ARTICLE

# Parental Influences and Child Characteristics as Predictors of Food Neophobia and Picky Eating: A Systematic Review

Charli Harlen BSc[1*] | Kevin Haubrick PhD, RD, LD, FAND[1]

**Abstract**

Picky eating and food neophobia are on a spectrum of feeding disturbances seen in youth and are common in preschool-aged children. The reported prevalence of picky eating and food neophobia vary across studies due to the lack of a standardized definition and criteria. This review aims to examine predictors of picky eating and food neophobia, explore how the two feeding disturbances interact, and better understand potential prevention and holistic treatment methods. A systematic search of available literature was conducted, thirty-eight articles were identified for review. Picky eating and food neophobia were found to share a common etiology and be significantly heritable. Four themes were identified as having significant impact as predictors for picky eating and food neophobia: early feeding practices, perception of picky eating, feeding environment, and feeding style. Of the four themes, only one had a uni-directional effect—early feeding practices. Overall, predictors of picky eating and food neophobia show a bidirectional nature. Maternal perception of or anxiety about picky eating was found to increase negative mealtime behavior and be a strong predictor of increased picky eating. Feeding styles and feeding environment showed the strongest bidirectional relationships with picky eating and food neophobia. To create effective interventional and preventative programs, early feeding practices, parental perceptions of picky eating, feeding style, and feeding environment need to be targeted.

**Key words:** Picky Eating, Food Neophobia, Parent-Child Relations, Child Feeding Disturbances, Pediatric Nutrition

## Introduction

Picky eating and food neophobia are on a spectrum of feeding disturbances seen in youth and are common in preschool-aged children.[1-7] The reported prevalence of picky eating and food neophobia vary across studies due to the lack of a standardized definition and criteria. [4-5,6,8] In a 2012 study, parental perception of picky eating changed based on how a survey question was asked, which can be explained by various social attitudes toward picky eating—relating to the inconsistency in prevalence. [9] For this review, adopted definitions of picky eating and food neophobia are as follows. Picky eating is characterized by highly specific food preferences with an unwillingness to accept new or familiar foods. [6] Food neophobia is characterized by an unwillingness, aversion, or fear of new or familiar foods. [5] As most of the definitions of food neophobia focus on the refusal of specifically unknown or unfamiliar food, it is essential to highlight refusal of familiar foods was included in this review's characterization.

1The University of Houston
Address correspondence to: Charli Harlen BSc, The University of Houston

[1,5,10] This is due to foods being a part of the home food environment and, thusly, familiar can be included in the rejected foods category of a food neophobic child.

Disturbed feeding behaviors are often causes for worry in parents and are often related to adverse outcomes over time. [3-4,6,10] Picky eating and food neophobia are widely accepted as a normal phase in early childhood, yet the antecedents to the behaviors, their persistence, and their relation to each other are not well-understood. [1,8,11-28] Existing literature focuses on the two feeding difficulties as two distinct behaviors, yet food neophobia is often seen in the list of characteristics of a picky eater. [4,6,8,28] More understanding on determinants of picky eating and food neophobia is needed to fill the gaps in knowledge surrounding these aforementioned feeding difficulties. This review aims to examine predictors of picky eating and food neophobia, explore how the two feeding disturbances interact, and better understand potential prevention and holistic treatment methods.

## Methods

This systematic review used the framework of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) to evaluate qualitative data on child eating patterns and associated factors. [29]

### Protocol and registration

This review, per the Preferred Reporting Items for Systematic Reviews and Meta-Analyses, was registered with PROSPERO international prospective register of systematic reviews (CRD42022313503).

### Search strategy

A search of the literature was performed of two primary databases, PubMed and CINAHL, to find peer-reviewed original research articles published between 2012 to 2022. For this review, the concepts of picky eating were considered as reluctance or aversion to eating new or familiar foods and highly specific food preferences. [6] The adopted definition of food neophobia in this review overlaps with picky eating as an unwillingness, aversion, or fear of eating new or familiar foods. [5] Considering there is no widely accepted and precise definition for either term, other qualifiers for similar food disturbances were included in the search strategy. Examples of search terms included food neophobia, picky eating, selective eating, food refusal, and more in combination with a varied list of terms describing the parent-child dyad; see Table 1 for the complete list. The search strategy was adapted for each database to retrieve a broader number of results and reduce the number of duplicates generated. The searches were limited to full-text primary research articles available in English and published in academic journals within the past decade. Citation searching was conducted to find related publications from articles that met all inclusion criteria.

**Table 1 Key Terms Describing the Topic Elements**

| Population | Exposures | Outcome |
|---|---|---|
| CHILD*, P(A)EDIATRIC, YOUNG, PRE(-)SCHOOL (CHILD*), TODDLER*, PARENT-CHILD DYAD, MOTHER-CHILD DYAD | PARENTING STYLE, FEEDING PRACTICES, HOME ENVIRONMENT, PARENT* EDUCATION, GUARDIAN*, CAREGIVER*, FAMIL*, ANTECEDENT*, PREDICTOR* | FOOD NEOPHOBIA, PICKY EAT*, FUSSY EAT*, CHOOSY EAT*, FINICKY EAT*, NON-NORMATIVE, FEEDING DISTURBANCE*, EATING BEHAVIO(U)R*, SELECTIVE EATING, INTAKE DISORDER, FOOD REFUSAL, FOOD REJECTION |

### Eligibility criteria

Eligibility criteria are outlined in Table 2. To be considered for this review, results were limited to empirical studies examining parent and/or child predictors of picky eating or food neophobic behaviors as a primary or secondary result.

Participants involved were healthy, typically developing children aged between 1-15 years and their parents/primary caregivers. Children under the age of 1 year were excluded because any perceived negative food reaction would be related to initial food taste experience and not genuine picky eating or food neophobia per the definition adopted in this review. Children with medical trauma and chronic illness or disease were excluded due to higher rates of feeding difficulties and alternate feeding methods, such as enteral or parenteral feeding. Children with Autism Spectrum Disorder were also excluded due to the prevalence of severe food selectivity and textural aversions. Studies set in the home, clinical environment, or community settings were preferred. Studies conducted in a school or care center were excluded as they do not fit the desired influential environment of the family home, specifically the parent-child relationship. Due to the limited amount of original research available on this topic, articles from the past ten years, 2012-2022, were included. Reviews and case studies were excluded.

