



Time to reconsider feeding difficulties in healthy children: a narrative synthesis of definitions and associated factors

Priscila Maximino¹ · Ana Carolina B. Leme¹ · Gabriela Malzyner¹ · Raquel Ricci¹ · Nathália Gioia¹ · Camila Fussi¹ · Mauro Fisberg^{1,2}

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Abstract

Objective Despite the lack of a “gold-standard” definition and identification of influential factors for identifying feeding difficulties in children, many international studies have been published in recent years on the subject. Thus, the aim was to examine studies on children with feeding difficulties and their associated factors that impact on their difficulties.

Methods Feeding difficulties were identified as limit the variety of food intake, and/or avoiding food due to sensory stimulus, i.e., food appearance, aroma, and flavor. A literature search in three databases was performed up to April 2021. English language articles were included if they investigated preschool and school age children using an observational or experimental design evaluating feeding difficulties and their factors.

Results Findings indicate that almost 60% of the studies evaluated picky/fussy eaters, followed by 20% evaluating food neophobia. Parental influence, mainly mothers, were seemed to be the most reported influence. Studies have shown a lower consumption of fruit and vegetables and higher intake of discretionary foods among picky and food neophobic children. Most of the studies showed that children were on normal weight to overweight status. Few studies identified socio-demographics (i.e., age, sex, race/ethnicity, and birth age), emotional distress and other lifestyle behaviors (screen-time use during meals). Studies were mixed in terms of positive effects on breastfeeding and introduction to foods.

Conclusion Improved feeding difficulties in this population group are dependent from these factors, whereas they should be used to inform policies, strategies, and use in clinical practices.

Keywords Feeding difficulties · Children · Behavioral factors · Narrative review

Introduction

Pediatric feeding difficulties can be defined as a pattern of oral consumption of nutrients that differs from accepted standards [1]. Although definitions and measures vary,

estimates of feeding difficulties are quite high in preschool and school age children, with 25 to 35% on healthy children and up to 80% with children with intellectual disabilities (such as autism disorders and down syndrome) [2]. This highlights the need to identify effective methods of

✉ Ana Carolina B. Leme
acarol.leme@gmail.com

Priscila Maximino
primaximino@gmail.com

Gabriela Malzyner
gamalzyner@gmail.com

Raquel Ricci
raquelnutrociencia@gmail.com

Nathália Gioia
nathaliagioiang@gmail.com

Camila Fussi
fussicamila@gmail.com

Mauro Fisberg
mauro.fisberg@gmail.com

¹ Center for Excellence in Nutrition and Feeding Difficulties, PENSI Institute, Sabará Children’s Hospital, José Luis Egydio Setúbal Foundation, Av. Angélica 2071, São Paulo, SP 01228-200, Brazil

² Department of Pediatrics, Federal University of São Paulo, São Paulo, SP, Brazil

assessment and intervention. Given that the act of feeding is complex, several issues can disrupt its execution, needing broad definitions to cover a wide spectrum of problems. As consequence, there are many cases of children with feeding difficulties that require interdisciplinary care, and complex aspects of feeding should be addressed in an integrated way, but might not be needed for all cases [3].

The preschool and school (2 to 10) age years are characterized as a time for rapid growth and development, with the peak for weight gain by age 2, and slowing between 2 to 5 years old [4, 5]. As a consequence, to the decrease rate of growth, this might impair on children appetite [6]. Thus, children's appetite can be quite irregular, presenting it into different spectrums of feeding difficulties, such as food neophobia (rejection or avoidance for new foods) and picky/fussy eating (unwillingness to eat familiar foods or try new foods) [7]. Alternatively, from an evolutionary perspective, its supposed that children show initial rejection of new foods to certify that they are not poisonous [8]. Evidence suggests that time and repetition to neutral exposures might change children acceptance for new foods [6].

There is a large body of evidence that many of these feeding difficulties are led by a combination of biological, medical, and environmental aspects [1–3, 9, 10]. Therefore, influence on children's food choices demands an understanding of the developmental factors that hinders their acceptance and consumption of certain food sources, such as fruit and vegetables, and whole grains sources [7, 11]. Essential to developmental influences are behaviors, such as fussy eating, picky eating, and food neophobia children. The nature of these feeding difficulties needs to be understood. Finally, consideration about what factors sustain these feeding difficulties through the different stages of childhood (from infancy to school age years) should also be understood to acknowledge before the development of successful policies and behavioral-change strategies.

Despite the lack of a guideline “gold-standard” definition and identification of influential factors for identifying feeding difficulties in typically developing children, many international studies have been published in recent years on the subject. For instance, studies have been consistently associating differences in food intake and other aspects that impact children eating behaviors. The purpose of this narrative review was to examine studies on children with feeding difficulties and their associated factors that impact on their difficulties. Feeding difficulties were self-reported by their parents/caregivers. This was presented to better understand the nutritional and clinical consequences of feeding difficulties among preschool and school age children.

Methods

This narrative review was conducted in accordance with guidance from Green et al. [12] stating the minimum acceptable criteria for narrative reviews of the literature. For reporting, the PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) guidelines were followed to certify that all steps for a literature search, screening, and inclusion were done [13].

Identification of the studies

A literature search of three electronic databases (i.e., PubMed, PsycINFO, and Web of Science) was performed up to April 2021. Search results were indexed within each database from the date of inception to the search date and were screened by two authors (AL and PM). The following structured search strings were used: Children OR Pediatric OR School Age OR preschoolers AND Feeding Difficulties OR Feeding Disorders OR Eating Disorders OR Feeding Behavior OR Eating Issue OR Eating Problem OR Picky Eating OR Eating Behavior OR Food Neophobia OR Food Preferences OR Food Intake. Relevant truncations and adjacencies were used to enhance results by allowing variations of the search terms. Manual review of the reference list was conducted to identify studies that may have been missed. Records were downloaded to EndNote X9.2 and duplicates removed. Records were first assessed by title and abstract and then full text. All records were assessed for inclusion based on the defined criteria. Any uncertainties regarding the inclusion of a study were resolved through discussion among A.L and P.M or G.M.

