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Association of Picky Eating and Food Neophobia with Weight: A Systematic Review

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Abstract

Background: Picky eating and food neophobia are common during childhood. Childhood eating behaviors are often predictive of adult eating behaviors.

Objectives: Determine if childhood picky eating or food neophobia is associated with childhood weight status, or with becoming underweight, overweight, or obese later in childhood.

Data Sources: We identified relevant studies from searches of PubMed, PsycINFO, and NEOHAL, as well as citations from identified studies.

Study Eligibility Criteria and Participants: Inclusion criteria were original research articles examining a relationship between picky eating and/or food neophobia with childhood weight status. We summarized definitions and prevalence of picky eating or food neophobia and association with weight status.

Study Appraisal: Two independent investigators assessed bias and confounding using the Agency for Healthcare Research and Quality's RTI Item Bank.

Results: Forty-one studies met inclusion criteria. Picky eating was defined inconsistently, and a large variation in prevalence was found (5.8%–59%). Food neophobia was consistently defined as an unwillingness to try new foods, with a prevalence between 40% and 60%. No association existed between childhood weight status and food neophobia, and results were unclear for picky eating.

Limitations: Risk of bias and confounding were moderate. Parental report was commonly used to assess picky eating, height, and weight and parental weight, feeding styles, and community characteristics were infrequently considered.

Conclusions and Implications: Heterogeneous definitions used for picky eating led to a wide range of reported prevalence and an unclear relationship with weight. Consistent definitions and an improved understanding of such a relationship could help clinicians provide appropriate anticipatory guidance.

Introduction

Parents commonly express concern that their children are poor eaters. As a feature of normal development, most children experience a reduction in appetite¹ and a decreased rate of growth^{2,3} between 2 and 6 years of age. Food preferences are typically established during toddlerhood, although toddlers' preferences for certain foods may vary significantly on a weekly or even a daily basis.⁴ Young children may need to try a novel food as many as 15 times before they will accept it as a component of their normal

diet.⁵ Picky or fussy eating is often defined as eating a limited variety of foods. As the terms are often used interchangeably, we will use the term picky eating to also refer to fussy eating, food fussiness, and selective eating throughout this article.^{4,6} Food neophobia, the fear/hesitation of eating new or novel foods, is often considered to be one specific component of picky eating.⁴ Given that picky eating and food neophobia are conceptualized based on a spectrum of behaviors⁶ and nearly all children experience picky eating or food neophobia to some degree,⁷ it is not well understood to what extent these behaviors affect weight status later in life.

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It is well established that childhood eating behaviors predict adult eating behaviors,^{8,9} and children who are overweight or obese are more likely to be overweight or obese in adulthood compared to their normal weight counterparts.¹⁰ Some evidence suggests that picky eaters who do not consume sufficient calories may become underweight.^{11,12} However, parents may also compensate for children's pickiness by pressuring their child to eat or by offering foods their children may find more acceptable, such as calorie-dense foods, which may inadvertently increase the risk for obesity.

While there are reports of picky eating and food neophobia in the obesity literature,¹³ it remains unknown whether picky eating during childhood plays a role in determining weight trajectory or future weight status. This systematic review seeks to determine if the presence of picky eating or food neophobia behaviors during childhood is associated with childhood weight status or with becoming underweight, overweight, or obese later in childhood or adolescence. We hypothesize that children reported to be picky eaters are at a higher risk for becoming overweight or obese as older children and adolescents, likely due to a preference for calorie-dense foods and decreased intake of fruits and vegetables. In addition, we describe the various definitions and reported prevalence of picky eating and food neophobia.

Methods

This systematic review was conducted and reported as per the guidelines from PRISMA (preferred reporting items for systematic reviews and meta-analyses) (see Supplementary Table S1 available online at www.liebertpub.com/chi).¹⁴ The protocol for this review was registered with PROSPERO (registration number CRD42015027830), the international prospective register for systematic reviews (www.crd.york.ac.uk/PROSPERO).