**Table 2 Inclusion and Exclusion Criteria**

| Domain | Inclusion | Exclusion |
|---|---|---|
| Study Design Preferences | Primary sources: RCT and clinical trials | Reviews and case studies |
| Size of Study Group | >10 Participants in each group | <10 Participants in each group |
| Language | Limited to articles available in English | |
| Publication Year Range | 2012-2022 | |
| Age | 1-15 years | <1 and >15 years |
| Health Status / Condition | Typically developing children | Chronic disease or illness, medical trauma, developmental disability, Autism Spectrum Disorder |
| Exposure | Parent-based exposures or controls | School / care-center interventions |
| Outcomes | Food selectivity, food neophobia, picky / fussy eating | Eating disorders, enteral / parenteral feeding |
| Other | Full-text available | |

**Study selection, data extraction, and quality assessment**

Study selection was performed independently by one author; all search results were screened by title and abstract, duplicates and articles that did not meet inclusion criteria were excluded. The remaining articles were then fully screened for eligibility for definitive inclusion, and citation searching was performed to find other relevant articles. Figure 1 outlines the selection process. Data extraction tables, adapted from the Cochrane template to fit the minimum requirements and the needs of this review, were created by the author, and the extracted information included author, date published, study design, the aim of the study, participants, number of groups, study methods and intervention description, measures, results/conclusions, and bias rating. [30] Authors were contacted for any missing information or clarification needed. Risk of bias and quality assessment was performed using The Academy of Nutrition and Dietetics Quality Criteria Checklist for primary research. [31] Each article was assessed based on several components—research question and aim, study design, selection bias, confounders, documentation of methods, and more—and then assigned a rating to determine its objectiveness and scientific relevancy. A positive, +, rating suggests the study is of high quality and adequately addresses a relevant issue. A neutral, ∅, rating suggests the study is neither strong or weak. Lastly, a negative, -, rating indicates the study does not address a relevant issue and is weak in quality. [31]

**Figure 1**

*Study Selection Process*
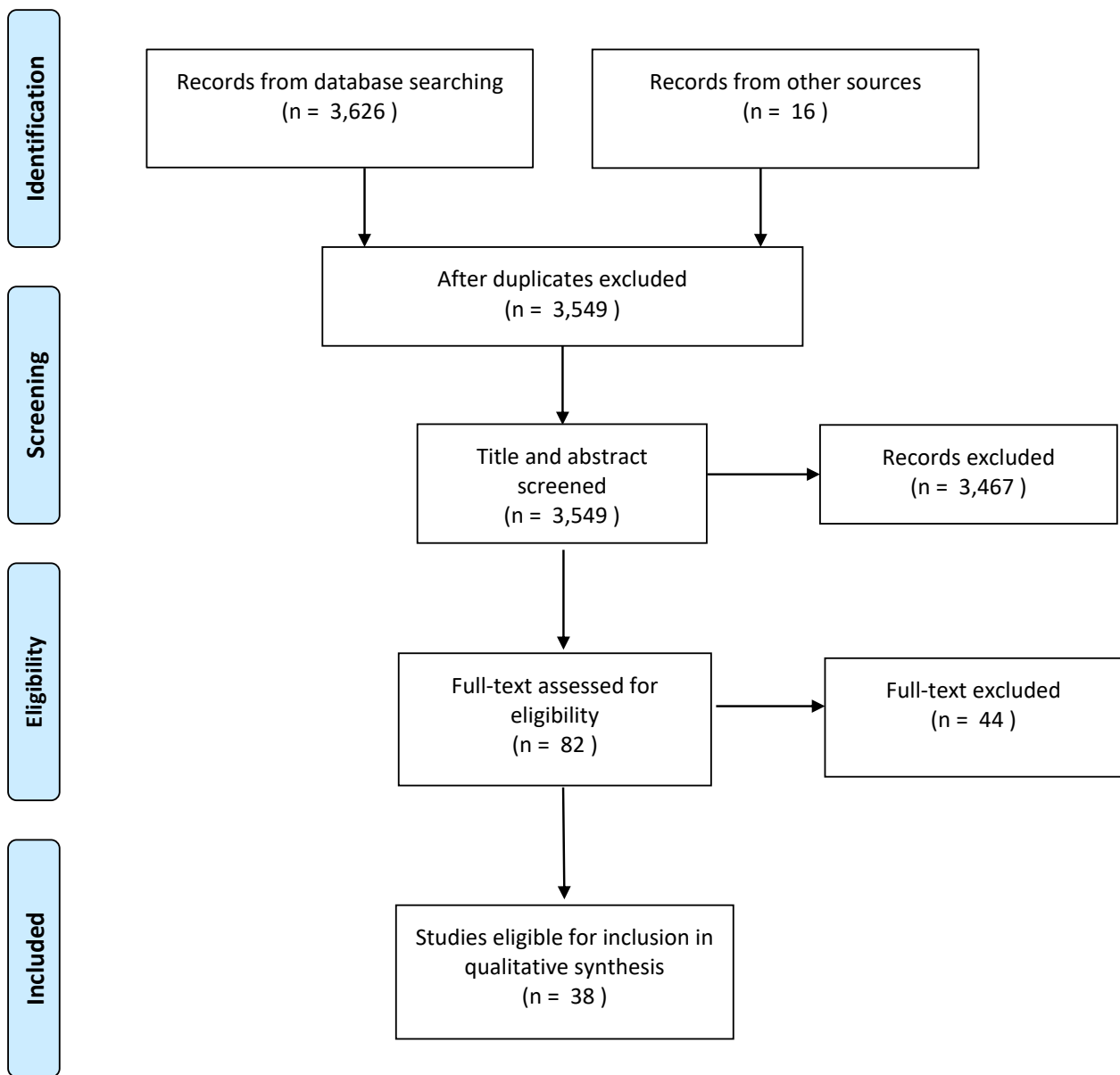


## Results

Data synthesis comprised of a narrative synthesis characterized by outcomes and summaries of the effects of the exposures for each study. The results data in Table 4 were first broadly categorized by demographical data, child factors, and parental influences; and then further synthesized where possible to show relationships between each factor. The narrative of the results are as follows.

**Prevalence and incidence**

The prevalence and incidence of picky eating were found to be closely related to child age. [2,32] A 2015 cohort study following 4,018 participants to examine picky eating trajectories through childhood found prevalence to decrease as the child ages, with a peak in behaviors at 3 years of age—from ages 1.5 to 6 years prevalence fell from 26.5% to only 13.2%, with the highest prevalence was 27.6% at age 3. [32] Another study found the prevalence of picky eating to be, depending on age group, between 21-74%, with the highest prevalence among children ages 3, 8, and 9 years of age. [2] The same study found the

incidence of picky eating increased with age—between ages 1-2 years the incidence rate was 21%, between ages 2-3 years it was 48%, and 72% between ages 3-4 years. [2] Results show, while the overall trajectory is unclear, the prevalence of picky eating tends to peak around the age of 3 years.