Eligibility criteria

This review was limited to studies published in English and with no limitation on studies date of publication. All studies were assessed according to the following inclusion and exclusion criteria summarized according to the PICO (Participants, Intervention/Exposure, Comparison, and, Outcome) framework:

Participants: Studies were eligible if they included free-living preschoolers and school age children from 2 to 10 years old. The age range was selected due to most of feeding difficulties cases are reported on these ages [1, 3]. Studies that included atypical developing children, i.e., any organic or genetic condition that could affect diet, were excluded (e.g., autism disorder, down syndrome, and, cleft lip).

Intervention/exposure: Studies were included if parents/caregivers and/or other health professional reported a feeding difficulty to the child. Feeding difficulties were defined based on the criteria that eating behaviors, in particular food selectivity, poor appetite, and fear of feeding/eating while diminishing the role that medical or psychological comorbidities play in feeding problems. Further, it was emphasized on specific types of eating behaviors, pertaining to the pediatric field [14].

Comparison: Different study designs, i.e., case-studies, cohort, cross-sectional, and, intervention (randomized and non-randomized trials), were included in this review. If intervention design was used, no exclusion criteria were placed on duration, length of follow-up, or date.

Outcome: The key outcome of this review was to assess the behavioral and environmental aspects associated to feeding difficulties on typically developing child. Studies were excluded if they focused on medical and biological aspects of feeding difficulties, i.e., genetic and other biological markers, and organic causes.

A secondary outcome of this review was to identify all the types of feeding difficulties reported in the studies.

Data extraction

Data were independently extracted from eligible studies by one reviewer (A.L) and cross-checked for accuracy by a

second reviewer (P.M). The extracted data included sample characteristics (sample size, sex, and, age), country, type of feeding difficulties, definition, and, behavioral factors associated to the feeding difficulties.

Data synthesis

Due to the broad topic approached in this study (feeding difficulties in children and its behavioral aspects), it was not possible to perform a systematic review. A narrative summary of the finding was conducted [12].

Quality assessment and risk of bias

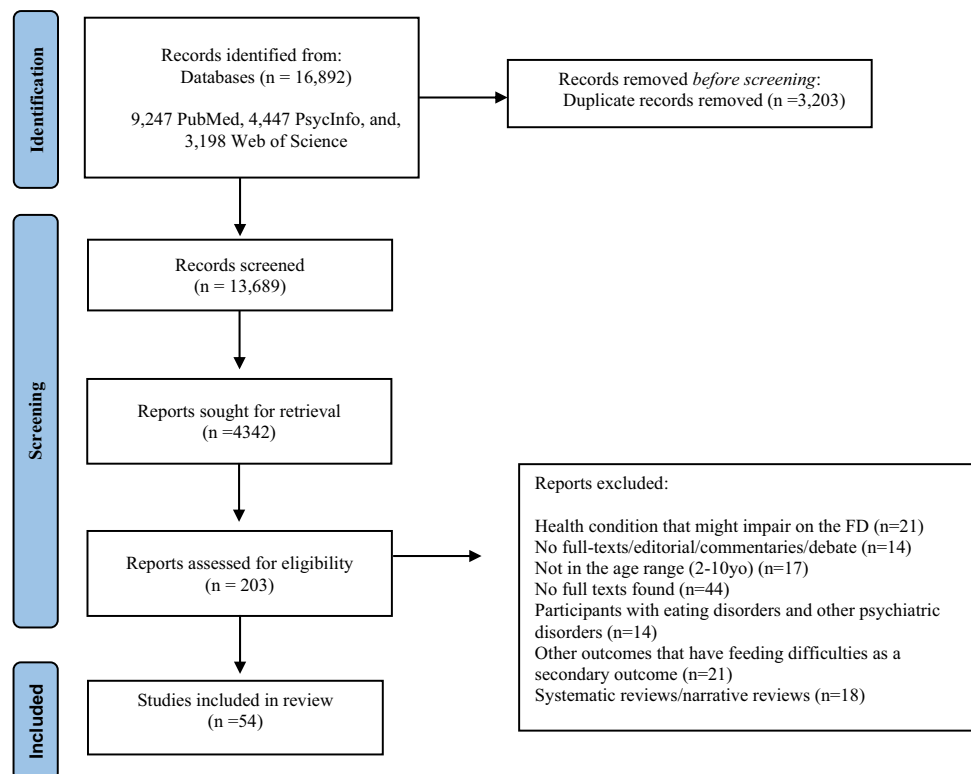
Study quality was assessed using a designed appraised tool developed by the Effective Public Health Practice Project (EPHPP) [15] for observational, cross-sectional, before and after studies, and randomized controlled trials. Individual component and overall quality ratings were scored as 1 for strong, 2 for moderate, and 3 for weak.

Results

Literature search and screening

Studies included in this review are summarized in Fig. 1. A total of eligible articles 16,892 were identified: 9,247 from

Fig. 1 Flowchart of the included articles for the narrative review



PubMed, 4,447 from PsycInfo, and 3,198 from Web of Science. After excluding duplicates and reading titles, 4,342 were sought for retrieval. Finally, 203 full-text articles met the inclusion criteria, and 54 were considered for the qualitative synthesis.

