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Review Article

Indexes to assess feeding practices of children under 2 years old: a systematic review

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Abstract

Objective: To systematically review studies that used indexes to assess feeding practices of children under 2 years.

Design: Seven databases were searched with no limit on language or publication date.

Setting: The reviewed studies included thirteen Asian, ten Latin American, four European, four North American, three Oceanian and three African.

Participants: Children under 2 years.

Results: We analysed thirty-six studies: twenty-two presenting original indexes and fourteen using adapted indexes. Among the original indexes, thirteen assess breast-feeding, fourteen food consumption, ten food groups, and ten other feeding practices. Original indexes were mainly adapted to fit the data available in the study, to update for current nutritional recommendations or to add components not present in the original indexes. Seven studies evaluated the associations between the indexes and nutrient intake or nutritional status. The main limitations cited by the authors were: flaws in the definition of the index components, criteria for cut-off points and weighting of the evaluated index components.

Conclusions: The assessment of feeding practices for young children and its comparison across countries remains a challenge, especially due to the lack of consensus on the construction of indexes and regional differences in dietary recommendations and practices. Lack of validation for some indexes also makes it difficult to choose the most appropriate index for a given objective. Adapting existing indexes is a viable option. We point out relevant recommendations that may contribute to future research. Validation and longitudinal studies in diverse populations are favourable to qualify the assessment of feeding practices in this group.

Keywords
Assessment and methodology
Infant
Complementary feeding
Diet quality

Early childhood feeding practices, especially in the first 2 years of life, are crucial for a healthy growth and development, shaping feeding habits that can last for a lifetime[1,2]. A poor and unhealthy diet is associated with child malnutrition especially in low- and middle-income countries, where undernutrition and micronutrient deficiencies often coexist with overweight/obesity and non-communicable diseases, a phenomenon called double burden of malnutrition[2,3]. Therefore, it is essential to provide reliable information about children's diet to allow health professionals to monitor dietary changes and plan actions.

Measuring the quality of the diet remains a challenge, as there is no consensus on which attributes should be included in this assessment, and an agreement does not exist about the most appropriate concept of what is a globally healthy and diverse diet[4,5,6,7,8]. According to Alkerwi

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(2014), when evaluating a diet, protocols should be adopted that combine several characteristics of the diet, so that the overall quality of the diet can be measured more reliably[4]. Ideally, in addition to nutritional aspects, other points should be part of this diet assessment, such as food security, sensory properties of food, and socio-cultural factors, which also still lack established measurement parameters.

Several approaches have been used to assess children's diets worldwide, and the use of indexes for assessing the overall diet quality has gained prominence. This is an *a priori* approach, which consists of assessing dietary intake data against a pre-established index according to a theoretical framework, generally based on current dietary recommendations[9]. According to Ruel and Menon (2002)[10], one of the main advantages of creating indexes is that they can be age-specific and can include different dimensions of eating practices, combining the information in a summary measure. In addition, indexes can be easier to interpret than a set of individual indicators and allow comparison of complex dimensions. However, failures in the construction and interpretation of the index can cause miscommunication and problems in decision-making[11].

Several systematic reviews on global diet quality indexes for the adult population have been published in the last 20 years[5,12–16]. But only four systematic reviews were found that identified indexes used to assess the diet of children under 2 years old; however, they included older children and adolescents, included indexes focused on specific aspects of the diet or specific health conditions, or included *a posteriori* dietary assessment method. In addition, in the most recent review, the search was conducted in only two databases, selecting articles published until 2013[9,17–19]; thus, the present study fills a relevant gap in the literature.

Considering the scarcity of literature on this theme, the objective of this study was to systematically review studies that developed and/or applied original and adapted indexes to assess eating practices and the overall dietary quality of children under 2 years old. We also aimed to identify the strengths and weaknesses of the identified indexes.

Methods

The systematic review protocol was registered at the International Prospective Register of Systematic Reviews (PROSPERO) (CRD42019119153) and was reported according to the Preferred Reporting Items for Systematic reviews and Meta-Analyses 2015 framework (PRISMA-P)[20].

Databases and keywords

The scientific databases MEDLINE via PubMed, Scopus, Embase, Scielo, Lilacs, Cochrane and ProQuest (for grey literature) were searched with no limit set for date and language. The following search strategy was built for PubMed database and adapted to the other databases: (Infant OR Child, Preschool OR Infant, Newborn) AND (Nutrition Surveys OR Diet Surveys OR Food variety score OR Dietary diversity score OR Diet score OR Healthy eating index OR Child feeding index OR Complementary feeding indicators OR Infant feeding index) AND (Infant Nutrition OR Nutritional Status OR Feeding Behavior OR Breast Feeding OR Bottle Feeding OR Mixed Feeding OR Young child feeding practices OR Complementary feeding OR Feeding practice OR Complementary foods OR Assessing Foods OR Dietary habits OR Diet quality OR Food intake). The search strategy employed a wide range of keywords to recover the largest number of studies in the field. The initial search was conducted in November 2019. Then, the search was updated in July 2020 using the same strategy and databases, with the application of a publication date filter (2019–2020).

Eligibility criteria

In this study, an index – which can also be called a composite indicator – is understood as a summary measure, built from the aggregation of multiple components, supported by a base model[11]. We included studies with full text available, of all types of quantitative designs, which may be original articles, dissertations, theses and official documents from national and international organizations, which used at least one index developed for the assessment of dietary practices of children under 2 years old. Exclusion criteria were studies that used *a posteriori* methods to assess dietary patterns, studies that focused only on breast-feeding (BF) assessment; studies that individually evaluated specific attributes of feeding practices without using an index; studies whose objective was to assess behaviours, knowledge or practices of parents or caregivers and studies with unhealthy populations. Systematic reviews, books, editorials and conference abstracts were also excluded.

Procedures and synthesis

Studies were first screened by title and abstract by two reviewers (R1 and R2). The second step was the full reading of selected publications independently by reviewers R1 and R2 to identify those that met all the inclusion criteria and would remain in the review. Disagreements were discussed between reviewers R1 and R2, and if there was no consensus, the reviewers R3 and R4 were consulted. The third step was to identify studies that presented: (a) original indexes; (b) modified indexes and (c) studies that only used indexes previously published, without changes. Adapted indexes were considered those that maintained the main characteristics of the original index and clearly described the changes made; articles that did not present the modifications objectively were not included.

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Only the first and second groups of articles (original and modified indexes) were included in the data extraction and synthesis presented in this systematic review. The search and selection of articles were performed using the StArt software (State of the Art through Systematic Review)[21].