## Demographics and characteristics

Family demographics and characteristics highlight some significant relationships with picky eating outcomes. [9,20,22,26,28,32] Families with a lower household income had a higher report of picky eating and persistent picky eating. [28,32] Reported family food insecurity did not have a significant reductive impact (p<0.001) on the relationship between picky eating and the availability of vegetables and fruits. [22] Low maternal age was significantly associated with both food insecurity (p= 0.008) and reported picky eating (p<0.01). [20,22] Children with older mothers who went to a university tended to have a wider diet variety. [26] Though, it was found children of professional parents had an increased likelihood of picky eating. [9] Low maternal age and low socioeconomic status showed strong relationships to increased child picky eating outcomes.

## Heritability and associations

Picky eating and food neophobia were found to share a common etiology and be significantly heritable. [15,17,27,33] A family history of picky eating was related to an increased likelihood of picky eating outcomes. [9] Seventy-one percent of parents of picky eaters said they were picky eaters themselves as children and 37% said they currently identified as picky eaters. [11] Food

neophobia scores for mothers were positively correlated (p=0.051 and p=0.04) to children's scores. [1,24] The food preferences for parent and child were similar in both boys and girls. [24]

In a twin study, food neophobia was found to be heritable—72% of the variance related to genetic factors, while the rest, 28%, was found to be due to environmental factors. [15] Another twin study found while both food neophobia and picky eating outcomes can be predicted by genetic influences, picky eating behaviors are shaped more substantially (p<0.03) by environmental factors than food neophobia. [27] Overall, associations between food neophobia and picky eating are mixed. Food neophobia is often used as a symptom or characteristic of picky eating, but they are just as often used as two completely separate feeding afflictions. [9,17,19,25-26,28,33-34] Food neophobia and picky eating share a common etiology and are both shown to be heritable, yet, picky eating outcomes were found to be more affected by environmental factors than neophobic outcomes and their relationship remains unclear.

## Parental influences vs. child factors

Throughout the literature, major themes between parental influences (i.e., feeding practices, parenting styles, feeding environment, etc.) and child factors became clear as foundations for the identification of the strongest predictors of picky eating outcomes. [1-2,8-9,11-12,14-15,18-19,22,24-25,28,32,34-41] Table 3 outlines the main themes identified, each theme and their relationship with each other will be further explored in depth over the next sections.

### Table 3 Major themes present

| Parental influences | Child factors |
|---|---|
| Early feeding practices (i.e., breastfeeding, introduction of complementary foods, etc.) | Characteristic (i.e., age, sex, birth weight, sensory sensitivity, etc.) |
| Feeding environment (i.e., parental diet, food exposures, parental mealtime emotion, etc.) | Feeding behaviors (i.e., food refusal, slow eating, food and satiety responsiveness, etc.) |
| Feeding style (i.e., strategies, behaviors, singleton vs sibling differences, etc.) | |
| Perceptions of child's behavior (i.e., beliefs, views, etc.) | |

## Child factors

Child factors are categorized to include basic child-specific characteristics that have been commonly acknowledged to be associated with or have been shown to have a significant association with picky eating outcomes—age, sex, birth weight, and sensory sensitivity. [9,28,32,34,38]

### Characteristic

As previously discussed in regard to the prevalence and incidence, children between 3-10 years of age are significantly (p=0.022 ) more likely to be picky eaters. [8-9,25] Only one study did not find a significant (p=0.34) relationship between age and picky eating on an overall basis, yet when the data was split into two age groups, older versus younger, the younger group exhibited a significant (p=0.021) relationship between tactile sensitivity and picky eating. [34] Generally, food neophobia did not differ between sex; yet boys had higher reported rates of picky eating outcomes. [14-15,24,28,32] Birth weight was negatively associated with picky eating and picky eaters tended to be categorized as thin or underweight. [28,32,38] Age is a strong predictor of picky eating outcomes, yet the association remains unclear for biological sex and weight status.

### Mealtime behavior

Mealtime behavior tended to be more negative in picky eaters (about 40% of the time) versus non-picky eaters. [11,35] Food neophobia was found to be associated with increased food refusal (p<0.001) and lower acceptance of repeated foods (p<0.001). [15] Food enjoyment (p<0.001), satiety responsiveness (p<0.01), and slow eating (p<0.01) were predictive of picky eating and also food preferences—higher food enjoyment predicted preference for vegetables and meats (p<0.05), while increased food responsiveness predicted preference for non-core foods (p<0.05). [16,37-38] Picky eating and food neophobia were related to increased negative mealtime behavior and preference for non-core foods.

## Parental Influences

Parental influences encompass a broad range of parent-controlled aspects of the child's environment, from the types and variety of foods children are exposed to and at what age to the manner and schedule in which children are fed throughout their early life. Early feeding practices and parental perceptions of child behavior appeared to stand alone in the literature; findings related to the feeding environment and feeding practices were found to be more directly connected to a response or reaction in child behavior, in both directions, and are presented later in the results.

### Early feeding practices

Associations of the impact of breastfeeding on picky eating outcomes are mixed. [14,4-42] Findings from a 2018 study on breastfeeding duration and eating behavior included a reduced (p=0.008) instance of pick eating outcomes when the child had been fully breastfed for 4-5 months versus 0-1 month. [42] Two other studies found no evidence of any association (p=0.62 and p=0.17) between breastfeeding duration and later development of picky eating behaviors. [14,41] Complimentary feeding has been associated with the later development of picky eating behaviors. [14] Specifically, the late introduction of lumpy textures has been associated with severe picky eating outcomes. [14] The introduction of greater variety at 1.2 years predicted food preferences and increased dietary intake at 3.7 years and was associated with reduced picky eating at 3.7 years. [41] Results indicate complementary feeding practices may have a greater impact on the development of picky eating than breastfeeding duration.

### Perceptions of behavior

Parental perceptions of picky eating behavior and actual picky eating outcomes have mixed relationships, showing both indications of measurable outcomes and over or underestimations of the degree of pickiness in children. [9,12,14,36] About 25% of caregivers reported picky eating as happening 'all of the time' and about 24% reported it occurring 'sometimes'; after being given a list of specific picky eating behaviors, the reports of 'all of the time' increased to 49.6%. [9] Parents who reported offering more variety and balance were found to be more likely (p<0.05) to identify their child as a picky eater. [12] Parental perception of picky eating was not an indication of a child's food refusal. [19] Child weight status was found

to have an impact on parental perception of eating behaviors. [48] Maternal anxiety about picky eating was a strong predictor (p=0.005) of picky behaviors at 1.3 years. [14] The mother's perception of picky eating was indicative of the relationship between the child's temperament and the meal setting. [39] Parental perception of picky eating is a strong predictor for measurable picky eating outcomes, yet the direction of this relationship is still unclear.