Studies design characteristics of the children with feeding difficulties

From the 54 articles included, 34 (62.9%) articles were cross-sectional [16–49], 13 (24.1%) were longitudinal/cohort studies [50–61], only two (3.7%) were case–control studies [62, 63], and five (9.3%) were interventions studies; from these, three (5.6%) were quasi-experimental [64–66], and two (3.7%) were randomized controlled trial [67, 68]. From these studies, only two used representative samples [55, 56] from a cohort conducted in the UK with over 13,000 parents/caregivers and children. Other studies were derived from convenience sample. Table 1 shows details of the studies, which included the type of feeding difficulties in children and definitions. The majority of the studies ($n = 32$, 59.3%) [17, 20, 21, 23, 26, 27, 29, 32–36, 38–40, 47, 49–58, 60, 61, 63, 67–69] was evaluating picky/fussy eating behaviors, 11 (20.4%) were evaluating food neophobia [18, 44, 46, 64, 65], 7 (12.9%) evaluated feeding difficulties as a broad concept (not specifying types) [16, 19, 37, 45, 62, 66], three (5.6%) were evaluating two types of feeding difficulties (food neophobia and picky/fussy eating) [22, 31, 67], and only one (1.9%) evaluated food avoidance [48] (Table 2).

Factors associated with feeding difficulties in developing children

The factors associated with feeding difficulties are reported based on the social-ecological model [70] and presented on Fig. 2. The majority of the studies reported that parents influence their children for having a feeding difficulty ($n = 25$, 43.10%) [18–23, 25–29, 31, 38, 39, 41–43, 47, 48, 50, 51, 53, 54, 66, 67] and mothers played a major role on their kids being picky eater and being neophobic to certain foods. For example, parents being concern of their child not eating enough foods, and thus, providing a variety of strategies to feed them, which includes physically promoting the child to eat or even forcing food on them. Studies analyzed also evaluated dietary intake among children ($n = 13$, 22.41%) [17, 24, 30, 31, 35, 39, 46, 55, 56, 59, 62, 63, 68] and from these studies' lower consumption of fruit and vegetables, and higher intake of discretionary foods were observed in picky eaters and food neophobic children.

Weight status and other anthropometric measurements were identified as factors related to feeding difficulties ($n = 9$, 15.5%) [16, 23, 29, 34, 52, 58, 60, 64, 68]. Most of these studies showed that children with feeding difficulties

were varying from normal weight to overweight status. Six (10.34%) of the studies observed differences between socio-demographic characteristics and feeding difficulties [19, 33, 35, 45, 49, 57]. Age, sex, race/ethnicity, and birth age being the associated factors. Emotional distress and other lifestyle behaviors (such as screen time use during meals) ($n = 7$, 12.1%) [22, 27, 42, 44, 52, 54, 65] were associated with being picky/fussy and/or food neophobic. Behaviors such as feeding strategies (e.g., forcing children to eat), restriction to certain foods, and negative affect were viewed as an influence for feeding difficulties in children. Only two studies (3.5%) [37, 61] were mixed in relation to positive effects on breastfeeding and/or introduction to foods in relation to feeding difficulties and/or being picky eaters.

Risk of bias

From all the included studies, withdrawals and dropouts ($M = 2.06 \pm 0.95$) were the most reported bias, while analysis ($M = 1.26 \pm 0.49$) was the less reported bias. Overall score was 1.59 ± 0.37 , i.e., strong to moderate studies included in this review. Figure 3 shows the risk of bias of each component rating for the included studies.

Discussion

This review synthesized the evidence from observational, case–control, and, intervention studies reporting the types of feeding difficulties and risk factors children. The 54 studies included in this review were conducted across 21 countries, thus representing a broad perspective on this study objective. This review found that picky/fussy eating and food neophobia were the most common feeding difficulties reported on the studies. Factors related to these difficulties were identified based on the socio-ecological model [70] as individual, environmental, and societal influences. Family, mainly parents, play a major role on their child eating behaviors and the developing of feeding difficulties. A review provided an approach for resolving a variety of feeding difficulties, advocating for a progressive approach of managing feeding problems in all clinical settings. Identifying for example, that a responsive feeding style is the ideal feeding approach for parents and is characterized by appropriate reactions to children's feeding cues [3].

Positive parental influences, in special maternal modeling, is commonly indicated as utmost importance in reducing the risk for picky/fussy eating or food neophobia in preschool and school age children. For example, in a study of Lebanese parents of 2 to 10 years old, parents; higher instrumental feeding scores (i.e., use food as reward instead of encouraging words) were associated with children refusal for eating fruit and vegetables, fish, and eggs [18]. Therefore,