The first reviewer extracted the data, and the second reviewer checked it for completion and accuracy. Data were extracted in a table designed specifically for this study (see online Supplemental Material S1a and S1b), including study information (title, author, year of publication, country, funding, design), sample characteristics (age, sample size and inclusion/exclusion criteria) and characteristics of the indexes – description, dietary components, dietary assessment methods, food groups (if applicable), index scoring system, key findings of studies, strengths and limitations of the index indicated by the authors themselves and measures related to the validation process (if available in the study). Data synthesis is presented in Tables 1, 2, and 3.

Risk of bias assessment

The assessment of the risk of bias in the studies was performed by R1 and checked by R2 to ensure the accuracy of the assessment (see online Supplemental material S3). To assess the quality of observational study designs, we employed the Newcastle–Ottawa Scale instrument for longitudinal studies and the adapted version for cross-sectional studies[22,23]; this instrument classifies the quality of studies as good, fair or poor. The following modifications were made to the instruments to better suit the studies: for cross-sectional studies that used secondary data, the question about non-respondents (Selection section) was considered not applicable and the maximum section score was four stars; in that same section (Selection), for the question dealing with the exposure of the instrument, we considered whether the dietary instrument used was validated or was described in the study. In the case of longitudinal studies, question 4 of the Selection section does not apply to the included studies; thus, the maximum value of this section was three stars. For intervention studies, the quality assessment instrument for quantitative studies of the Effective Public Health Practice Project[24] was employed, which classifies studies as strong, moderate or weak. Studies with analyses of more than one type of design were evaluated for both instruments.

Results

The process of identifying and selecting the articles is presented in a PRISMA flow diagram (Fig. 1). After removing the duplicates, 6837 publications were screened for title and abstract and 976 were selected for full reading. Most of the items (*n* 758) were excluded because they assessed only individual attributes of children's diet, without using an index. After the full reading, fifty-six articles were identified that employed at least one index to assess child feeding practices. As described in the Methods section, an additional step was done to classify the selected articles into three groups: original indexes, adapted indexes and studies that only used a previously published index, without modifications. After this step, we identified thirty-six studies that presented an original or adapted index and were selected for data extraction and synthesis in this review. Of these, twenty-two described original indexes[10,25–45] and fourteen described adapted indexes[46–59]. The other twenty articles that only used existing indexes without changes are presented in Supplementary Material S2.

Overview of the studies

All indexes were constructed to assess compliance with current dietary recommendations for this age group and/or the quality of the diet in the first years of life.

The studies included in the qualitative synthesis were published between 2000 and 2020, with the majority (*n* 26) after 2010[26,27,29,31–38,40–50,52–54,56]. Six studies were published between 2019 and 2020[27,37,42,45,50,53]. The sample ranged from eighty-two[28] to 12 146[56] participants.

Twenty-four studies employed a cross-sectional design[10,25–29,31,32,34,37,38,40,43,44,48,49,52–54,56–59], six were longitudinal studies[36,39,42,45–47], five were intervention studies[30,33,35,41,50] and one presented cross-sectional and longitudinal analyses[55].

Twelve studies were conducted in Asian countries[27,34,39,44,45,49,51,55–59], ten in Latin America[10,32,33,35,37,38,40,48,50,54], four studies in Europe[29–31,43], four in North America[28,42,46,53], three in Oceania[26,36,41] and three in Africa[25,47,52]. Only two studies[10,52] evaluated data from more than one country. Most studies (*n* 25) were conducted in low- and middle-income countries.

Risk of bias assessment

According to Newcastle–Ottawa Scale instrument, twenty-four articles were classified as having good quality (twenty cross-sectional; four longitudinal)[25,27,29,31,32,34,38,40,42–45,47–49,51,53–59], three were allocated to the fair category[10,37,46] and five as poor[26,28,36,39,52]. The main reasons why the articles were classified as fair or poor were because they did not justify the sample size, state the response rate and the characteristics of the non-respondents or control the analyses for possible confounding factors. When the Effective Public Health Practice Project instrument was used to evaluate intervention studies, four studies were classified as strong[33,35,41,50] and one as moderate[30], due to the lack of information about blinding and the low agreement rate for participation in the study. The evaluation of the articles is described in Supplementary Material S3.

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Table 1 Characteristics of original indexes used for assessment of infant and young child feeding practices

Index	Index components	Dietary assessment method	Evaluated period	Validation
Child feeding index[25]	BF; specific foods; other dietary practices/ characteristics	Child feeding practices questionnaire	Not reported	No
Dietary risk scores[26]	Food groups; UPF	FFQ	Previous week	Yes
Diet quality index[27]	Food groups; UPF	FFQ and 24-h dietary recall (for a subsample)	Previous day/previous month	Yes
Healthy eating index-C[28]	Food groups; nutrients; UPF	24-h dietary recall	Previous day	No
Complementary feeding utility index (CFUI)[29]	BF; specific foods; other dietary practices/ characteristics; UPF	FFQ and child feeding practices questionnaire	Week/other	Yes
Dietary scores[30]	BF; specific foods; UPF	Infant feeding practices questionnaire	Previous day	No
Finnish children healthy index[31]	Specific foods; food groups; UPF	Food records	Current day	Yes
Escore de Inadequações na alimentação complementar (EIAC)[32]	Specific foods; other dietary practices/ characteristics; UPF	Child feeding practices questionnaire	Not reported	No
Infant and young child feeding index (IYCF index)[33]	BF; specific foods; other dietary practices/ characteristics	24-h dietary recall and child feeding practices questionnaire	Previous day and other	No
Composite child feeding index[34]	BF; specific foods; other dietary practices/ characteristics	Child feeding practices questionnaire	Previous day and other	No
Escore de cumprimento dos 10 passos para a alimentação de menores de 2 anos do ministério da saúde[35]	BF; specific foods; other dietary practices/ characteristics; UPF	FFQ and child feeding practices questionnaire	Week	No
Toddlers diet score[36]	Food groups; other dietary practices/characteristics; UPF	24-h dietary recall	Previous day	No
Index for measuring the quality of complementary feeding – IMQCF[37]	BF; food groups; UPF	24-h dietary recall	Previous day	No
Diet quality index score (DQIS)[38]	BF; food groups; UPF	FFQ	Not reported	Yes
Infant and child feeding index (ICFI)[10]	BF; specific foods; other dietary practices/ characteristics	24-h dietary recall and FFQ	Previous day and previous week	Yes
Infant Feeding Scales[39]	BF; specific foods; other dietary practices/ characteristics	Child feeding practices questionnaire	Month	No
Escore de prática alimentar adequada[40]	BF; specific foods; other dietary practices/ characteristics; UPF	Child feeding practices questionnaire	Not reported	No
Obesity protective dietary index (OPDI)[41]	Specific foods; UPF	24-h dietary recall	Previous day	Yes
Overall food score[42]	Specific foods; food groups	Child feeding practices questionnaire	A day	No
Diet quality score[43]	Specific foods; food groups; UPF	FFQ	Previous month	Yes
Feeding practices index[44]	BF; food groups	Child feeding practices questionnaire	Not reported	Yes
Infant and young child feeding index[45]	BF; food groups	FFQ and child feeding practices questionnaire	Not reported	No

BF, breast-feeding; UPF, ultra-processed foods; FFQ, Food Frequency Questionnaire.

