6 months. 5-year-old children in EDEN to whom CF was introduced before 4 months of age were found to have higher fat mass level compared to whom CF was introduced between 5 and 6 months of age (P = 0.046). These associations showed no effect of early feeding practices on body fat mass in preschool children
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BLW – baby led weaning; TSF – traditional spoon feeding; CF – complementary feeding; WAZ – weight for age z-score; BMI – body mass index; BMIZ – body mass index z-score; HAZ – height for age z-score; WHR – waist to hip ratio; CC – waist circumference; WAZV – weight gain velocity; LAZ – length for age z-score.