Table 1 Key characteristics of the identified studies

Reference	Study design, country	Sample size, sex, age	Classification of feeding difficulties	Characteristics of feeding difficulties	Main results
Schmidt et al. [62]	Case control, Germany	29, 45% female, 7.5 ± 3.3 years (20 from the ARFID and 9 control group)	Avoidant/Restrictive Feeding Intake Disorder (ARFID) Semi-structure interview based on the Eating Disorder Examination	Limit variety of food intake Diet with limit amount	Lower total energy intake, carbohydrate intake, but no reduced in micronutrient intake
Prasetyo et al. [16]	Cross-sectional, Indonesia	245, 55.1% female, 3–5 years old	ARFID Based on the diagnostic of DSM-5	Avoiding food due to sensory stimulus (food appearance, aroma, and flavor)	Majority of children (76.7%) were normal weight followed by 11% obese
Pickard et al. [65]	Pre-posttest, France	83, 57.8% female, 58.5 ± 10.7 months	Food Neophobia and Pickiness Parents report by Child Food Rejection Scale	Food rejection tendencies	Increased levels of food rejection predict poor food identification
Maiz et al. [64]	Quasi-experimental, Spain	196, 43.4% female, 8–9 years: nutrition education and hands on group	Food neophobia Spanish Food Neophobia Scale	Reluctance to eat new foods, hinder willingness to try fruit and vegetables	No differences in weight status and diet quality scores between two groups Nutrition education slighted higher diet quality score Hand on slighted higher BMI
Iwinski et al. [50]	Longitudinal, USA	110, 51.8% female, 21 ± 2.7 months	Picky eating behaviors Self-reported questionnaire (Oregon Research Institute Child Eating Behavior Inventory—ORI-CEBI) Video-taped family meal-times	Physical food refusals, physiological food avoidances, verbal food avoidances, and verbal food refusals	Caregiver-child interactions may impact degree to which food responsiveness is effective in reducing picky eating
Fraser et al. [17]	Qualitative study, Australia, Canada, German, UK, USA	Forum posts with over 105,000 parents of 12–36 months	Fussy eating Definition from previous research	Fussy or picky are used to describe a spectrum of food refusal behaviors: refusal of both familiar and unfamiliar foods (neophobia), limited dietary variety and inequate intake	Fussy eating poses a barrier to children's dietary variety and establishing healthy eating habits
El Moullem et al. [18]	Cross-sectional, Lebanon	656, 50.8% female, 2–10 years	Food neophobia	Rejection for new or unfamiliar foods	Parents' instrumental feeding score: refused to eat vegetables, fish, fruits, or eggs Parents' encouragement lower neophobia

Table 1 (continued)

Reference	Study design, country	Sample size, sex, age	Classification of feeding difficulties	Characteristics of feeding difficulties	Main results
Zohar et al., [51]	Longitudinal, Israel	215, 52.6% female, 3.3 ± 1.0 years	Picky eating Self-reported	Child refuse to foods	Picking eating is a passing phase. Maternal feeding practices limit long-term influences on children's PE. Unless picking eating is persistent and severe, parents would best be advised to relax their feeding efforts
Simione et al. [19]	Qualitative study, USA	30, 43.3% female, 43.0 ± 13.4 months	Feeding difficulties: broad spectrum Parents' perspective	Broad range of difficulties resulting in oral intakes impairment	Feeding disorders impact daily lives of children and families Treatment incorporates principles of family-centered care focus on meaningful outcomes to improve health quality of life and address modifiable socio-contextual determinants
Shimsoni et al. [66]	Pre-post treatment, USA	15, 13.3% female, 9.14 ± 2.63 years	Avoidant/restrictive food intake	Selective of foods based on sensory properties (picky eating or food neophobia); limited interest in eating or poor appetite; fear of aversive consequences from eating, such as choking, vomiting, or gastrointestinal pain	93% picky eating; 6% poor appetite; and 26% fear of eating Family has an important role on the accommodation of the severity of the ARFID
Searle et al. [20]	Cross-sectional, Australia	205, 49% female, 3.6 ± 1.0 years	Fussy eating	Rejection of both familiar and unfamiliar foods is thought to be developmental expression of autonomy	Mothers' perception of child food fussiness mediated the relationship between difficult temperament and increased provision of alternative meals to the child from the rest of the family Mothers' and fathers' perception of child food fussiness mediated the relationship between difficult child temperament and lower frequency of sitting at a table together for family meals

Table 1 (continued)

Reference	Study design, country	Sample size, sex, age	Classification of feeding difficulties	Characteristics of feeding difficulties	Main results
Rendall et al. [21]	Validation study, UK	67, 58.2% female, 3 ± 1.0 years	Fussy eating	Rejection of familiar and novel foods resulting in diet that is insufficient and/or inadequately varied	Maternal reports of food fussiness were positively related to food rejection behaviors and negatively related to food acceptance behaviors. Maternal reports of food fussiness were also found to be negatively related to the proportion of familiar/appealing of familiar foods consumed by the child
Kutbi [22]	Cross-sectional, Saudi Arabia	195, 48.2% female, ≤ 2 to 7 years old (55.4–2 to 4 years)	Food neophobia and picky eating	Reluctance of eating novel foods and the rejection of substantial amounts of familiar and unfamiliar foods	Positive associations with pressure-to-eat feeding strategy and food neophobia and picky eating. Negative associations with healthy home food environment and food neophobia/picky eating. Maternal practices of teaching and monitoring were associated with food neophobia/picky eating
Fernandez et al. [52]	Longitudinal, USA	269, 48.1% female, and 4–9 years measured at five different times	Picky eating	Eating a limited number of foods, rejection of novel foods, and strong food preferences	Three trajectories of picky eaters: persistently low, medium, and high. High picky eating was associated with higher emotional lability and lower emotional regulation. Picky eating was associated with restrictions and demandingness—low picky eating with low restriction and high picky eating with high demandingness. Medium and high-picky eating associated with low BMIz

Table 1 (continued)