Table 2 Description of studies that used original indexes for assessment of infant and young child feeding practices

Study and sample characteristics	Index description and components	Dietary assessment method	Strengths and limitations*	Studies that used the index†
Armar-Klemesu *et al* (2000)[25] Sample: 512 Age: under 3 years old Country: Gana Design: cross-sectional	Child feeding index assesses diet in children between 4 and 36 months, according to recommended practices. Prelacteal feeds used; still breast-feeding; water: gave to child (0–4 months); sugar-based liquids: gave to child (0–4 months); infant formula: gave to child (0–4 months); cows' milk: gave to child (0–4 months); solid foods: gave to child (0–4 months); first food offered to child; if anyone helps the child eat; caregiver's attitude when child refuses to eat	Child feeding questionnaire	Limitations: The index captures only some aspects of feeding practices	0
Bell *et al* (2014)[26]. Sample: 111. Age: 12–36 months. Country: Australia. Design: cross-sectional	Dietary risk scores assess the diet quality based at the consumption of food groups, according to three categories, considering that dietary risk is associated with inappropriate eating patterns. Portion-size categories of: core intake (fruit, vegetables, grains, dairy products, meat and water); non-core intake (high-fat, high-sugar and/or high-salt products, and sweetened beverages); usual intake (bread type, milk beverages and non-milk beverages)	FFQ	Strengths: This methodology can be useful for dietary risk screening and to be used in research setting for development and evaluation of interventions.	1
Chen *et al* (2019)[27]. Sample: 111. Age: 12–36 months. Country: Singapore. Design: cross-sectional	Diet quality index assesses the diet quality and the compliance with dietary recommendations for children between 1 and 2 years old. Number of consumed portions: Total rice, bread and alternatives; total fruit; total vegetables; total meat and alternatives; total milk and dairy products; whole grains; foods high in sugar	FFQ and 24-h dietary recall for a subsample	Strengths: Consider the recommendations from several countries, making the index more representative. Focuses on foods, instead of nutrients, making easier the use in cases of there is limited data about nutrient intake; also makes public understanding easier. The index showed good construct validity (association with some nutrients intakes). Limitations: there is no consensus about measurement of diet quality, and the definition of the included indicators is based on the current recommendations.	0
Glanville *et al* (2006)[28]. Sample: 82. Age: 1–3 years old. Country: Canada. Design: cross-sectional	Healthy Eating Index (HEI-C) assesses the overall diet quality by using nine components that include food groups, nutrients and diet variety. Grains; fruits and vegetables; milk; meat; total fat; saturated fat; cholesterol; other foods; variety	24-h dietary recalls	Strengths: the component "Other foods" includes processed and ultra-processed foods rich in sugar, salt and fat, which are not assessed in the original HEI	0
Golley *et al* (2012)[29]. Sample: 6065. Age: under 3 years old. Country: England. Design: Longitudinal	Complementary Feeding Utility Index (CFUI)† is a summary measure to assess the adherence to the complementary feeding guidelines. Breast-feeding duration; feeding on demand; timing of solids introduction; exposure to Fe-rich cereals; frequent exposure to vegetables; frequent exposure to fruit; variety of protein foods;	FFQ-Time of introduction of complementary feeding questionnaire	Limitations: There may be variations in the scores of specific components, due to the period of data collection and the questionnaire used; the ability to predict health and development outcomes has not been validated; refinement of components with respect to	1

Table 2 *Continued*

Study and sample characteristics	Index description and components	Dietary assessment method	Strengths and limitations*	Studies that used the index†
	exposure to types of sugary drinks; exposure to confectionary, cakes, biscuits and savoury snacks; timing of cows' milk introduction; exposure to tea; timing of lumpy foods introduction; exposure to commercial infant foods; number of daily meals and snacks		number and weight in the total score can improve the relationship with outcomes	
Koehler *et al* (2007)[30]. Sample: 235. Age: 0–12 months. Country: Germany. Design: randomised trial	Dietary scores assess the accomplishment to the national current recommendations of feeding practices in the first year of life. Milk (breast-feeding; choice of milk; milk and allergy); complementary food (ingredients, recipes and meal supplements containing vegetables, potatoes, meat, fruits, cereal and milk); beverages; snacks	Child feeding questionnaire at 2, 4, 6, 9 and 12 months old.	Not reported	0
Kytalla *et al* (2013)[31]. Sample: 455. Age: 1 year old. Country: Finland. Design: cross-sectional	Finnish Children Healthy Eating Index (FCHEI) assesses the diet of Finland children from 1 to 6 years old, according to the main concerns related to the quality of food in the country. Vegetables, fruits and berries (fresh and cooked); oils and margarine (fat $55 %); foods containing high amounts of sugar; fish and fish dishes (The component skimmed milk is not assessed for 1-year-old children)	Three food records in consecutive days	Strengths: the index showed correlation with several nutrients and is useful as a valid indicator of Finnish children's diet	0
Mais *et al* (2014)[32]. Sample: 324. Age: under 2 years old‡. Country: Brazil. Design: cross-sectional	Complementary Food Inadequacy Score (Escore de Inadequações na Alimentação Complementar -EIAC) assesses the degree of inadequacy in complementary feeding and considers the importance of each component of inadequacy in the child's feeding. Early introduction of liquids; early introduction of solids; early introduction of cows' milk; early introduction of sugar and/or thickener; late introduction of liquids; late introduction of solids; inadequacy in the preparation of porridge	Child feeding questionnaire	Limitations: the index does not consider the time of introduction of processed foods, the consistency of the porridge, the utensil used in offering food, times and fractionation of meals, amount of food consumed, as well as how to prepare the porridge and the age of introduction of eggs	0
Monterrosa *et al* (2015)[33]. Sample: 370. Age: 0–24 months. Country: Mexico. Design: randomised trial	Infant and young child feeding index (IYCF index) is age-specific and is built according to the Pan American Health Organization. Breast-feeding; use of bottles; sweetened beverage; carbonated beverage; complementary food	Child feeding questionnaire and 24-h dietary-recalls	Limitations: The index assesses only 4 of the 9 recommendations used as a reference; in addition, the index captures different dimensions as age increases, thus, high scores at 1 month do not correspond to the same behaviours that led to high scores at 12 months	0
Mukhopadhyay *et al* (2013)[34]. Sample: 245. Age: 0–23 months. Country: India. Design: cross-sectional	Composite child feeding index is based on the recommendations for feeding practices of children under 2 years and includes WHO indicators. 0–5 months age group: any breast-feeding; exclusive breast-feeding;	Child feeding questionnaire	Not reported	0