### Feeding environment and behaviors

The feeding environment and child behavior were found to be highly associated. [1,9,12,18,22,25,33,43] The mealtime and food environments—exposures, stressors, and control—are shown to have an impact on mealtime behaviors for both parent and child, as described here.

**Mealtime environment.** Parents identified picky eating as a mealtime stressor. [12,22,33] Child mealtime temperament was found to be inversely related (p=0.005) to mealtime structure, and increased mealtime temper was related (p<0.003) to less mealtime structure. [39] Mother's negative mealtime emotions, including feeling stressed, hectic, and crying, were associated with (p<0.001) increased food neophobia score. [1] Caregiver stress during feeding was associated with (p=0.000026) all picky eating and all feeding difficulty behaviors reported as happening 'all the time'. [9] Distractions during mealtime (p<0.05) and child control of foods (p<0.05) both had a positive relationship to picky eating outcomes and increased the odds of picky eating within one year. [12] Positive mealtime environments were associated with (p=0.03) an overall increase in food intake and lower picky eating and food neophobia. [12,25,43] Routine in family mealtime and inclusion of children in the planning or preparation of meals were all associated with (p<0.05) lower rates of food refusal, fussiness, and increased food enjoyment. [12,18] The results show a bi-directional nature between the mealtime environment, including the presence of distractions, negative parental emotions, as well as structure and routine, and child eating behaviors.

**Food environment.** Food choices, preferences, and exposures constitute the food environment, which was shown to be associated with or affected by picky eating. [14,22,26,33,36] Feeding quick meals or ready-prepared foods was shown to be a predictor (p=0.002) of picky eating; likewise, picky eating and food neophobia were indicative of (p<0.05) increased preference or intake of non-core foods. [14,22,26,33,37] Maternal diet variety and child exposure to fresh fruit showed a protective effect (p=0.004) in later picky eating. [14,36] Maternal intake of raw (p<0.001) and cooked vegetables (p=0.037) and fruits, specifically berries, (p=0.005) is associated with child intake. [36] The results show the bi-directional nature of the relationship between the food environment and child eating behaviors, particularly when it comes to foods offered and maternal diet.

### Feeding styles and behaviors

Overall, parental feeding styles and practices were related to picky eating outcomes. [1-2,12, 18-19,25,40] Inappropriate parent-child interactions and practices during mealtimes are more commonly seen in picky eating dyads and related to increased picky eating outcomes. [2,12-13,18-19,23]

**Effects of siblings.** The effect of siblings on picky eating outcomes is mixed. One study found having siblings had a reductive effect (p<0.001) on picky eating. [20] In contrast, another noted having siblings increased (p=0.004) consumption of non-core foods and decreased (p=0.003) diet variety in children with higher food neophobia scores. [26] In deciding how to feed siblings, parents use a combination of planned meals, child preferences, and in-the-moment decisions—picky eating was managed through flexibility in mealtime to offer alternative choices. [44] Differences between twins in fussiness were found to be associated with differences in pressure to eat and instrumental (reward/punishment) feeding—parents tend to use pressure and reward with the fussier twin. [21] The effect of siblings on picky eating outcomes remains unclear, yet eating differences in siblings show a bidirectional effect on parental feeding practices.

**Responsive vs. non-responsive.** As previously discussed, parent-child interactions and parent response to picky eating were found to be both associated with and driven by child eating behaviors, this is also clear when feeding style is

considered. [1-2,8-9,12-14,18-19,23-25,28,38,45] In response to child food refusal, mother behaviors, including persuasion to eat (p<0.001), punishment (p<0.037), and anxiety about the behavior (p<0.001), were all associated with an increased food neophobia score. [1,14] Pressure-based feeding was positively (p<0.01) related to food neophobia, while feeding practices of offering variety in new foods were inversely related to food neophobia (p<0.001) and pressure to eat (p=0.07). [8-9,18-19,23-25,28,38, 40,45] Persuasion feeding tactics were related to increased fussiness (p<0.001) and lower food enjoyment (p=0.003). [18] Conversely, increased feeding/mealtime structure and lower non-responsive feeding were associated with (p=0.01) reduced picky eating and increased food enjoyment. [8,18,45]

Anecdotal evidence showed parents experienced stress from potential food waste related to picky eating and having a child who needed special preparations or separate meals or foods during mealtime. [22,33] Strategies for responding to picky eaters included encouraging children to try the meal, allowing children to prepare their own meal or cook a separate meal for the child, using a 'take it or leave it' approach, or allowing children to eat what and how much to eat off the plate served. [33] The relationship between feeding styles (i.e., responsive versus non-responsive) and child feeding behaviors is significant and shows a bidirectional nature.

## Quality assessment/risk of bias

The quality assessment results of each article showed an overall positive result in the relevant questions. Validity was mixed, mostly neutral or positive results and no negative results for all articles included. Neutral outcomes were almost entirely due to a lack of clear criteria for sample selection, comparable study groups, unclear procedures or lack of methods, and in some cases, lack of clearly stated valid or reliable measurements. None of the articles included in this review rated with negative validity, meaning no article showed six or more negative results on the validity questions. Overall, the results show a relatively positive or neutral result in validity and all articles were deemed relevant.

**Table 4 Articles Included and Major Findings**

| Primary Author & Year | Study Aim | Major Findings | Bias Rating |
|---|---|---|---|
| Adamson et al., 2015 | Explore the relationship between meal length and mealtime behaviors of typically developing toddlers with mild mealtime disturbances. | The PE group exhibited more negative mealtime behaviors and less positive than the control group (p<0.001). | R/+; V/+ |
| An et al., 2020 | Investigate the factors linking toddlers' food neophobia and maternal neophobia, feeding practices, and mealtime emotions. | FN scores for mothers and children were positively correlated. Mother's negative mealtime emotions and negative feeding practices were associated with increased FN scores. | R/+; V/+ |
| Berger et al., 2016 | Identify parental feeding practices between siblings. | Parental feeding practices differed between siblings depending on PE, FN, and other outcomes. | R/+; V/⊘ |
| Boquin et al., 2014 | Investigate the relationships between parent perceptions of PE, child mealtime behavior, and parent mealtime behavior. | 71% of parents of PE were PE as children and 37% said they were current PE. Adverse mealtime behavior was seen in PE children more than 40% of the time. | R/+; V/+ |
| Cano et al., 2015 | Examine the prevalence, predictors, and trajectories of | PE prevalence decreased with age and tended to be higher in boys. Birth weight was | R/+; V/⊘ |