Search Strategy

We chose studies by searching electronic databases and article reference lists. We searched PubMed, PsycINFO, and NEOHAL without study design, article type, or publication status restrictions. Studies were included if published in English from January 1, 1990, through November 2, 2015, and if studies reported results on children (aged birth–18 years). We searched databases for the terms picky eating, food neophobia, food fussiness, fussy eating, or selective eating, and these terms were cross searched with the terms weight, overweight, underweight, body weight, and obesity. The last search was completed on November 2, 2015. The details of search terms used are available in Table 1.

Eligibility Criteria

A single investigator (C.L.B.) compiled search results, screened titles and abstracts, and removed duplicates to identify studies relevant to the objectives of this review. Abstracts were not included if studies evaluated the following:

Table 1. Search Strategy

Number	Searches
1	Picky eating or food neophobia or food fussiness or fussy eating or selective eating
2	Weight or obesity or overweight or underweight or body weight
3	1 and 2
4	3 and Humans
5	4 and Publication date from 1990/01/01
6	5 and English
7	6 and Child: birth–18 years

nonhuman subjects, adult subjects exclusively, only children with developmental delays or autism, taste acuity, eating disorders (such as anorexia nervosa or bulimia nervosa), digestibility, or prenatal exposures. Two authors (C.L.B. and G.M.C.) then independently reviewed the full manuscripts of the remaining articles. Studies were included if they examined children's weight and its relationship to picky eating or food neophobia. A third author (J.A.S.) resolved any discrepancies. The study selection process is presented in Figure 1.

Data Extraction

Data extraction was performed by two authors (C.L.B. and G.M.C.), and the following information was extracted: study design, age of subjects, sample size, definition of picky eating, prevalence of picky eating or food neophobia, method of prevalence measurement, method of obtaining anthropometrics, and relationship of picky eating or food neophobia to weight.

Subgroup Examination

Given that picky eating is a common feature of early childhood and this developmental period typically is characterized by a brief reduction in BMI, it is necessary to distinguish results of studies, including toddlers and young children from those including older children. Doing so may help determine if a decrease in BMI associated with picky eating is actually attributable to normal fluctuations in child weight status. Therefore, we examined separately studies containing children aged six or older from studies containing children younger than 6 years old. In addition, we qualitatively considered relationships by study type (longitudinal, cross sectional, or case–control); parental report vs. measured height or weight; questionnaire type; and picky eating severity.

Study-Quality Assessment

Two investigators (C.L.B. and E.B.V.) independently determined risk of bias and confounding. As all included studies in this review were observational, bias was assessed using the Agency for Healthcare Research and Quality's RTI Item Bank to Assess Risk of Bias and Confounding.¹⁵