Reference	Study design, country	Sample size, sex, age	Classification of feeding difficulties	Characteristics of feeding difficulties	Main results
Brown & Perrin [23]	Cross-sectional, USA	286, 47.8% female, 4.9 ± 2.3 years	Picky eating	Wide range of what is considered “decreased variety” is why picky eating is described on a spectrum. Picky eating is generally considered a developmentally normal behavior in young children that usually resolves by school age and does not affect growth	Three distinct picky eating factors: try new foods, eating sufficient quantity, and desire for specific food preparation. No factors were associated with weight perceptions. Parents’ who were more concerned with their child did not eat enough were more likely to pressure-to-eat and these children had lower BMIz
Anjos et al. [24]	Cross-sectional, Brazil	214, 50.47% female, 3–6 years (62.6% from 5–6 years)	Food neophobia	Reluctance to eat or the avoidance of new or unfamiliar foods	85.9% low-median and 11.2% high food neophobia. Children with high neophobia consumed more ultra-processed foods and protein-rich foods. Children with level of neophobia had lower adherence to traditional dietary patterns
An et al. [25]	Cross-sectional, Ireland	205, 43.9% female, 2.4 ± 0.7 years	Food neophobia	Reluctance to eat or avoidance of new foods	Higher score of food neophobia was associated with maternal practice of coaxing the children to eat at refusal, unpleasant emotions at mealtime, and mother’s own degree of food neophobia. Mothers not worried when confronted with child’s food refusal were negatively associated with kids neophobia
Wolstenholme et al. [26]	Qualitative, Ireland	24 children, 56.5% female, 6–10 years	Fussy eating	Consumption of inadequate variety or quantity of foods through the rejection of both new and familiar foods	Three family process themes were identified, explaining how families respond to fussy eating behaviors: dynamic and evolving feeding goals, managing negative emotions, and parenting practices. Changes of parent responses change over time: resistance-to-acceptance, fluctuating response, and consistent response

Table 1 (continued)

Reference	Study design, country	Sample size, sex, age	Classification of feeding difficulties	Characteristics of feeding difficulties	Main results
Whelan & Penrod [63]	Case-study, USA	Two brothers, 6 and 3 years old	Picky eating	Consumption of restrictive number of foods (i.e., < than 3) in at least one food group and resistance to trying new foods when presented	Presenting non-preferred foods as an appetizer was not successful in increasing consumption Consumption only increased after high-preferred foods were made contingent on consumption of non-preferred foods
Sandvik et al. [68]	Randomized controlled trial, Sweden	130, 54% female, 5.2±0.7 years	Picky/fussy eating	Child's unwillingness to eat familiar foods or try new foods, with negative impacts on children and parents in their daily activities	Intervention was unable to reduce the degree of picky eating using two instruments (CBEQ and LBC) Intervention=evidenced-based parenting styles Picky eating was associated with lower BMIz and lower intake of vegetables
Rahill et al. [27]	Cross-sectional, Ireland	296, 51.0% female, 5–8 years	Fussy eating	Rejection of a large proportion of both familiar and novel foods	Child preferences and food advertising are barriers to provide healthy eating as higher score for fussy eating Parental neophobia and child's preference were positively associated with higher score for child being fussy, and advertising was negatively associated with higher scores for fussy eating
Kutbi et al. [28]	Cross-sectional, Saudi Arabia	216, 50% female, 5.09 ± 1.06 years	Food Neophobia Picky eating	Food neophobia: refusal of new foods Picky eating: limited variety of foods through the rejection of either familiar or unfamiliar food	98.6% food neophobia and 89.9% pickiness eating Peer modeling and parental strategies were negatively associated with neophobia and picky eating
Katzow et al. [67]	Randomized controlled trial, USA	187, 53% female, newborn to 2 years	Picky eating	Food neophobia: refusal to accept new foods Picky eating: response to new foods and limitations in the variety of foods accepted	Maternal concerns about picky eating may reflect deeper depressive symptoms and negative perceptions of her child's behavior

Table 1 (continued)

Reference	Study design, country	Sample size, sex, age	Classification of feeding difficulties	Characteristics of feeding difficulties	Main results
Sandvik et al., [29]	Cross-sectional, Sweden	1272, 51% female, 4.9 ± 0.8 years	Picky eating	Unwillingness to eat familiar foods or try new foods, with negative impacts on children/parents' daily activities	Half of the children was picky eating 30% severe picky eating Food responsiveness was lower for picky eaters with differences only in obese children Slowness in eating was not pronounced in obese children High pressure to eat was more pronounced in thinness/normal weight children Parents of picky eaters were more likely to report more time spent on screens, complaining about PA, and negative affect toward food Picky eating was less common, but still prevalent with obese children
Koziol-Kozakowska et al. [30]	Cross-sectional, Poland	325, 48.6% females, 2–7 years	Food neophobia	Tendency to reject novel or unknown foods	12.3% low and 10.8% high food neophobia High level of neophobia consumed less eggs, raw and cooked vegetables, and legumes. Tend to consume more frequently sweets and snacks and often consumed in-between meals Low consumption of vegetables impact on meeting far below the recommendations for vitamins
Harris et al. (a) [31]	Qualitative, Australia	12, N/E gender, 9–48 months age	Fussy eating/food neophobia	Reject new or familiar foods	Feeding concerns: learning challenges in the process of transition from a milk-based to a solid-based diet; Emotional accounts of feeding as intractable problem Child's eating behavior battle, over limited intake and variety of foods constructed as bad or wrong Parent anxiety evoked parent non-responsive feeding practices or provision of foods the child preferred

Table 1 (continued)