| | | | |
|---|---|---|---|
| | PE. | negatively associated with PE and lower-income was associated with persistent PE. | |
| Chao & Chang, 2016 | Investigate the link between PE behaviors, parent-child relationships, and mental/physical development. | PE incidence was highest in ages 3-4 years. Inappropriate caregiver behavior was higher in the PE group. | R/+; V/+ |
| Cole et al., 2018 | Investigate the link between the home feeding environment and PE behaviors in children 2-5 years. | Distractions during mealtime and child control of foods increased PE. Positive mealtime environments were associated with increased variety and food acceptance. | R/+; V/+ |
| Costa et al., 2021 | Investigate the bidirectional relationship between parent feeding practices and child eating behaviors. | All parenting practices, except restriction, showed a bidirectional effect. | R/+; V/⊘ |
| Emmett et al., 2018 | Examine factors early in life that are associated with the development of PE. | Disrupted or disturbed complementary feeding was associated with PE outcome. Maternal anxiety about PE was a strong predictor for PE at 15 months. | R/+; V/+ |
| Faith et al., 2013 | Observe food neophobia in twins and to investigate associations in FN and parent-child feeding patterns. | FN heritability is 72%. FN was associated with increased food refusal and lower acceptance of repeated foods. | R/+; V/⊘ |
| Fildes et al., 2015 | Investigate associations between appetite and fruit, vegetable, and noncore food preferences. | Vegetable preference was related to increased food enjoyment. Fruit preference was related to increased food enjoyment. | R/+; V/⊘ |
| Fildes et al., 2016 | Quantify genetic influence of food fussiness and vegetable preferences in early childhood. | The heritability estimates pointed to a significant genetic association between vegetable preference and fussiness (70%) and between fruit preference and fussiness (66%). | R/+; V/⊘ |
| Finnane et al., 2016 | Identify links between feeding practices and PE. | Parental feeding practices were related to PE outcomes. Persuasion feeding tactics were related to increased fussiness (p<0.001) and lower food enjoyment (p=0.003). | R/+; V/+ |
| Fries et al., 2017 | Investigate associations of parent reported feeding practices and food refusal in toddlers. | Perceptions of PE were not an indicator of food refusal, yet reported FN was associated with negative mealtime behaviors. | R/+; V/⊘ |
| Goh & Jacob, 2012 | Identify aspects of PE and feeding difficulties in children aged 1-10 years as well as how it affects caregivers. | Children between 3-10 years were more likely to be PE. Family history of PE and having professional parents were related to a greater likelihood of PE. | R/+; V/+ |
| Hafstad et al., 2013 | Investigate predictors and illustratethe development of PE in preschool aged children. | Having siblings reduced PE (p<0.001). Low maternal age was associated with PE. | R/+; V/⊘ |
| Harris et al., | Investigate whether mothers of | Differences between twins in fussiness were | R/+; |

| | | | |
|---|---|---|---|
| 2016 | twins change feeding practices in response to child fussiness. | found to be associated with differences in feeding practices. | V/⊘ |
| Harris et al., 2019 | Investigate whether food insecurity affects the relationship between PE and parental food provision and feeding in regard to variety. | Food insecurity did not have a significant impact on the relationship between food fussiness and the availability of fruit and vegetables. | R/+; V/⊘ |
| Holley et al., 2016 | Examine what role parental feeding practices, child eating behaviors, and child temperament play in the success of interventions. | Positive home environments and child sociability were associated with increased consumption. | R/+; V/⊘ |
| Jani et al., 2015 | Explore the relationship between feeding practices and child appetite. | Increased parental pressure to eat was related to reduced food enjoyment, increased fussiness, and increased slow eating. | R/+; V/⊘ |
| Jansen et al., 2017 | Examine the relationship of pressure to eat and fussiness. | A bi-directional relationship was found between parental pressure to eat as a predictor of PE and also a strategy to deal with it. | R/+; V/⊘ |
| Jordan et al., 2020 | Examine dynamics between maternal prompting types and dietary intake and PE in children. | Coercive control (in PE and non-PE), modeling, and the number of total prompts were all inversely related to the number of green beans eaten. | R/+; V/+ |
| Kaar et al., 2016 | Examine food preference, neophobia, and feeding practices in parent-child dyads. | The relationship between parental FN and child FN was significant. The food preferences for parent and child were similar. | R/+; V/⊘ |
| Kähkönen et al., 2020 | Examine the relationship of the home food environment and the fruit and vegetable intake in children and parents. | Children between 3-5 years and their parents were found to have a low intake of vegetables and fruits. | R/+; V/+ |
| Kutbi, 2020 | Examine the bidirectional relationship of feeding practices and FN and PE in children. | 37.4% of children participants were reported to show extreme FNPE behaviors by mothers. A positive bidirectional association between pressure and FN/PE existed. | R/+; V/⊘ |
| Mallan et al., 2015 | Investigate the relationship between increased exposure to fruit, vegetables, and noncore foods at 14 months and child food preferences at 3.7 years. | The introduction of greater variety at 1.2 years predicted food preferences and increased dietary intake at 3.7 years and was associated with reduced PE at 3.7 years. | R/+; V/⊘ |
| Nederkoorn et al., 2015 | Investigate whether children who were sensitive to touch were also PE. | There was a significant relationship between the two, especially in younger children. Age did not relate to PE. | R/+; V/⊘ |
| Perry et al., 2015 | Examine the relationship FN in children aged 2 and their fruit and vegetable intake. | Children with older mothers that went to university tended to have a wider diet variety. | R/+; V/⊘ |
| Power et al., | Examine the effectiveness in | Children of authoritative mothers tended to | R/+; |