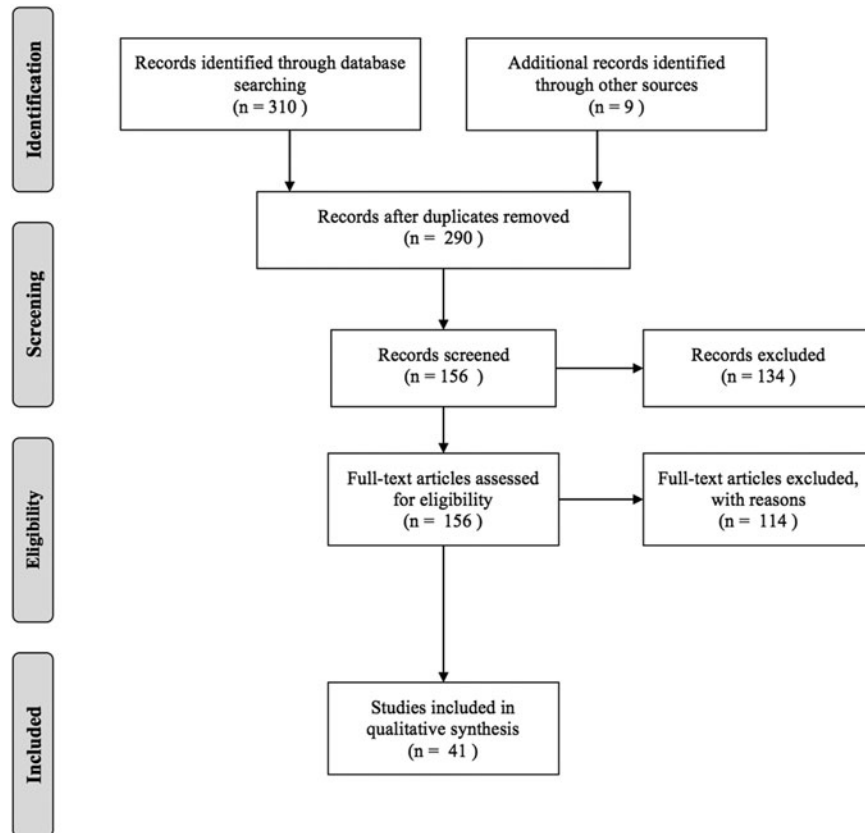


Figure 1. Systematic review search results.

In addition, bias that may affect the cumulative evidence was considered. Studies used inconsistent definitions of picky eating with quite a variable prevalence. This limited the ability to combine weight status outcome data for meta-analysis.

Results

The electronic database search yielded 310 results. Nine additional abstracts were obtained through reviewing reference lists. Duplicates were removed and 290 abstracts were screened. Based on a priori exclusion criteria, 134 abstracts were excluded, and the remaining 156 full-text articles were assessed for eligibility. Of these, 41 met inclusion criteria and were included in the review (Fig. 1).

Study Characteristics

Characteristics of the 41 studies included in analysis are summarized in Table 2. Of the studies included in analysis, all were observational; 31 were cross-sectional, 9 were longitudinal, and 1 was case-control. Participant age ranged from 4 months to 17 years. Sample size varied from 32 to 4987.

Definitions and Prevalence of Picky Eating and Food Neophobia

All studies relied on parental report to determine the presence of picky eating and food neophobia, although

one study used referral to a feeding clinic (based on parental report of picky eating behaviors) to define case inclusion¹² and another study also tested food acceptance by giving children yogurt with a variety of textures, colors, and tastes.¹⁶ Studies determined the presence of picky eating through the following methods: directly asking parents if their children were picky eaters,¹⁷⁻²⁴ administering questionnaires,^{11,13,16,19,20,25-52} and referral of children to a specialty feeding clinic for picky eating behaviors.¹² Standardized questionnaires that were used to evaluate picky eating included the Child Eating Behavior Questionnaire (CEBQ), Child Feeding Questionnaire (CFQ), Stanford Feeding Questionnaire (SFQ), Eating Behavior Questionnaire (EBQ), Picky Eating Scale modified from Pelchat and Pliner, Oregon Research Institute Child Eating Behavior Inventory (ORI-CEBI), and Chinese Preschoolers' Eating Behavior Questionnaire (CPEBQ).

Questionnaires asked an array of questions to assess picky eating behaviors, including eating a limited variety of foods, preparing foods in a specific way, slow eating, and low enjoyment of food. The two most commonly used questionnaires were the CEBQ ($n=16$) and the CFQ ($n=4$). The CEBQ contains a food fussiness subscale, which assesses a child's dietary variety, difficulty pleasing with meals, and refusal of new foods. Studies using the CFQ examined three questions relating to pickiness: diet consisting of only a few foods, child unwilling to eat many foods that the family eats,