Table 2 *Continued*

Study and sample characteristics	Index description and components	Dietary assessment method	Strengths and limitations*	Studies that used the index†
	breast-feeding eight times or more; intake of liquid food other than breast milk/intake of solid, semi-solid, soft food and bottle feeding. 6–23 months age group: continued breast-feeding; introduction of solid, semi-solid, soft food; minimum meal frequency; minimum amount per meal; minimum dietary diversity; active feeding; consistency and safety of food			
Nunes *et al* (2017)[35]. Sample: 234. Age: 12 months. Country: Brazil. Design: Randomised trial	Score of compliance with the 10 steps for feeding children under 2 years of the Ministry of Health (Escore de cumprimento dos 10 passos para a alimentação de menores de 2 anos do Ministério da Saúde) assesses the compliance with the ten steps and is used as a proxy for the quality of complementary food.	FFQ and child feeding practices questionnaire	The authors did not mention specific limitations, they only reported the difficulty of constructing a score that could translate the fulfilment of the steps of the Brazilian Ministry of Health.	0
Nyaradi *et al* (2013)[36]. Sample: 2868. Age: 12 months. Country: Australia. Design: Longitudinal	Toddlers diet score is a summary measure of the diet quality of children 1–3 years old. Wholegrain; vegetables; fruit; meat ratio; dairy; snack foods; sweetened beverages	24-h dietary recall	Not reported	0
Ribas *et al* (2020)[37]. Sample: 108. Age: under 2 years old. Country: Brazil. Design: cross-sectional	Index for Measuring the Quality of Complementary Feeding (IMQCF) assesses the quality of complementary food, based on Brazilian and international dietary recommendations. Continued with breast milk or infant formula; introduction semi-solid foods other than breast milk or infant formula; meals per day; introduction of sugar, sweets, soft drinks, teas, sugary drinks and/or some wheat-based foods; introduction of other un-sweetened ultra-processed foods; evaluation of consistency; portions of vegetables and fruits; groups make up the main meal; introduction cow milk and/or dairy products	Four 24-h dietary recalls	Strengths: Considers the consumption of ultra-processed foods (according to the current guidelines). Suitable for children born preterm. Limitations: Does not consider the amount of food consumed	0
Ríos *et al* (2016)[38]. Sample: 269. Age: 0–24 months. Country: Puerto Rico. Design: cross-sectional	Diet Quality Index Score (DQIS) assesses the quality of the diet of children between 0 and 24 months (excluding children aged 6–7 months). For children up to 5 months, the time of introduction of food was considered. For the others, the amount consumed from each food group was considered. Milk (type of feeding); cereal; grains; protein; vegetables; fruits; 100 % fruit juices; sugar-sweetened beverages; sweets; salty snacks	FFQ	Strengths: This is the first algorithm for the assessment of diet quality in infants and toddlers considering intake of each food group and their portion sizes.	1
Ruel and Menon (2002)[10]. Sample: not reported. Age: 6–36 months. Country: Bolivia; Colombia; Guatemala;	Child Feeding Index (CFI) is based on recommendations for feeding children between 6 and 36 months. Breast-feeding; use of bottle;	FFQ 24 h food group consumption	Limitations: The indexes can mask the association of specific practices that compose them with the outcomes of interest	13

Table 2 *Continued*

Study and sample characteristics	Index description and components	Dietary assessment method	Strengths and limitations*	Studies that used the index†
Nicaragua; Peru. Design: cross-sectional	Dietary diversity score (food groups: cereals, tubers, milk, egg/fish/poultry, meat and other); food frequency score: number of days the child consumed different food groups in the past 7 d; Meal frequency past 24 h			
Saha *et al* (2008)[39]. Sample: 1343. Age: under 2 years old. Country: Bangladesh. Design: Longitudinal	Infant Feeding Scales are based on children's feeding practices at 3, 6, 9 and 12 months of age, to assess compliance with current recommendations for each age group. Breast-feeding; supply of water and water containing sugar or glucose, fruit juice, cows' milk, solid or semi-solid foods; first food offered to the child; bottle use	Monthly child feeding practices questionnaire	Limitations: scales do not capture the multidimensionality of feeding practices, which may be associated with health and growth outcomes	0
Sousa *et al* (2019)[40]. Sample: 151. Age: 12–23 months. Country: Brazil. Design: cross-sectional	Adequate dietary practice score (Escore de prática alimentar adequada) is based on the Ten Steps to Healthy Eating for children under 2 years of age from the Ministry of Health of Brazil, to assess adherence to current dietary recommendations.	Questionnaire about complementary feeding practices	Not reported	0
Spence *et al* (2013)[41]. Sample: 398. Age: under 2 years old. Country: Australia. Design: Randomised trial	Obesity Protective Dietary Index (OPDI) specifically evaluates the outcomes intended by the study: increase intakes of fruits and vegetables and decrease intakes of non-core foods (juice, soft drink, cordial, sweetened milks, sweet and savoury biscuits, crisps, confectionary, cakes, pastries, buns and takeaway foods)	Three 24-h dietary recalls	Not reported	0
Vadiveloo *et al* (2019)[42]. Sample: 398. Age: under 2 years old. Country: Australia. Design: Randomised trial	Overall food score is based on two scores: Healthy Food Score (fruits and vegetables intake) and Unhealthy Food Score (French fries, ice cream, baby snacks and sweets intake)	Child feeding practices questionnaire	Not reported	0
Voortman *et al* (2015)[43]. Sample: 3629 children (13 months). 844 children (25 months). Age: under 2 years old. Country: Netherlands. Design: cross-sectional	Diet Quality Score assesses the overall diet quality and was built based on recommendations for feeding practices for preschoolers (from 1 year). Daily intake of vegetables (≥100 g/d); fruit (≥150 g/d); bread and cereals (≥70 g/d); rice, pasta, potatoes, and legumes dairy (≥350 g/d); meat, poultry, eggs, and meat substitutes (≥35 g/d); fish (≥15 g/d); oils and fats (≥25 g/d); candy and snacks (≤20 g/d); sugar-sweetened beverages (≤100 g/d)	Semi-quantitative FFQ	Strengths: The index was associated with nutrient intake (low and moderate) and can be a useful tool for assessing the overall diet quality of preschoolers. Limitations: The construction of the index was based on current recommendations; however, there is a shortage of quantitative recommendations based on food for this age group.	3
Wang *et al* (2015)[44]. Sample: 386. Age: under 2 years old. Country: China. Design: cross-sectional	Feeding practices index assesses the status of infant feeding practices (IFP) and its association with health status, based on WHO recommendations for feeding practices for children under 2 years old. Breast-feeding; still	Child feeding practices questionnaire	Strengths: Allows the assessment of children under 6 months; considers the interrelation between the feeding practices that make up the index, due to the method used (rank sum ratio) of the association between the index and	0