| | | | |
|---|---|---|---|
| 2018 | analysis of the relationship of maternal feeding practices, child meal behaviors and weight. | have increased slow eating and satiety responsiveness. Children of authoritative or indulgent mothers tended to have higher food enjoyment. Children of authoritative or uninvolved mothers tended to have the highest rates of fussiness. | V/⊘ |
| Russell & Worsley, 2016 | Evaluate the relationship between appetitive traits and food preferences in pre-school children. | Fussiness was a predictor of food preference. Food responsiveness was a predictor for preferring non-core foods. | R/+; V/⊘ |
| Sandvik et al., 2018 | Evaluate characteristics and prevalence of PE children of preschool age. | Eating behaviors were more predictive of PE, while parental feeding practices were found to be less predictive. | R/+; V/⊘ |
| Searle et al., 2020 | Evaluate the relationship between feeding practices and child temperament and investigate if the associations were indicated or affected by PE. | Child temperament was inversely related to mealtime structure, and increased difficult temper was related to less structure. The mother's perception of PE was indicative of the relationship between child temperament and the meal setting. | R/+; V/⊘ |
| Smith et al., 2017 | Investigate the effect of genetic and environmental factors on fussiness and FN. | PE and FN are strongly associated and share environmental influences. Heritability is shown at 1.4 years. | R/+; V/⊘ |
| Somaraki et al., 2018 | Investigate the differences in eating behaviors of children born to native vs migrant mothers in Sweden. | Food approach and avoidance were related to the maternal migrant status, and findings for fussiness were limited. | R/+; V/⊘ |
| Specht et al., 2018 | Examine the relationship between breastfeeding duration and PE or intake of fruits, vegetables, and noncore foods in 2-6 year old children. | PE was lower in children that had been fully breastfed for 4-5 months compared to those only fully breastfed for 0-1 month. Children who were fully breastfed for 6-10 months tended to have a higher daily average intake of vegetables. | R/+; V/⊘ |
| Steinsbekk et al., 2017 | Examine the factors, both parent and child, that predict PE in children aged 4-6 years. | At both interview points, 26% of children were identified as PE. Roughly 50% of PE identified at age 4 were categorized the same after two years passed. Parental structuring reduced the risk of PE at the second interview point, alternatively, parental sensitivity increased the risks. | R/+; V/⊘ |
| Tharner et al., 2014 | Describe characteristics and identify a behavior profile for PE in children. | PE tended to be from low-income households. Mothers of PE used more pressure to eat and less monitoring of their children's eating behaviors. | R/+; V/⊘ |
| Trofholz et al., 2016 | Investigate effect of PE on mealtime. | More than 60% (56/88) of the participants described having a picky eater in the home. 16% of participants described pickiness as the child having food neophobic behaviors. | R/+; V/⊘ |

PE – picky eating, FF – food fussiness, FN – food neophobia
Picky eating and fussiness are used interchangeably in this chart.

## Discussion

A consistent, singular definition of picky eating does not exist; in its place, characteristics that often describe picky eaters are used. [1-3,6,8-9,11-14,18-20,23-25,28,33,36,38-40,43,45,47,49-50] Official statements or publications from authorities on pediatric feeding issues were difficult to locate. Overall, the lack of recent literature on such a ubiquitous issue is a barrier to defining, identifying, strategizing, preventing, and managing picky eating and food neophobic behaviors in young children.

The current examination reviewed data from thirty-eight recent studies on picky eating outcomes in children. The primary aim of this review was to examine predictors of picky eating and food neophobia. In reviewing the current literature, four major themes became clear as primary predictors for picky eating and food neophobia: early feeding practices, perception of picky eating, feeding environment, and feeding style. Of the four themes, only one had a uni-directional effect—early feeding practices. During the first year of life, infants experience taste sensations for the first time. Perceived negative food reactions are related to initial reactions to sensations and not genuine picky eating or food neophobic behaviors. Early feeding practices (i.e., breastfeeding, introduction to solids, texture variety, etc.) are uni-directional in nature due to the inability of the infant to obtain any control over these practices. The results support this notion—as late introduction to complementary feeding and textures was found to be related to the later development of severe picky eating outcomes.

The three other themes—parental perceptions of picky eating, feeding styles, and feeding environment—were all found to both predict and be driven by picky eating behaviors in children. [1-2,8-9,11-14,18-20,23-25,28,33,36,38-40,43,45,47] Maternal perception of or anxiety about picky eating was found to increase negative mealtime behavior and be a strong predictor of increased picky eating. [3,5,9,12,14,19,36,39,48] Feeding styles (i.e., responsive versus non-responsive) and feeding environment (i.e., mealtime distractions, stress and emotions, food choices, food control, maternal diet, etc.) showed the strongest bidirectional relationships with picky

eating and food neophobia. [1-2,8-9,12-14,18-26,28,33,36,38-40,43-45] This review further confirms the bidirectional nature of parental influences and picky eating outcomes.

Secondary to the identification of predictors was exploring the relationship between picky eating and food neophobia. The relationship remains unclear, as no singular definition for picky eating is currently cemented and, therefore, no standard criteria to describe its manifestations. [6,27,33] Our study confirms the need for more research on building a clear and widely accepted definition of picky eating and standardizing criteria for its identification. In doing so, the relationship between food neophobia and picky eating can be better investigated.

### Applications for prevention and interventions

Picky eating and food neophobia share common origins; therefore, the most substantial modifiable factors associated with their development should be the focus of developing preventative strategies and tailoring interventions to fit unique environments and situations. [27,39] Targeting early (i.e., perinatal, infants 0-6 months, etc.) preventative strategies on parent perceptions of picky eating, with a focus on normalizing their experiences and setting realistic expectations for possible child behaviors and temperaments, could help to reduce the impact of the bidirectional nature of their relationship. Educational programs for expecting or new mothers on infant feeding practices with realistic timelines for complementary feeding practices as well as acknowledgment and education on circumstances that affect that timeline (i.e., preterm birth, NICU stays, delayed oral feeding, etc.) will help to increase early feeding successes and reduce its impact on picky eating development. Targeting parental stress and emotion management related to child feeding behaviors can positively influence parental feeding styles and practices to help reduce the impact of the bidirectional nature of their relationship. Overall, strategizing on methods to enhance the mealtime experience, reduce mealtime stress or emotion, increase parental awareness of implications of feeding styles, and increase resources to expand the accessibility of food variety will positively impact the associations these factors have on the

development and persistence of picky eating and food neophobia.

## Strengths & Limitations

This review and the studies included have limitations. Recent research on picky eating and food neophobia, in the absence of other medical or developmental differences, was lacking, and the eligibility criteria of this study had to include a broader timeframe for publication date—reducing the relatability to recent developments in the subject. This review is not exhaustive and excluded some resources due to inaccessibility. Lastly, data on the relationship between picky eating and food neophobia is limited and impacted this study's ability to investigate its secondary aim thoroughly. The strengths of this review include the number of studies reviewed and the systematic nature followed.

## Conclusions

Picky eating behaviors in childhood are predicted by early feeding practices, perception of picky eating, feeding environment, and feeding style. [1-2,8-9,11-14,18-20,23-25,28,33,36,38-43,45,47] Early feeding practices have a uni-directional effect on picky eating outcomes; parental perceptions and practices directly affect later eating behaviors in children. [14,41-42] Parental perception of picky eating—especially anxiety about perceived behaviors, feeding environment, and feeding style have a bidirectional relationship with picky eating in children, parental practices and child behaviors affect each other and perpetuate negative relationships. [1-2,8-9,11-14,18-20,24-25,28,33,36,38-40,43,45,47] To create effective interventional and preventative programs, early feeding practices, parental perceptions of picky eating, feeding style, and feeding environment need to be targeted.