Table 2. Characteristics and Main Findings of Included Studies

First author (year)	Study design	Age range	Sample size	Definition of picky eating (PE) or food neophobia (FN)	Prevalence of PE or FN	Measure of PE or FN	Weight status variable	Relationship between PE or FN and weight status
Antoniou (2015) ³²	Longitudinal	5–9 years	2814	PE: five-point Likert scale assessing: diet consists of only a few foods, unwilling to eat many of the foods that our family eats at mealtimes, fussy or picky about what child eats; used quartile split for analysis	14% at 5 years	CFQ	Parent report; categorical weight categories	PE more often underweight (23% vs. 18%) and less often overweight (6% vs. 10%) at 5 years; PE less likely to be overweight at 9 years if BMI is above median for age/gender at 5 years [OR 0.21 (95% CI: 0.06–0.76)] and no association if BMI is below median at 5 years [OR 0.95 (0.47–1.94)], adjusting for baseline BMI
Brown (2015) ³³	Cross sectional	18–24 months	298	PE: food fussiness subscale	Not reported	CEBQ	Parent report; weight z-scores	Weight inversely associated with PE (Pearson's $r = -0.171$, $p = 0.003$)
Cao (2012) ³⁴	Cross sectional	12–18 months	219	PE: food fussiness subscale	Not reported	CEBQ	Measured; BMIZ (Chinese growth curves)	No association
Carruth (1998) ²⁵	Longitudinal	2 of: 24, 28, 32, or 36 months	118	PE: based on response to 20 feeding behavior questions; unclear how participants labeled as picky vs. nonpicky	36%	Picky eating questionnaire (modified from Pelchat and Pliner)	Measured; weight and height as continuous variables	No significant differences between picky and nonpicky males and females by t-test; did not adjust for baseline weight
Carruth (2000) ¹⁷	Longitudinal	42, 60, 72, and 84 months	71	PE: caregiver asked, "is your child a picky eater?" (yes/no)	32% never; 46% >3 times in the interviews; 10% at every interview; 17% consistently	Picky eating questionnaire (modified from Pelchat and Pliner)	Measured; weight and height as continuous variables	No significant differences between picky and nonpicky males and females by t-test at each time point; did not adjust for baseline weight
Carruth (2004) ¹⁸	Cross sectional	4–24 months	3022	PE: caregiver reported their child is somewhat or a very picky eater (as opposed to not a picky eater)	19% of 4–6-month olds; 50% of 19–24-month olds.	Parent report; WFA percentiles	Parent report; WFA percentiles	Children in higher weight-for-age percentiles were less likely to be picky (WVFA 0%–25% referent; WVFA 25%–50%, 50%–75%, and 75%–100% had OR 0.6 (95% CI: 0.5–0.9)
Chatoor (2000) ²²	Cross sectional	12–37 months	102	PE: responded often or always to whether their child is a picky eater (as opposed to sometimes or never)	NA	Measured; percent ideal body weight	Measured; percent ideal body weight	PE mean% ideal body weight 102.4, healthy eater mean% ideal body weight 107.7 ($p < 0.05$)

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Table 2. Characteristics and Main Findings of Included Studies continued

First author (year)	Study design	Age range	Sample size	Definition of picky eating (PE) or food neophobia (FN)	Prevalence of PE or FN	Measure of PE or FN	Weight status variable	Relationship between PE or FN and weight status
Dubois (2007) ¹¹	Longitudinal	2.5, 3.5 and 4.5 years	1498	PE: children who “always” eat different meals than rest of family, “often” refuse to eat the right food, or “often” refuse to eat	14% at 2.5 years, 17% at 3.5 years, and 16% at 4.5 years. 30% classified as picky eaters at some point. 5.5% classified as picky eaters all 3 years.	Survey completed by mothers, EBQ	Measured; BMI categorical	Increased odds of being underweight at 4.5 years [OR 2.4 (95% CI 1.4–4.2)] if picky at all three ages compared to children who were never picky eaters; no association with weight if never picky or only at one/two ages; increased proportion of underweight with increased PE (13.2% if never picky, 18.3% if once or twice, 26.8% if picky at all three ages, $p < 0.05$); mean BMI at 4.5 years significantly lower (16.4 vs. 16.7) if ever or always reported at picky vs. those who were never picky eaters ($p = 0.05$); did not adjust for baseline weight
Ekstein (2010) ¹²	Case-control	14–92 months	170	PE: caretakers described “unwillingness to eat familiar foods or try new foods, severe enough to interfere with daily routines to an extent that was problematic to the parent, child, or parent-child relationship” for more than one month	NA	Cases: Identified by referral to a clinic for PE behaviors Controls: From primary care offices without history of picky eating	Obtained from medical record; weight (continuous) and WFL (categorical)	Increased risk of being underweight [OR 3.6 (95% CI: 1.2–10.7), 20.6% vs. 6.6%, $p = 0.02$]
Equit (2013) ³⁵	Cross sectional	4–7 years	1090	PE: selective eating—avoiding certain foods, eating a narrow range of foods, and unwillingness to try new foods	34%	Latent class analysis of novel questionnaire	BMI categorical (>90% overweight, <3% underweight)	No association
Faith (2013) ²⁶	Cross sectional	4–7 years	132	FN: “tendency to avoid eating unfamiliar foods”	40%	CFNS	Measured; BMIz	No association ($r = -0.003$, $p = 0.78$)