Table 2 *Continued*

Study and sample characteristics	Index description and components	Dietary assessment method	Strengths and limitations*	Studies that used the index†
	breast-feeding; beginning breast-feeding (h); breast milk is enough or not; introduced complementary food; frequency of added complementary food		the prevalence of respiratory infection. Limitations: it is not possible to apply the method if there are missing values	
Zhu *et al* (2020)[45]. Sample: 386. Age: under 2 years old. Country: China. Design: cross-sectional	Infant and young child feeding index assesses compliance with WHO dietary recommendations. Exclusive breast-feeding duration; any breast-feeding duration; vitamin/mineral supplements; initial time of beans and eggs; initial time of cows'/goat's milk; regular consumption of Fe-rich food or Fe-fortified foods at 6–23 months	FFQ and other questions about feeding practices	Limitations: the index has not been validated. The authors did not consider the weights or relative importance of the components and did not specify the type of supplement received.	0

*Strengths and limitations pointed out by studies' authors.
†Studies that used the original indexes without adaptations.
‡The age range of the participants included in the study was 0–6 years old, but the assessment of complementary feeding practices referred to the first 2 years of age of children.

Studies with original indexes

The synthesis of the main characteristics of the original indexes (*n* 22) is presented in Table 1. Table 2 presents the characteristics of these studies: identification of the study, sample characteristics, index used, components, dietary assessment method, strengths and limitations of the index, and number of studies found in the systematic review which used that index.

The indexes were constructed with different types of components, which focus on assessing BF (exclusive and continued BF), consumption of foods and food groups, other feeding practices (frequency of meals, bottle use, hygiene when preparing and offering food, complementary food introduction, if the child receives help to eat, the caregiver's attitude towards the child's refusal, exposure to advertising about infant foods) and consistency of the diet. Among the twenty-two original indexes, thirteen evaluate aspects related to BF[10,25,29,30,33–35,37–40,44,45] (more common in the indexes that assess diet of children under 1 year old), fourteen evaluate consumption of foods[10,25,29–35,39–43], ten assessed food groups consumption[26,27,31,36–38,42–45] and ten include the assessment of other feeding practices and feeding characteristics[10,25,29,32–36,39,40], such as consistency of the diet. More than half of the original indexes (*n* 13) investigated the consumption of ultra-processed foods (UPF) (in some studies described as foods high in Na, sugar and fat)[26,27,29–32,35–38,40,41,43], twelve of which were published since 2012. Only one index assessed the intake of specific nutrients[28].

Although the purpose of the review was to identify indexes that aimed at the population under 2 years old, we decided not to exclude studies with indexes that exceed this limit, as long as children under 2 years old were part of the analysed age group and the index was constructed taking into account the dietary recommendations for children of this age range, including seven studies[10,25,26,28,31,32,45].

All indexes were constructed based on the current dietary recommendations for the age group. These recommendations included country-specific guidelines and, more commonly, the general recommendations of the WHO.

As primary tool to collect dietary data, twelve studies used specific questionnaires[25,29,30,32–35,39,40,42,44,45] containing questions related to food consumption and other aspects of eating practices, but many of them did not provide details on the instruments. Eight studies used the FFQ[10,26, 27,29,35,38,43,45], seven used the 24-h dietary recall[10,27,28,33,36,37,41], one used 1-d food records[31] and six studies used more than one dietary instrument[10,27,29,33,35,45].

About the reference time of the used tools to evaluate diet, eight studies requested dietary data from the day before the survey[27,28,30,33,34,36,37,41], four from the previous week[10,26,29,35], six studies did not specify the time period[25,32,38,40,44,45] and the others evaluated random periods of time, such as month or year.

Regarding the quantity of food consumed, thirteen indexes assessed whether the child consumed a food/food

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Table 3. Description of studies that used adapted indexes for assessment of infant and young child feeding practices

Study and sample characteristics	Adapted index	Adaptations	Reasons for adaptations
Au *et al* (2018)[46]. Sample: 1261. Age: 7–24 months. Country: USA. Design: Longitudinal	Complementary Feeding Utility Index (CFUI)[29]	- Excludes the number of daily meals and snacks component- Replaces the use of commercial infant foods component with use of non-recommended feeding practices (i.e. mixing formula with more or less water, using an infant feeder or bottle with an extra-large nipple hole, or adding cereal to the bottle). - Adapts the timing for scoring of solid food introduction component to include more detailed age groups	The index was adapted according to the data available for the survey and to meet the current recommendations in the country
Hamner *et al* (2020)[47]. Sample: not reported. Age: 6–23 months. Country: Sierra Leone, Niger, Sudan, Ethiopia. Design: cross-sectional	Diet Quality Index Score (DQIS)[38]	- Changes the age range and the division of analysis age groups - Changes the milk component - Changes scoring criteria of components - Changes portion sizes of evaluated food groups - Changes the final score	The index was adapted to meet the current recommendations in the country and to assess children of the research age group
Bork *et al* (2012)[48]. Sample: 1060. Age: 6–36 months. Country: Senegal. Design: Longitudinal	Infant and Child Feeding Index (ICFI)[10]	- Excludes the bottle-feeding component - Replaces the frequency component of food consumption in the last 7 d with a Food Variety Index (FVI). The Diet Diversity component is composed of seven food groups (animal milk products, animal-based foods, cereals and tubers, pulses and nuts, fruit and vegetables, vitamin A – rich foods, and food with fat added) - Changes component scores and the final score	The index was adapted according to the data available for the research
Bortolini *et al* (2015)[49]. Sample: 2477. Age: 6–36 months. Country: Brazil. Design: cross-sectional		- Changes the division of age groups - Replaces the bottle-feeding component with consumption of another milk the day before - Modifies food groups (cereals or tubers; beans; vegetables; fruit; meat or egg or fish or chicken); excludes the milk group - Evaluates the Diversity component of the diet in the last 7 d - Only considers the recommendation of the main meals in the meal frequency component	The index was adapted according to the data available for the survey and to meet the current recommendations in the country
Chaudary *et al* (2018)[50]. Sample: 210. Age: 6–36 months. Country: India. Design: cross-sectional		- Excludes the food frequency component - Modifies food groups (grains, tubers; meat, fish; pulses; dairy; eggs; other fruits and vegetables) - Changes the final score	The index was adapted to meet the current recommendations in the country
Ferreira *et al* (2019)[51]. Sample: 1133. Age: 6–12 months. Country: Brazil. Design: Randomised trial		- Excludes milk from the Dietary diversity score because, in Brazil, breast milk is replaced by other milks and is associated with the use of bottles - Includes fruit and vegetable groups in the food frequency score - Details the criteria of the component meal frequency (meal is defined as including at least 3 of 4 food groups)	The index was modified to align with current recommendations in the country
Garg *et al* (2009)[52]. Sample: 151. Age: 6–12 months. Country: India. Design: cross-sectional		- Includes the timely initiation of complementary feeding component - Modifies food groups; specifies other fat and sugar food in the other foods group - Changes the final score	Not reported
Guevarra *et al* (2014)[53]. Sample: not reported. Age: 6–23 months. Country:		- Excludes the bottle-feeding and food frequency component	