Reference	Study design, country	Sample size, sex, age	Classification of feeding difficulties	Characteristics of feeding difficulties	Main results
Harris et al. (b) [32]	Cross-sectional, Australia	208, 50.0% females, 3.6 ± 1.0 years	Fussy eating/picky eating	Reject foods, whether novel or familiar	Parents' rewards for behaviors were associated with child fussy eating
Galloway et al. [33]	Cross-sectional, New Zealand	193, 47% females, 1–5 years	Picky eating/fussy eating	Rejection of number of foods that results in low dietary variety and low food intake in general	Socio-economic status and picky eating predict infant growth over the time
Cole et al. [53]	Longitudinal, USA	326, 48.5% female, 52.4 ± 8.4 months	Picky eating	Avoidance of food and inadequate dietary variety	Child control over feeding and watching TV during mealtimes with picky eating Higher sense of positive climate during family meals less the change of picky eating
Chao [34]	Cross-sectional, China	300, 48% female, 2.95 ± 0.59 years	Picky eating	Strong preferences, consuming an inadequate variety of foods, restricting the intake of some food groups, eating a limit amount of food, or being unwilling to try new foods	54% picky eaters Anthropometric measurements were lower in picky eaters Fear of unfamiliar places, poor physical activity, constipation, and high frequency of medical illness was associated with being picky eater
Brown et al. [35]	Cross-sectional, USA	506, 51.38% female, 49.31 ± 6.35 months	Picky eating	Eating a limit variety of foods	Sex, age, and difficult temperament were associated with picky eating. Overall diet quality score was negatively associated with picky eating, as well as for total and whole fruits, vegetables, greens/beans, and total proteins
Steinsbekk et al. [36]	Cross-sectional, Norway	752, 50% female, 6.7 ± 0.18 years	Picky eating	Unwillingness to eat specific foods or try new foods, thus limiting dietary variety	20.7% moderate picky eaters 0.5% severe picky eaters
Steinsbekk et al. [54]	Cohort, Norway	1250, N/E gender, 4 and 6 years in the two cohorts	Picky eating	Unwillingness to eat specific foods or try new foods, thus limiting dietary variety	26% picky eaters Parental structuring was found to reduce the risk of children's picky eating, whereas parental sensitivity increased Sensory sensitivity predicts picky eating at age 4 Temperamental surgency, and negative affectivity not

Table 1 (continued)

Reference	Study design, country	Sample size, sex, age	Classification of feeding difficulties	Characteristics of feeding difficulties	Main results
Ramos et al. [37]	Cross-sectional, Brazil	70, 32.9% female, 3.0 ± 2.1 years	Feeding difficulties	Broad concept: agitated, limited appetite, phobia, misinterpretation, organic, picky eating	No differences in presenting any type of feeding difficulties as compared to picky eating. Age at texture transition both from breastfeeding to complementary feeding and from complementary feeding to solid foods did not vary according to feeding difficulties diagnostic
Luchini et al. [38]	Cross-sectional, USA	50, 52.0% female, 3–5 years	Picky eating	--	Parents perceived 1.4 × their child as being picky eating as providers from child care. Perceived pickiness from parents has greater influence on mealtime strategies
Kwon et al. [39]	Cross-sectional, South Korea	184, N/E gender, 1–5 years	Picky eating	Limit variety	Children eating small amounts consumed less energy and nutrients. Picky eaters' differences in energy density and micronutrients content
Byrne et al. [40]	Cross-sectional, Australia	336, 51% female, 13.8 ± 1.3 months	Fussy eating	Rejection of a substantial amount of familiar and unfamiliar foods, potentially resulting in limited dietary variety and food intake	Reward for eating, reward for behavior, persuasive feeding, and over-restriction with mothers' perceptions of child being fussy
Taylor et al. [55]	Longitudinal, UK	13,998, N/E gender, 2–5.5 years	Picky eating	Reduction in dietary variety and consequently an unhealthy or possibly inadequate diet	Picky eaters aged 3 lower mean for carotene, iron, and zinc. Free sugars were consumed as more than the recommendations. Nutrients differences were explained by lower intakes of meat, fish, vegetables, and fruits. Sugary foods and drinks were higher in older picky eaters
Taylor et al. [56]	Longitudinal, UK	13,998, N/E gender, 2–5.5 years	Picky eating	Reduction in dietary variety and consequently an unhealthy or possibly inadequate diet	Dietary fiber was lower in picky eaters due to low consumption of vegetables

Table 1 (continued)

Reference	Study design, country	Sample size, sex, age	Classification of feeding difficulties	Characteristics of feeding difficulties	Main results
Moding and Stifter (a) [41]	Cross-sectional, USA	115, 45.2% female, 6–12 months	Food neophobia	Tendency to reject novel or unknown foods	Maternal neophobia has been associated with children rejection of novel foods
Moding and Stifter (b) [42]	Cross-sectional, USA	115, 45.2% female, 6–12 months	Food neophobia	Tendency to reject novel or unknown foods	Maternal pressure predicts child food neophobia Toddler negative affect was associated with food neophobia
Cano et al. [57]	Cohort study, the Netherlands	3,748, 49.4% female, 1.5, 3, and 6 years	Picky eating	Food refusal, eating a limited variety of food, an unwillingness to try new food (food neophobia)	Persisting PE predict pervasive developmental problems at age 7. Not associated with behavioral or emotional problems
Antoniou et al. [58]	Cohort study, the Netherlands	1024, 60.9% female, 5 years	Picky eating	--	39.4% picky eaters Picky eaters have higher changes to become overweight
Perry et al. [59]	Longitudinal, Australia	194, 54.2% female, 5, 14, and 24 months	Food neophobia	Rejection of novel or unknown foods, is minimal at infancy and peaks sometime between two and six	Neophobic children have lower variety of fruits and vegetables, and greater proportion of daily discretionary foods
Harvey et al. [43]	Cross-sectional, UK	61, 44.3% female, 4.23 ± 1.83 years	Feeding difficulties—in general	Not defined	Parents' anxiety and reports of child feeding difficulties
Barse et al. [60]	Longitudinal, the Netherlands	4191, 50.3% female, 4 to 6 years	Fussy eating/picky/selective/choosy eating	Often reject new food items (food neophobia), but they are particularly characterized by their consistent rejection of specific familiar foods, especially vegetables	Fussy eaters are at risk for lower BMI z scores and fat-free mass
Cano et al. [69]	Longitudinal, the Netherlands	4191, 50.3% female, 4 to 6 years	Picky eating	Consuming a limited variety of foods, unwillingness to try new foods (food neophobia) and aberrant eating behaviors	26.5% of picky eaters at 1.5 years and 27.6% at 3 years, declined to 13.2% at 6 years Male sex, lower birth weight, non-Western maternal ethnicity, and low-parental income predicted persistent picky eating