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Table 2. Characteristics and Main Findings of Included Studies continued

First author (year)	Study design	Age range	Sample size	Definition of picky eating (PE) or food neophobia (FN)	Prevalence of PE or FN	Measure of PE or FN	Weight status variable	Relationship between PE or FN and weight status
Ferreira (2008) ²⁷	Cross-sectional	6–10 years	1225	PE: parents answered no to “eats everything” FN: “unwillingness to eat novel foods.” PE: diet consists of only a few foods; unwilling to eat many of the foods that family eats at mealtimes; fussy or picky about what child eats	23.1% overall; 26% if normal weight, 14% if overweight, and 7% if obese ($P < 0.001$) Not reported	Novel questionnaire	Measured; BMI, categorical	Decreased risk of obesity: Boys OR 0.15 (95% CI: 0.04–0.63), girls OR 0.19 (95% CI: 0.06–0.64) Overweight/obese children were more picky (6.9 ± 2.2 vs. 5.7 ± 1.5 , $p = 0.03$) and neophobic (18.8 ± 6.4 vs. 15.7 ± 7.6 , $p = 0.03$) than normal weight children
Finistrella (2012) ¹³	Cross sectional	2–6 years	127	PE: diet consists of only a few foods; unwilling to eat many of the foods that family eats at mealtimes; fussy or picky about what child eats	Not reported	CFNS, CFQ	Measured; BMI, categorical	Lower proportion of PE were overweight/obese (20% vs. 43%, $p < 0.01$); PE had lower BMIs ($t = 2.10$, $p < 0.05$)
Galloway (2005) ²⁸	Cross sectional	9 years	173	PE: diet consists of only a few foods; unwilling to eat many of the foods that our family eats at mealtimes; fussy or picky about what child eats	25% with score of 3 or greater; 48% by median split of the data	CFQ	Measured, BMI, categorical	No association ($r^2_{\text{change}} = 0.01$, $p = 0.707$) adjusting for baseline BMIZ
Gregory (2010) ³⁶	Longitudinal	2–4 and 3–5 years	156	PE: food fussiness subscale	Not reported	CEBQ	Measured; BMIZ	Lower weight-for-height z-score at year 1 (mean -1.02 , SD 1.26); no association with change in standardized weight from year 1 to year 3 (mean 0.48, SD 1.25, $p = 0.4$)
Hittner (2011) ³⁷	Longitudinal	1 and 3 years	487	PE: fussy eaters—highly reactive eaters, small appetite, distractible; identified through factor analysis	9%	Novel questionnaire	Measured; weight-for height z-score (age 1), BMIZ (age 3)	No association overall; picky girls had increase in BMI (15.3–15.7) over one year compared to nonpicky girls (BMI 16.4–16.3)
Jacobi (2003) ¹⁹	Longitudinal	4 and 5 years	135	PE: “is your child a picky eater” at 4 and 5 years old; picky if “sometimes” at and 5 years or “often” at least once	21%	SFQ	Measured; BMI	BMIZ inversely associated with FF [$\beta = -0.07$ (95% CI: $-0.1, -0.04$)]
Jansen (2012) ³⁸	Cross sectional	4 years	4987	PE: food fussiness subscale	Not reported	CEBQ	Measured; BMIZ	

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Table 2. Characteristics and Main Findings of Included Studies continued