Table 3. *Continued*

Study and sample characteristics	Adapted index	Adaptations	Reasons for adaptations
Sierra Leone, Niger, Sudan, Ethiopia. Design: cross-sectional		- Evaluates breast-feeding in the last 24 h - Changes the scoring criteria of components and final score - Does not specify the food groups of the Dietary Diversity component - Classifies children into two categories: good (6 points) and not good infant and young child feeding (<6 points)	The index was adapted to suit the available data and to simplify use in the contexts in which researchers are inserted
Jones (2015)[54]. Sample: 251. Age: 6–23 months. Country: Bolivia. Design: cross-sectional		- Changes food groups (cereal grains, roots, tubers; vegetables and nuts; dairy products; flesh foods; eggs; vitamin A rich fruits and vegetables; other fruits and vegetables) - Includes the components: consistency of the diet and responsive food The meal frequency component considers main meals and snacks - Changes the final score (0 to 11 points)	The change in food groups aimed to reflect the proposal of WHO indicators (2008). The inclusion of the two components not present in the original index was justified because they are practices that are not usually reached in infant feeding
Ma *et al* (2012)[55]. Sample: 180. Age: 5–7 months (baseline). Country: China. Design: cross-sectional and longitudinal		- Excludes the bottle-feeding component - Includes the consistency component of the diet - Changes the final score	The replacement of the bottle-feeding component by consistency of the diet was justified because the use of a bottle is considered harmful to children at all ages assessed by the index
Qu *et al* (2017)[56]. Sample: 12 146. Age: 6–35 months. Country: China. Design: cross-sectional		- Does not include the meal frequency component - Includes other food groups and changes the score for consumption of each group - Includes age of introduction of complementary feeding - Changes the final score	The index was adapted to account for Chinese recommendations about child feeding practices
Sawadogo *et al* (2006)[57]. Sample: 2466. Age: 6–35 meses. Country: Burkina Faso. Design: cross-sectional		- Changes the division of age groups - Changes the score of the breast-feeding component - Changes the criteria of the meal frequency component (differentiates main meals and snacks) - Excludes the food frequency component - Includes the food variety score component (24 h) - Changes food groups	The index was adapted according to the local context and the data available for the research
Srivastava and Sandhu (2007)[58]. Sample: 204. Age: 6–23 months. Country: India. Design: cross-sectional)		- Includes the components hygiene during preparation and feeding and psychosocial care during feeding - Excludes bottle feeding and meal frequency components	The index was adapted to simplify its use and incorporate other aspects of infant feeding recommended by WHO, in addition to dietary components
Zhang *et al* (2009)[59]. Sample: 501. Age: 6–11 months Country: China. Design: cross-sectional		- Includes the snack frequency component - Changes the final score, which varies according to the age group (1–14 for 6–9 months; 4–13 for 9–11 months) - Changes food groups (cereals/tubers, beans, animal milk, egg, meat/fish and other foods)	The index was adapted to incorporate current recommendations for dietary practices in the age group evaluated

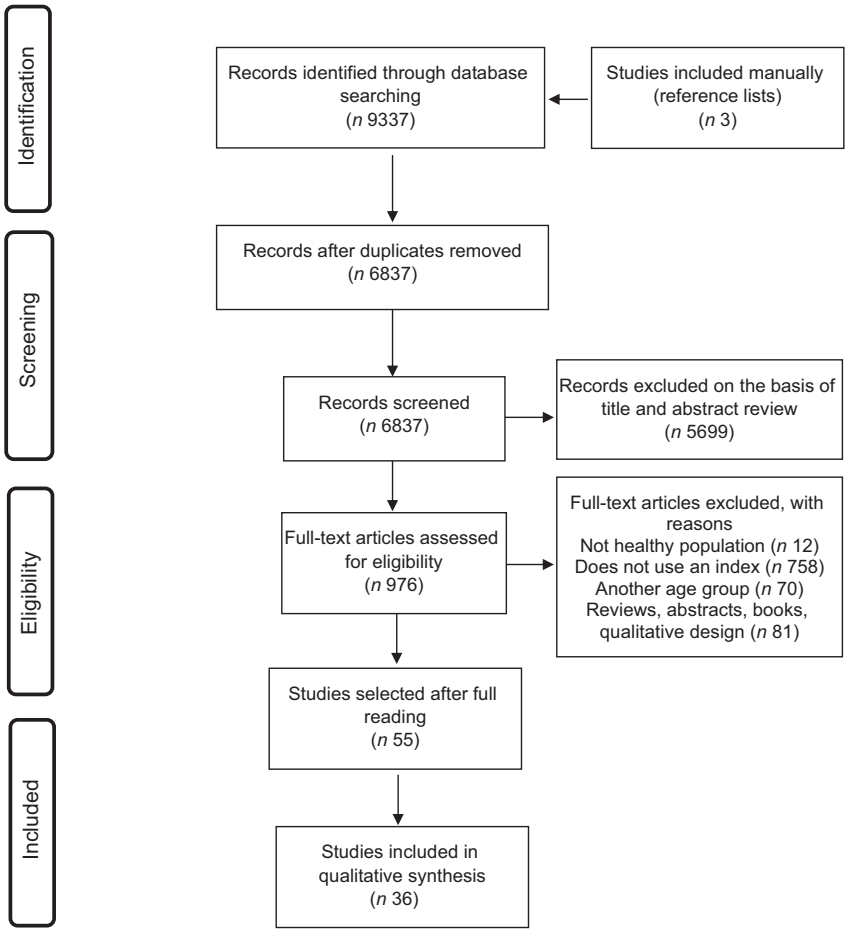

Fig. 1 Preferred reporting items for systematic reviews and meta-analyses (PRISMA) flow diagram of the study selection process

group or not, irrespective of the quantity or number of portions[10,25,29,30,32–35,39,40,42,44,45]. The others establish the minimum amount of food consumed or the number of portions of each food/food group, according to the dietary recommendations[26–28,31,36–38,41,43].