Table 1 (continued)

Reference	Study design, country	Sample size, sex, age	Classification of feeding difficulties	Characteristics of feeding difficulties	Main results
Faith et al. [44]	Cross-sectional, USA	66 (twins), 53% female, 4–7 years	Food neophobia	Tendency to avoid eating unfamiliar foods	Food neophobia was related to reduced child compliance of prompted foods; compliance with initially refused foods—overall sample, boys and girls. Girls only food neophobia was also related to food type demandingness
Benjasuwantep et al. [45]	Cross-sectional, Thailand	402, 46.8% female, 22.93 ± 9.62 months	Feeding difficulties—general	Persistence feeding disturbance and either a failure to gain weight or significant weight for at least one month without significant medical conditions or lack of available food	26.9% feeding difficulties (15.43% highly selective intake) Birth order was associated with feeding difficulties Less frequency of meals, prolonged meal durations, fed at child's table/table with other family members
Howard et al. [46]	Cross-sectional, Australia	277, 51.0% female, 24 ± 1.0 years	Food neophobia	Reduced preferences for all food groups, in particular vegetables, with liking fewer food types, a higher number of untried food preferences and less healthful food preferences overall	Food neophobia was associated with liking fewer vegetables and fruits, and trying vegetables Repeated exposure to new food was not associated with food liking
Goh and Jacob et al. [47]	Cross-sectional, Singapore	46.2% female, 1–10 years	Picky eating	Inadequate variety of foods	One year most prevalent year of present first episode 45% parents/caregivers were very much concern Pressure to eat was significant associated with picky eating Caregiver's stress was associated with picky eating, and picky eating impact negatively on family relationships

Table 1 (continued)

Reference	Study design, country	Sample size, sex, age	Classification of feeding difficulties	Characteristics of feeding difficulties	Main results
Shim et al. [70]	Cohort, USA	129, 57.4 female, 2.97 ± 0.7 years	Picky eating	Unwilling to try new foods or having strong opinions on food preferences, preparation methods, and choice of food groups	Exclusive breastfeeding at 3 m was associated with preference for specific food preparation method Exclusive breastfeeding at 6 m was associated with preference for specific food preparation method, food rejection, and food neophobia Introduction with complementary foods before 4 m was associated with limited variety of foods Introduction with complementary foods before 6 m was associated with food neophobia and limited variety of foods
Powel et al. [48]	Cross-sectional, UK	95, 44.2% female, 5.20 ± 1.13 years	Food avoidance	Display of such behaviors: food refusal, selective, picky or fussy eating, eating slowly, being less interested in food and having less appetite	Food avoidance were associated with an emotional child temperament, high levels of maternal feeding control, using food for behavior regulation, and low encouragement of a balanced and varied food intake. Maternal pressure to eat predict food avoidance in child
Evans et al. [49]	Cross-sectional, USA	659, N/E gender, 3.26 ± 1.35 years	Picky eating	Not defined	Spanish and black parents were more used to use food to calm their kids (than English-speaking Spanish parents)

Notes: *BMI* body mass index, *PA* physical activity, *PE* physical education

Table 2 Types of feeding difficulties in typically developing children and their definition according to the included studies

Feeding difficulties	Definition
<i>Feeding difficulties broad definition</i> [16, 19, 37, 43, 45, 62, 66]	<ul style="list-style-type: none"> • Limit variety of food intake • Avoiding food due to sensory stimulus (appearance, aroma, and flavor) • Persistence feeding disturbance and either a failure to gain weight or significant weight for at least 1 month without significant medical conditions or lack of available food
<i>Picky/fussy eating</i> [20, 21, 23, 26, 27, 29, 32–36, 38–40, 47, 49–58, 60, 61, 63, 64, 67–69]	<ul style="list-style-type: none"> • Physical food refusals, physical food avoidances, verbal food avoidances, and verbal food refusals • Spectrum of food refusal behaviors: refusal of both familiar and unfamiliar foods (neophobia), limited dietary variety and inadequate intake • Eating a limited number of foods, rejection of novel foods, and strong food preferences • Child’s unwillingness to eat familiar foods or try new foods, with negative impacts on children and parents in their daily activities
<i>Food neophobia</i> [30, 41, 42, 46, 59, 64, 65]	<ul style="list-style-type: none"> • Reluctance to eat or the avoidance of new or unfamiliar foods • Tendency to reject novel or unknown foods
<i>Food avoidance</i> [48]	Display of such behaviors: food refusal, selective picky or fussy eating, eating slowly, being less interest in food and having less appetite