First author (year)	Study design	Age range	Sample size	Definition of picky eating (PE) or food neophobia (FN)	Prevalence of PE or FN	Measure of PE or FN	Weight status variable	Relationship between PE or FN and weight status
Jiang (2014) ³⁹	Cross sectional	3–6 years	603	PE: food fussiness subscale	Not reported	CPEBQ	Measured; BMI categorical (Chinese standards)	Increased FF associated with increased weight status (NW 2.25 ± 0.7 , OW 2.69 ± 0.69 , OB 3.36 ± 0.72 , $p < 0.02$)
Johnson (2015) ⁴⁰	Cross sectional	4 years	180	FN: score >35	44%	CFNS	Measured; BMIz	No association
Laureati (2015) ⁴¹	Cross sectional	6–9 years	528	FN: score categorized as low (lower quartile), medium (25–75%ile), and high (highest quartile)	Not reported	FNS (Italian adaptation)	Measured; BMI/BMIz, categorical	No association
Lewinsohn (2005) ⁴²	Cross sectional	3 years	93	PE: subscore based on factor analysis	Not reported	ORI-CEBI	Parent report; BMI	No association
Li (2008) ⁵³	Cross sectional	11–17 years	1792	PE: fussy eaters—“only having favorite food and avoid unfavorable foods”	55%		Measured; BMI	Nonfussy eaters were 1.5 (95% CI: 1.2–2.2) times more likely to be overweight/obese
Loh (2013) ⁴³	Cross sectional	13 years	646	PE: food fussiness subscale, split into two components through factor analysis; “dislike toward food” and “trying new foods”	Not reported	CEBQ	Measured; BMIz	Negative association with “dislike toward food” [beta -0.12 (95% CI: -0.23 , -0.02)]; no association with “trying new foods” [beta -0.05 (-0.12 , 0.02)]
Mackenbach (2012) ⁴⁴	Cross sectional	3–4 years	3137	PE: food fussiness subscale		CEBQ	Measured; BMIz and BMI categorical	Negative correlation with BMIz (Pearson correlation coefficient -0.07 , $p < 0.01$)
Mascola (2010) ²⁰	Longitudinal	2–11 years	120	PE: parents responded to “Is your child a picky eater?” with “often” or “always” (as opposed to never, rarely, or sometimes)	13–22% at any time point; 39% at some point	SFQ	Measured; BMI	No association; did not adjust for baseline BMI

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Table 2. Characteristics and Main Findings of Included Studies continued

First author (year)	Study design	Age range	Sample size	Definition of picky eating (PE) or food neophobia (FN)	Prevalence of PE or FN	Measure of PE or FN	Weight status variable	Relationship between PE or FN and weight status
Moroshko (2013) ⁴⁵	Cross sectional	2–5 years	90	PE: diet consists of only a few foods; unwilling to eat many of the foods that our family eats at mealtimes; fussy or picky about what child eats FN: “caution around unfamiliar foods”	Not reported	CFQ, CFNS	Parent report; BMIz	No association
Morrison (2013) ²⁹	Cross sectional	2.8–5.8 years	222	PE: food fussiness, slowness in eating, emotional under-eating, satiety responsiveness, and enjoyment of food (loaded together in principal component analysis)	Not reported	CEBQ	Measured; BMIz	Negative correlation (-0.24 , $p < 0.01$)
Mosli (2015) ⁴⁶	Cross sectional	4–8 years	274	PE: food fussiness subscale	Not reported	CEBQ	Measured; BMI categorical	Overweight/obese with lower mean FF subscale score compared to healthy weight (2.58 ± 0.79 vs. 2.80 ± 0.72 , $p = 0.02$)
Perry (2015) ⁴⁷	Cross sectional	2 years	330	FN: total CFNS score (range 6–24)	Not reported	CFNS	Measured; BMIz	No association (beta = -0.061 , $p = 0.24$)
Rodenburg (2012) ⁴⁸	Longitudinal	7–10 years	1275	PE: food fussiness subscale	Not reported	CEBQ	Measured; BMIz	No association (beta = 0.00 , $p > 0.05$) if adjust for baseline BMIz; negative association (beta = -0.08 , $p < 0.01$) if do not adjust for baseline BMIz
Sleddens (2008) ⁴⁹	Cross sectional	6–7 years	135	PE: food fussiness subscale	Not reported	CEBQ	Parent report; BMIz	No association (beta = -0.10 , $p = 0.3$)
Spence (2011) ⁵⁰	Cross sectional	4–5 years	1730	PE: food fussiness subscale	Not reported	CEBQ	Measured; BMI categorical	Negative association with weight status and mean FF subscale score: obese 2.87 , overweight 2.98 , normal weight 3.08 , and underweight 3.27 ($p_{\text{trend}} < 0.01$)
Svensson (2011) ⁵¹	Cross sectional	1–6 years	174	PE: food fussiness subscale	Not reported	CEBQ	Parent report; BMIz categorical	No association