Regarding the scoring system, for most indexes, the final score was calculated by simply adding together the scores of all the components[10,25,28,31–36,38–43,45]. Usually, practices considered positive or recommended received positive scores and practices considered negative received negative scores or were not scored, and the final score represented the degree of compliance with the dietary recommendations for age or quality of diet; thus, higher scores indicated a greater degree of adequacy or better quality of the diet. Due to variations in dietary recommendations according to the child's age, the indexes commonly divided the assessment by age subgroups, changing the scoring criteria or the cut-off point value according to the recommendations. An example of this variation is the assessment of BF, which usually received higher scores in the youngest subgroup. Some indexes required more complex procedures to generate the final score, such as using equations or converting scales (*n* 6)[26,27,29,30,37,44].

The final results of the indexes were presented as the score mean – and SD – for the full sample or age subgroups (*n* 9)[25,27,30,34–37,39,43], in predefined categories (e.g. total score – 0–100, ≤50: poor diet; 51–80: diet needs improvement; >80: good diet) (*n* 8)[26,28,30,38,41,43] or classifying the final score in quantiles (*n* 5)[10,29,31,41,45].

No study compared the index to a gold reference standard for assessing food consumption for validation. Among the twenty-two original indexes identified, only five assessed the association between the results and the intake or adequacy of nutrients and energy[27,29,31,41,43]. Seven studies associated the index with nutritional status[10,33,34,37–39,42].

The most employed index was the ICFI proposed by Ruel and Menon (2002)[10], with twelve records. Other four indexes – Dietary risk scores[26], Complementary Feeding Utility Index[29], Diet Quality Index Score[38], Diet Quality Score[43] – were also used in further studies. The full list of the studies that used original indexes is in Supplementary Material S2.

Only sixteen studies indicated strengths and/or weakness of the index used[10,25–29,31–33,35,37–39,43–45]. The following strengths were cited: the use of the index as a

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valid approach for assessing and monitoring children's eating practices, especially due to the positive association between the results of the indexes with nutrient intake and/or nutritional status; and the assessment of consumption of UPF. The most common weaknesses were the lack of consensus on the choice of components, the lack of established criteria for defining the weight and cut-off points of the components and the impossibility of including other aspects of eating practices.

Studies with adapted indexes

The fourteen studies that adapted previously published indexes are described in Table 3. The changes made to the original indexes and the justifications presented by the authors are also presented. Among these fourteen studies, twelve[47–53,55–59] were based on the Infant and Child Feeding Index by Ruel and Menon (2002)[10]; one[46] was based on the Complementary Feeding Utility Index by Golley *et al* (2018)[29] and one[53] was based on the Diet Quality Index Score by Ríos *et al* (2020)[38].

The extent of modifications made to the original indexes varied widely between studies and included changes in the component scoring criteria; alterations in the final score; exclusion, inclusion and replacement of components; modification of evaluated food groups and adjustments in the age group, as shown in Table 3. The existing indexes were adapted for a variety of reasons: to fit the index to the data available in the research, especially studies with secondary data (*n* 5)[46–48,52,57]; to adapt the indexes to the national or international current nutritional recommendations, as well as to adapt to the local food context (*n* 10)[46,48–50,53–55,57–59]; or to aggregate components not evaluated in the original indexes that were considered important by the authors (*n* 1)[54]. One study reported no justification for the changes[51].

Two adapted indexes[52,57] were used in further studies, presented in Supplementary Material S2.

Discussion

This review provided an overview of the assessment of feeding practices in children under 2 years old using indexes built specifically for this audience throughout the world. A wide range of proposals have been developed aimed at achieving a valid, adequate and viable methodology for a more comprehensive assessment of the diet in this age group, which take into account the complexity of the diet, the profound relationship of food intake with nutritional and health outcomes, the evolution of dietary evidence and recommendations over time.

The study of dietary patterns can be divided into two broad categories of *a posteriori* and *a priori* approaches. *A posteriori* method uses statistical techniques to derive dietary patterns from the food intake, grouping the foods that are often consumed together or putting together people with similar food consumption. Because it is constructed using data from a specific population, this approach may not be reproducible across populations; also, it may not always be able to set the healthiest food patterns, since it is not based on evidence-based dietary guidelines[9,60]. On the other hand, the *a priori* approach is based on current scientific knowledge about food and nutrition and it is composed of variables/components (food, nutrients and other practices) considered important for health, generating measurements of diet quality[13]. The indexes in this group assess the overall quality of the diet, by comparing the behaviour/practices/food consumption of a population or individual with the current dietary guidelines to define how healthy the diet is[5].

Several indexes have been developed in the last two decades to assess the overall quality of the diet in the first 2 years of life, based on the current global and/or local dietary recommendations for this age group. Over two-thirds of the studies included in this review were published since 2010, and six of them, in 2019 and 2020, which evidences an increased interest in the topic and shows the efforts of researchers in achieving better paths to conduct this assessment.

Most of the studies included in the review were cross-sectional (*n* 24), which allows associations between diet and outcomes, but without investigating causal relationships. Longitudinal studies can establish stronger evidence about these associations[17]. The choice of the index to be used must take into account the study design, as some indexes were built specifically to be used in longitudinal studies and require information at multiple times, such as the one used in the study by Zhu *et al* (2020)[45].

Most studies analysed were conducted in Asian countries (*n* 12), especially China and India, and Latin American (*n* = 10) regions that concentrate low- and middle-income countries. These countries still face a major challenge in the double burden of malnutrition, in which malnutrition and overweight, and chronic diseases coexist[2,3]. In this scenario, research on food and nutrition is essential, which may be one of the reasons for the greater interest in the development of methodologies for assessing infant feeding practices in these countries.

Of the thirty-six articles included in this systematic review, 25 % (*n* 9) were classified as having fair or poor quality, especially due to methodological limitations related to the sample or the analysis process. Nevertheless, the articles included are generally good quality, which also contributed to the quality of the review.

The identified indexes had an extensive variety of evaluated components. Some indexes only assessed food consumption, while others included additional aspects related to the eating practices of children under 2 years old (*n* 10), developing a more comprehensive approach translating the complexity of the phenomenon. The intake of specific nutrients was evaluated in only one index[28],

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indicating that approaches based on the consumption of foods and/or food groups were most common.