## References

1. An M, Zhou Q, Younger KM, Liu X, Kearney JM. Are maternal feeding practices and mealtime emotions associated with toddlers' food neophobia? A follow-up to the DIT-Coombe Hospital birth cohort in Ireland. International Journal of Environmental Research and Public Health. 2020; 17: 8401. https://doi.org/10.3390/ijerph17228401

2. Chao HC, Chang HL. Picky eating behaviors linked to inappropriate caregiver-child interaction, caregiver intervention, and impaired general development in children. Pediatrics and Neonatology. 2015; 58: 22-28. https://doi.org/10.1016/j.pedneo.2015.11.008

3. Cole NC, An R, Lee S, Donovan SM. Correlates of picky eating and food neophobia in young children: a systematic review and meta-analysis. Nutrition Reviews. 2017; 75(7): 516-532. https://doi.org/10.1093/nutrit/nux024

4. de Barse LM, Tiemeier H, Leermakers ETM, Voortman T, Jaddoe VWV, Edelson LR, et al. Longitudinal association between preschool fussy eating and body composition at 6 years of age: The Generation R Study. International Journal of Behavioral Nutrition and Physical Activity. 2015; 12: 153. https://doi.org/10.1186/s12966-015-0313-2

5. de Oliveira Torres T, Gomes DR, Mattos MP. Factors associated with food neophobia in children: Systematic review. Revista paulista de pediatria: orgao official da Sociedade de Pediatria de Sao Paulo. 2020; 39. https://doi.org/10.1590/1984-0462/2021/39/2020089.

6. Taylor CM, Wernimont SM, Northstone K, Emmett PM. Picky/fussy eating in children: Review of definitions, assessment, prevalence and dietary intakes. Appetite. 2015; 95: 349-359. https://doi.org/10.1016/j.appet.2015.07.026

7. Wolstenholme H, Kelly C, Hennessy M, Heary C. Childhood fussy/picky eating behaviours: a systematic review and synthesis of qualitative studies. International Journal of Behavioral Nutrition and Physical Activity. 2020; 17(2). https://doi.org/10.1186/s12966-019-0899-x

8. Steinsbekk S, Bonneville-Roussy A, Fildes A, Llewellyn CH, Wichstrøm L. Child and parent predictors of picky eating from preschool to school age. International Journal of Behavioral Nutrition and Physical Activity. 2017; 14(87). https://doi.org/10.1186/s12966-017-0542-7

9. Goh DYT, Jacob A. Perception of picky eating among children in Singapore and its impact on caregivers: a questionnaire survey. Asia Pacific Family Medicine. 2012; 11(5). https://doi.org/10.1186/1447-056X-11-5

10. Cassells EL, Magarey AM, Daniels LA, Mallan KM. The influence of maternal infant feeding practices and beliefs on the expression of food neophobia in toddlers. Appetite. 2014; 82: 36-42. https://doi.org/10.1016/j.appet.2014.07.001

11. Boquin M, Smith-Simpson S, Donovan SM, Lee SY. Mealtime behaviors and food consumption of perceived picky and nonpicky eaters through home use test. Journal of Food Science. 2014; 79(12): S2523-S2532. https://doi.org/10.1111/1750-3841.1298

12. Cole NC, Musaad SM, Lee SY, Donovan SM, The STRONG Kids Team. Home feeding environment and picky eating behavior in preschool-aged children: A prospective analysis. Eating Behaviors. 2018; 30: 76-82. https://doi.org/10.1016/j.eatbeh.2018.06.003

13. Costa A, Severo M, Oliveira A. Food parenting practices and eating behaviors in childhood: a cross-lagged approach within the Generation XXI cohort. American Journal of Clinical Nutrition. 2021; 114(1): 101-108. https://doi.org/10.1093/ajcn/nqab024

14. Emmett PM, Hays NP, Taylor CM. Antecedents of picky eating behavior in young children. Appetite. 2018; 130: 168-173. https://doi.org/10.1016/j.appet.2018.07.032

15. Faith MS, Heo M, Keller KL, Pietrobelli A. Child food neophobia is heritable, associated with less compliant eating, and moderates familial resemblance for BMI. Obesity. 2013; 21(8): 1650-1655. https://doi.org/10.1002/oby.20369.

16. Fildes A, Mallan KM, Cooke L, van Jaarsveld CHM, Llewellyn CH, Fisher A, et al. The relationship between appetite and food preferences in British and Australian children. International Journal of Behavioral Nutrition and Physical Activity. 2015; 12(116). https://doi.org/10.1186/s12966-015-0275-4

17. Fildes A, van Jaarsveld CHM, Cooke L, Wardle J, Llewellyn CH. Common genetic architecture underlying young children's food fussiness and liking for vegetables and fruit. American Journal of Clinical Nutrition. 2016; 103(4): 1099-1104. https://doi.org/10.3945/ajcn.115.122945

18. Finnane JM, Jansen E, Mallan KM, Daniels LA. Mealtime structure and responsive feeding practices are associated with less food fussiness and more food enjoyment in children. Journal of Nutrition Education and Behavior. 2016; 49(1): 11-18. https://doi.org/10.1016/j.jneb.2016.08.007

19. Fries LR, Martin N, van der Horst K. Parent-child mealtime interactions associated with toddlers' refusal of novel and familiar foods. Physiology & Behavior. 2017; 176: 93-100. https://doi.org/10.1016/j.physbeh.2017.03.001

20. Hafstad GS, Abebe DS, Torgersen L, von Soest T. Picky eating in preschool children: The predictive role of the child's temperament and mother's negative affectivity. Eating Behaviors. 2013; 14: 274-277. https://doi.org/10.1016/j.eatbeh.2013.04.001

21. Harris HA, Fildes A, Mallan KM, Llewellyn CH. Maternal feeding practices and fussy eating in toddlerhood: a discordant twin analysis. International Journal of Behavioral Nutrition and Physical Activity. 2016; 13(81). https://doi.org/10.1186/s12966-016-0408-4

22. Harris HA, Staton S, Morawska A, Gallegos D, Oakes C, Thorpe K. A comparison of maternal feeding responses to child fussy eating in low income food secure and food insecure households. Appetite. 2019; 137: 259-266. https://doi.org/10.1016/j.appet.2019.03.005

23. Jansen PW, de Barse LM, Jaddoe VWV, Verhulst FC, Franco OH, Tiemeier H. Bi-directional associations between child fussy eating and parents' pressure to eat: who influences whom?. Physiology & Behavior. 2017; 176: 101-106. https://doi.org/10.1016/j.physbeh.2017.02.015

24. Kaar JL, Shapiro ALB, Fell DM, Johnson SL. Parental feeding practices, food neophobia, and child food preferences: What combination of factors results in children eating a variety of foods?. Food Quality and Preference. 2016; 50: 57-64. https://doi.org/10.1016/j. foodqual.2016.01.006