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Table 2. Characteristics and Main Findings of Included Studies continued

First author (year)	Study design	Age range	Sample size	Definition of picky eating (PE) or food neophobia (FN)	Prevalence of PE or FN	Measure of PE or FN	Weight status variable	Relationship between PE or FN and weight status
Tan (2012) ³⁰	Cross sectional	3–12 years	85	FN: “fear of new foods, rejecting foods that are unfamiliar”	Not reported	CFNS	Parent report; BMIz	No association (correlation -0.09 , $p > 0.05$)
Tharner (2014) ³¹	Cross sectional	4 years	3 117	PE: fussy eating—high food fussiness, slow eating, low enjoyment of food (loaded together in latent profile analysis)	5.8%	CEBQ at 4 years old	Measured; BMI and BMIz categorical	Increased proportion of underweight (19.3% vs. 12.3%, $p = 0.02$) and lower (-0.18 ± 0.07 vs. 0.10 ± 0.02 , $p < 0.01$)
Webber (2009) ⁵²	Cross sectional	7–12 years	406	PE: food fussiness subscale	Not reported	CEBQ	Measured; BMIz categorical	Negative association with weight and mean FF subscale score ($p_{\text{trend}} = 0.023$ for girls and $p_{\text{trend}} = 0.045$ for boys)
Werthmann (2015) ¹⁶	Cross sectional	2.5–4 years	32	PE: food fussiness subscale and laboratory assessment of food acceptance (number of spoonfuls consumed of yogurt with a variety of textures, colors, and tastes)	Not reported	CEBQ; food acceptance test	Weight measured, height parental report; BMI categorical	No association with parental report or behavioral measures of food acceptance
Wright (2007) ²¹	Cross sectional	30 months	455	Faddy/PE: parents responded definitely/ maybe/no to the question “is your child a faddy eater” Limited variety of foods: parents responded definitely/ maybe/no to the question “does your child eat a limited variety of foods”	Faddy: 8.2% definitely maybe Limited variety: 17.6%	Novel questionnaire	Parent report; weight SD scores and BMIz	Increased proportion of underweight at 2 years for faddy eaters (11.1% vs. 3.5%, $p = 0.01$); no difference in proportions for eating limited variety of foods; no association with faddy eating or limited variety and BMIz

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Table 2. Characteristics and Main Findings of Included Studies continued

First author (year)	Study design	Age range	Sample size	Definition of picky eating (PE) or food neophobia (FN)	Prevalence of PE or FN	Measure of PE or FN	Weight status variable	Relationship between PE or FN and weight status
Xue, Lee (2015) ²³	Cross sectional	7–12 years	793	PE: consume “an inadequate variety and amount of food(s) through rejection of foods that were familiar (and unfamiliar)”; parents asked “Do you consider your child as having picky eating behavior?” and if answered somewhat or always then classified as picky	59.3%		Measured; BMIz	Lower BMI [beta -1.198 (95% CI: -1.653, -0.743)] and BMIz [beta -0.383 (95% CI: -0.563, -0.203)]
Xue, Zhao (2015) ²⁴	Cross sectional	3–7 years	937	PE: defined as consuming “an inadequate variety and amount of food(s) through rejection of foods that were familiar (and unfamiliar)”; parents asked “Do you consider your child as having picky eating behavior?” and if answered somewhat or always then classified as picky	54%; 42% lasted 0–2 years, 25% lasted 2–3 years, and 21% lasted >3 years		Measured; BMI	No association during first or second year of PE [beta 0.01 (95% CI: -0.14, 0.16)] or third year of PE [beta -0.17 (95% CI: -0.36, 0.01)]; decreased BMI if PE >3 years [beta -0.25 (95% CI: -0.45, -0.06)]