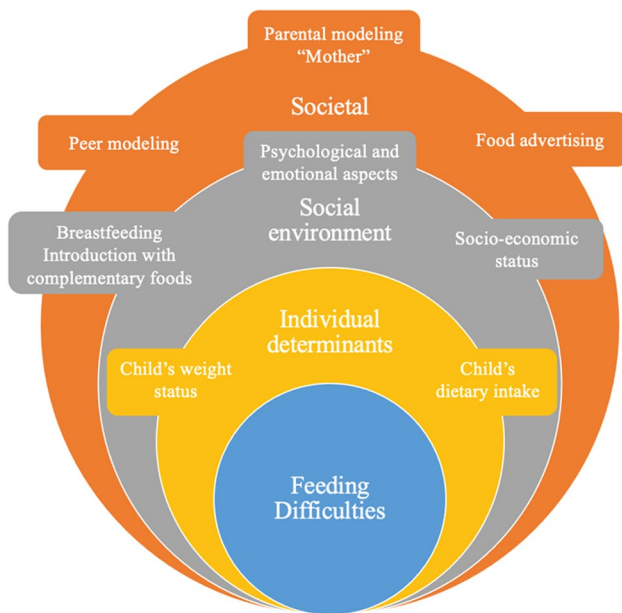


Fig. 2 Social ecological model adapted to the feeding difficulties in developing children

parents should be aware of the adequate methods to use to help their child get familiarized with food. Encouraging words and attitudes might be an opportunity to reduce levels of food avoidance in children. Alternatively, offering food as reward in a tentative to eat certain food showed more signs of avoidance [71]. Feeding difficulties are common during the early years [8, 71]. Thus, results associating picky or neophobic children with lower consumption for certain food sources can explain the urgency of dealing with inadequate

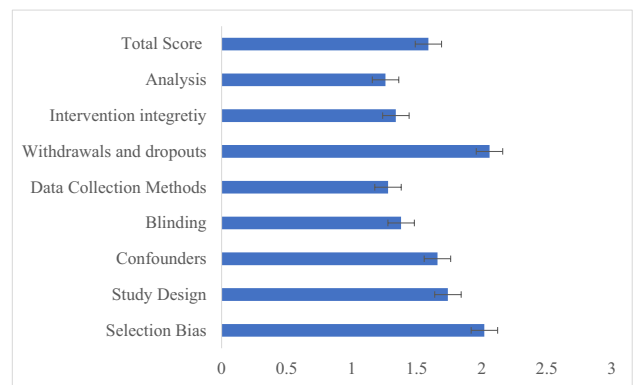


Fig. 3 Risk of bias of the included studies based on the Effective Public Health Practice Project: ratings for each component and overall score

eating behaviors to help diversify the diet of children. Also, poor diet quality might be risk factors for the development of broaden concept of the feeding difficulties [72].

Studies have been mixed in terms of total energy intake, but were unanimously in terms of eating less fruit and vegetables, and more discretionary foods (e.g., sugar-sweetened beverages, and other sweets and sugary items). Alternatively, few studies have found evidence for nutrient-specific deficiencies, with one study reporting lower vitamins and minerals intake in a sample of 20 children and adolescents, as determined by three-day food records [62]. This might explain the increased prevalence of overweight in this population, while in the past years, children with feeding difficulties were associated with underweight or malnutrition [4, 8, 73, 74]. This is consistent with evidence that parents

of picky/fussy eaters and neophobic children apply greater pressure to eat [74]. Children tend to gain less weight if their parents/caregivers responded to refuse food with more pressure to eat; this might simply be caregivers responding to slow infant growth, although it is possible that the pressure could actually suppress the young infants' appetite for some foods [75]. However, there is somewhat conflicting evidence that suggests that feeding difficulties in children may reduce the risk of obesity and may not be a serious health concern unless the diet restriction is extreme.

The strengths of this narrative review include the examination of a topic that filled a gap in the existing literature. This study aimed to identify types of feeding difficulties in typically developing children and the associated factors regarding to these difficulties. This study corroborates with the argument of Walton et al. [8] that labelling children as a picky/fussy or neophobic to foods might lead to difficult feeding interactions. This is due to such labels pathologize what may be normal variations in child food preferences and reinforce parent and child stress. This study was not without limitations. Only studies including children between 2 to 10 years old. Prevalence for feeding difficulties in older children (pre-adolescents) may be lower and the difficulties to identify feeding difficulties in infants (≤ 2 years old). Infants have different nutritional requirements, and most of them are breastfed. Only studies that evaluate feeding difficulties in developing children were included; no other children with a health condition (e.g., autism disorder and Down syndrome) that might impair on their dietary intake were included. This may have caused confirmation bias, when interpreting the studies [76]. Further, despite the authors' extensive efforts, including searching of databases and manual searching of literature reference lists, it is possible that studies meeting the inclusion criteria may have been missed. Only one author performed title, abstract, and full-text screenings. However, any uncertainties regarding study inclusion were resolved through discussion among three authors. This review was also limited by the heterogeneity of the included studies, whereby reporting measures and outcomes were often not consistent. Finally, uncertainties on risk of bias information may be considered a limitation. Some studies did not provide relevant information on certain sources of bias, such as allocation, concealment and blinding of participants, personnel and outcome assessment, an underpowered study, and an analysis not accounting for clustering.

Conclusion

In sum, this narrative review showed that children are naturally prone to be picky/fussy eater and/or food neophobic, and this depends on different factors. These factors can be classified according to the socio-ecological model proposed

by Bronfenbrenner in 1974 [70], and they were linked to individual (i.e., child weight status and dietary intake), environment (socio-demographics and being breastfed), and societal (peer/family modelling and food advertising). Improved feeding difficulties in this population group are dependent from these factors, whereas they should be used to inform public health policies, behavioral-change strategies, and their use on clinical practices. Moreover, most of the studies have showed the opposite that instead of feeding difficulties being a common problem among underweight children; this has been also a problem in those in an overweight status. This may be impact on their different food choices. However, more research is needed to examine how these factors may be impacting on children that can be addressed in different types of feeding difficulties, as well as to identify whether additional support is needed for overweight preschoolers and school age children.

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Availability of data and material The dataset and/or files used during the current study are available from the corresponding author on reasonable request.

Code availability Not applicable.

Declarations

Ethics approval Not applicable.

Consent to participate Not applicable.

Consent to publication Not applicable.

Conflict of interest The authors declare no competing interests.

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