25. Kutbi HA. The relationship between maternal feeding practices and food neophobia and picky eating. International Journal of Environmental Research and Public Health. 2020; 17: 3894. https://doi.org/10.3390/ijerph17113894

26. Perry RA, Mallan KM, Koo J, Mauch CE, Daniels LA, Magarey AM. Food neophobia and its association with diet quality and weight

in children aged 24 months: a cross sectional study. International Journal of Behavioral Nutrition and Physical Activity. 2015; 12(13). https://doi.org/10.1186/s12966-015-0184-6

27. Smith AD, Herle M, Fildes A, Cooke L, Steinsbekk S, Llewellyn CH. Food fussiness and food neophobia share a common etiology in early childhood. The Journal of Child Psychology and Psychiatry. 2017; 58(2): 189-196. https://doi.org/10.1111/jcpp.12647

28. Tharner A, Jansen PW, Jong JCK, Moll HA, Ende JVD, Jaddoe VWV, et al. Toward an operative diagnosis of fussy/picky eating: a latent profile approach in a population-based cohort. International Journal of Behavioral Nutrition and Physical Activity. 2014; 11(14). https://doi.org/10.1186/1479-5868-11-14

29. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021; 372. https://doi.org/10.1136/bmj.n71

30. Ryan R, Synnot A, Prictor M, Hill S. Data Extraction Template for Included Studies. 2016. https://elearning.uh.edu/bbcswebdav/pid-8849787-dt-content-rid-75969694_1/courses/H_20221_NUTR_6311_20419/Data%20extraction%20table%20information%281%29.pdf

31. Academy of Nutrition and Dietetics. Evidence analysis manual: Steps in the Academy Evidence Analysis Process. Evidence Analysis Library. 2016. https://www.andeal.org/vault/2440/web/files/2016_April_EA_Manual.pdf

32. Cano SC, Tiemeier H, van Hoeken D, Tharner A, Jaddoe VWV, Hofman A, et al. Trajectories of picky eating during childhood: a general population study. International Journal of Eating Disorders. 2015; 48: 570-579. https://doi.org/10.1002/eat.22384

33. Trofholz AC, Schulte AK, Berge JM. How parents describe picky eating and its impact on family meals: A qualitative study. Appetite. 2016; 110: 36-43. https://doi.org/10.1016/j.appet.2016.11.027

34. Nederkoorn C, Jansen A, Havermans RC. Feel your food. The influence of tactile sensitivity on picky eating in children. Appetite. 2015; 84: 7-10. https://doi.org/10.1016/j.appet.2014.09.014

35. Adamson M, Morawska A, Wigginton B. Mealtime duration in problem and non-problem eaters. Appetite. 2015; 84: 228-234. https://doi.org/10.1016/j.appet.2014.10.019

36. Kähkönen K, Hujo M, Sandell M, Rönkä A, Lyytikäinen A, Nuutinen O. Fruit and vegetable consumption among 3–5-year-old Finnish children and their parents: Is there an association?. Food Quality and Preference. 2020; 82. https://doi.org/10.1016/j.foodqual.2020.103886

37. Russell CG, Worsley T. Associations between appetitive traits and food preferences in preschool children. Food Quality and Preference. 2016; 52: 172-178. https://doi.org/10.1016/j.foodqual.2016.04.006

38. Sandvik P, Ek A, Somaraki M, Hammar U, Eli K, Nowicka P. Picky eating in Swedish preschoolers of different weight status: application of two new screening cut-offs. International Journal of Behavioral Nutrition and Physical Activity. 2018; 15(74). https://doi.org/10.1186/s12966-018-0706-0

39. Searle BRE, Harris HA, Thorpe K, Jansen E. What children bring to the table: The association of temperament and child fussy eating with maternal and paternal mealtime structure. Appetite. 2020, 151. https://doi.org/10.1016/j.appet.2020.104680

40. Jani R, Mallan KM, Daniels L. Association between Australian-Indian mothers' controlling feeding practices and children's appetite traits. Appetite. 2015; 84: 188-195. https://doi.org/10.1016/j.appet.2014.10.020

41. Mallan KM, Fildes A, Magarey AM, Daniels LA. The relationship between number of fruits, vegetables, and non-core foods tried at age 14 months and food preferences, dietary intake patterns, fussy eating behavior, and weight status at age 3.7 years. Journal of the Academy of Nutrition and Dietetics. 2015; 116(4): 630-637. https://doi.org/10.1016/j.jand.2015.06.006

42. Specht IO, Rohde JF, Olsen NJ, Heitmann BL. Duration of exclusive breastfeeding may be related to eating behaviour and dietary intake in obesity prone normal weight young children. PLoS ONE. 2018; 13(7). https://doi.org/10.1371/journal.pone.0200388

43. Holley CE, Farrow C, Haycraft E. Investigating the role of parent and child

characteristics in healthy eating intervention outcomes. Appetite. 2016; 105: 291-297. https://doi.org/10.1016/j.appet.2016.05.038

44. Berge JM, Trofholz A, Schulte A, Conger K, Neumark-Sztainer D. A qualitative investigation of parents' perspectives about feeding practices with siblings among racially/ethnically and socioeconomically diverse households. Journal of Nutrition Education and Behavior. 2016; 48: 496-504. https://doi.org/10.1016/j.jneb.2016.05.002

45. Power TG, Garcia KS, Beck AD, Goodell LS, Johnson SL, Hughes SO. Observed and self-reported assessments of caregivers' feeding styles: Variable- and person-centered approaches for examining relationships with children's eating behaviors. Appetite. 2018; 130: 174-183. https://doi.org/10.1016/j.appet.2018.08.010

46. Chao HC. Association of picky eating with growth, nutritional status, development, physical activity, and health in preschool children. Frontiers in Pediatrics. 2018; 6(22). https://doi.org/10.3389/fped.2018.00022

47. Jordan AA, Appugliese DP, Miller AL, Lumeng JC, Rosenblum KL, Pesch MH. Maternal prompting types and child vegetable intake: Exploring the moderating role of picky eating. Appetite. 2020, 146. https://doi.org/10.1016/j.appet.2019.104518

48. Lam J. Picky eating in children. Frontiers in Pediatrics. 2015; 3(41). https://doi.org/10.3389/fped.2015.00041

49. Zucker NL, Hughes SO. The persistence of picky eating: Opportunities to improve our strategies and messaging. Pediatrics. 2020; 145(6). https://doi.org/10.1542/peds.2020-0893

50. Somaraki M, Karin E, Sorjonen K, Flodmark CE, Marcus C, Faith MS, et al. Perceived child eating behaviours and maternal migrant background. Appetite. 2018; 125: 302-313. https://doi.org/10.1016/j.appet.2018.02.010