The development of more complex approaches to assess the overall quality of the diet, instead of simple indicators or individual aspects ('reductionist' approach), has proved to be a promising approach, a perspective that meets the most current dietary recommendations in countries, for example, the Brazilian Dietary Guidelines for Children Under Age Two[61]. This becomes even more relevant in this age group, when intense changes in the child's diet occur, and there are many variables influencing the feeding practices.

Of the twenty-two original indexes, only thirteen included BF, which is considered a key element for the child's health and development. Some studies that evaluated children older than one prioritised the consumption of other foods rather than breast milk. Although BF is recommended in a complementary way until the age of 2 or more[1], from 12 months onwards, this practice reduces considerably, while other foods become much more important in the child's energy and nutrient intake[62].

The assessment of the consumption of foods considered unhealthy, with a high content of sugar, fat and salt, such as UPF[63] appeared more frequently in more recent indexes, justified by the growing trend towards the consumption of these foods and the possible negative consequences of this practice[64–68]. Among the thirteen original indexes that evaluated the consumption of UPF, twelve were published since 2012. For indexes that do not evaluate the consumption of UPF, even if the child reaches a high final score, the classification of the diet as good quality could be relative, as it is impossible to assess whether negative feeding practices are also present.

To calculate the index scores, the authors summed the component scores[10,25,28,31–36,38–43,45] or employed more complex equations[26,27,29,30,37,44]. The second option requires extra work for final analysis, which may limit their wider use.

The adapted indexes justified the changes to the indexes due to current recommendations, local context or to the available data. The adaptation of existing indexes is a viable alternative to achieve more appropriate measures, whether at the local or global level. This strategy can be strengthened to help improve previous proposals, often with some type of validation, instead of concentrating efforts to create new indexes.

We identified that a relevant gap is the lack of validation of some indexes, which was also an aspect pointed out by Lazarou and Newby (2011) in their review. We checked all the studies that did not report validation to guarantee that those indexes were not validated in previous or later studies. Validation is an important aspect to determine the choice of the most appropriate index for the objectives of the study[60]. In the context of dietary assessment, the reference for validating a method would be a comparison with biological nutritional markers[17]. However, it is necessary to highlight that regarding infant and young child feeding practices, there is no established gold standard and this may not be necessary because indexes could serve different purposes depending on the context and the diets.

The articles used other measures to assess the validity of the indexes, such as association with nutrient intake, internal validity tests, reliability and repeatability, and association with nutritional status, which added more confidence to the results but were not enough to guarantee that the proposed methodology could properly measure the quality of the diet or identify variations in the diet[9,13,19]. The lack of adequate validation of some of the dietary quality indexes has been identified as a problem since the first reviews on this topic[12], and it remains a critical issue in current studies. Smithers *et al* (2011) also identified in their review this lack of validation of the indexes[9]. Waijers *et al* (2007) pointed to arbitrary choices in the construction of the indexes and the lack of perception about the consequences of these choices[13].

Regarding their weaknesses, a relevant concern of the researchers is the lack of consensus on the choice of components and the absence of criteria for defining the weight and cut-off points. Some aspects or eating practices may have a greater influence on health and nutrition outcomes than others, so the ideal index would weigh the components in relation to the total score, to more adequately reflect the relationship of the diet with the outcomes. However, evidence remains insufficient to properly establish weights for these parameters[29]. Some studies try to minimise this limitation, proposing different scores of the same component depending on the age subgroup, for example in the BF component[10], or using other calculation procedures[29]; however, the indexes generally score the components equally.

This difficulty in establishing consensus is not limited to weighting or cut-off points but extends to defining the concept of quality diet or what would constitute an adequate diet[4]. In this sense, comparisons between countries can also be difficult. As the cultural contexts or needs can vary greatly by region and across time, establishing a unique approach could be a major challenge for researchers and also limit the possibilities of assessment based on the particular characteristics of places and populations. Thus, the question arises: would a single approach be reliable for universal use or are multiple key approaches more appropriate?

Indexes can be an interesting alternative to provide an overview of a child's diet quality and are easier to interpret than several separate indicators, but they need to be well constructed and carefully interpreted. Given the above, we can point out some relevant recommendations for future works on this topic. For the components of the indexes, the inclusion of BF assessment is crucial for indexes constructed for younger children, especially under 1 year of age. The construction of the indexes commonly

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follows the international dietary guidelines, established by the WHO, which does not eliminate the importance of considering the local context. Thus, national guidelines, such as those expressed by food-based dietary guidelines, can also guide the elaboration of the index, for example, in the choice of food groups. The inclusion of an UPF component should also be taken into account, to provide a more complete picture of the quality of the children's diet. The division by age subgroups can also be a good way to provide a more realistic and reliable assessment, since many changes occur between the introduction of complementary feeding and the age of two.

Strengths and weaknesses

As far as we know, our study is the first to do an extensive investigation of indexes for assessing the feeding practices focusing on children under 2 years old. These include original indexes and studies that have adapted existing proposals, indicating the reasons that led to the adaptations, and pointing out strengths and weaknesses. In addition, studies conducted in countries of all income levels were included.

Selection of an index, among the many existing ones, is not a simple task for a researcher. This choice depends on factors such as study objectives, outcomes of interest, available data and the researchers' data analysis abilities. Validation is also an important element to assess whether a given index adequately measures the quality of the diet and whether it is associated with important health outcomes related to food and nutrition; however, many studies still do not perform these analyses. Thus, the lack of studies with validation limited the possibility of indicating the most appropriate index to use. This issue is still a gap and demands further study to provide researchers with more reliable parameters.

Conclusions

A wide variety of indexes have been used to assess the eating practices of children under 2 years old, and the list of different components that make up the indexes is also extensive, which is due to the complexity of the issue. The lack of consensus on the concept of diet quality and the peculiarities of this age group contribute to the lack of a reference standard. Cultural and regional differences as well as the evolution of knowledge in the area also present obstacles. Many authors have proposed approaches that contemplate multiple dietary variables and are not limited to individual aspects to achieve a more complete assessment of the diet.

Although there are still gaps, this review showed important steps already taken in assessing the eating practices of young children. The advancement of the proposals, which seek to include multiple components and consider regional and cultural particularities to find the best way to reflect the diet in this age group, provides important aids to continue pursuing the best method.

We emphasise that the adaptation of indexes in accordance with the current recommendations is an interesting alternative, qualifying existing indexes and expanding their possibilities. Thus, a basic proposal that is flexible for modifications according to different scenarios may be a valid option.

Studies with a longitudinal design and validation studies, which evaluate different contexts (urban/rural, cultural, income levels) are important to provide strong and reliable instruments and evidence to support other research and actions directed to the health, nutrition and development of children in their first years of life.

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Supplementary material

For supplementary material accompanying this paper visit https://doi.org/10.1017/S1368980021000410

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