BMIz, body mass index z-score; CEBQ, Child Eating Behavior Questionnaire; CFNS, Child Food Neophobia Scale; CFQ, Child Feeding Questionnaire; CPEBQ, Chinese Preschoolers’ Eating Behavior Questionnaire; EBQ, Eating Behavior Questionnaire; FF, food fussiness; FN, food neophobia; ORI-CEBI, Oregon Research Institute Child Eating Behavior Inventory; PE, picky eating; SD, standard deviation; SFQ, Stanford Feeding Questionnaire; WFA, weight for age; WFL, weight for length.

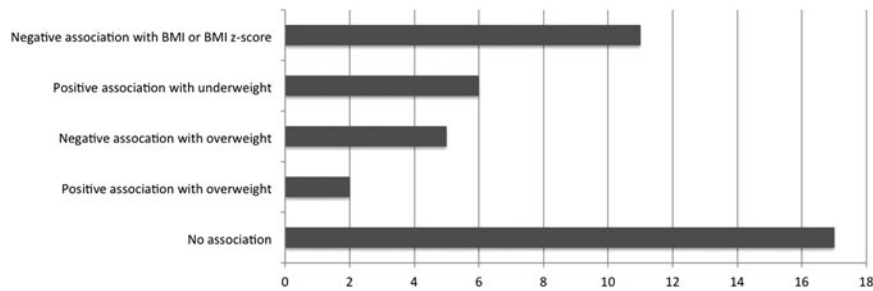


Figure 2. Association of picky eating or food neophobia with weight: all studies from systematic review (N = 41).

and child is fussy or picky about what he/she eats. Those studies utilizing nonstandardized questionnaires of picky eating relied on parents to report common signs of picky eating (*i.e.*, eating different meals from the rest of the family, refusing to eat certain foods, refusing to try new foods) to determine if children were picky. All studies that examined food neophobia ($n=7$) did so using the Child Food Neophobia Scale (CFNS), a measure assessing a child's willingness to try new foods.

Some studies ($n=4$) did not provide a clear definition for picky eating,^{17–20,22} leaving parents to interpret whether their children were picky eaters based on their own criteria. Of the studies that did include an explicit definition of picky eating, these definitions included the following: “unwillingness to eat familiar foods or try new foods, severe enough to interfere with daily routines to an extent that was problematic to the parent, child, or parent-child relationship”¹²; whether a child “eats everything”²⁷; “the unwillingness to try many different, already familiar, foods”¹³; and consuming “an inadequate variety and amount of foods through rejection of foods that are familiar.”^{23,24} Food neophobia was universally defined as “an unwillingness to eat novel foods.”¹³

The prevalence of picky eating varied widely from 5.8% to 59% and the prevalence of food neophobia ranged from 40% to 60%. Table 2 describes an overview of study methods and the reported prevalence of picky eating or food neophobia.

General Findings

Of the 41 studies reviewed, 17 found no association between picky eating or food neophobia and weight sta-

tus^{16,17,19,20,25,26,30,34,36,40–42,45,47–49,51}; 2 found that picky eating or food neophobia had a positive association with overweight^{13,39}; 5 found a negative association with overweight or obesity^{27,28,32,46,53}; 6 found a positive association with underweight^{11,12,21,31,35,50}; and 11 found a decreased association with BMI or BMI z-score (but did not specify if underweight or decreased risk of overweight)^{18,22–24,29,33,37,38,43,44,52} (Table 2). These results are depicted in Figure 2.

When picky eating and food neophobia are examined separately, results of studies examining picky eating continue to be disparate (Fig. 3). In contrast, of the seven studies examining food neophobia, there is more consistency, with six studies finding no association and one study finding a positive overweight (Fig. 3).

Twenty of the 41 identified studies reviewed here included children 6 years old or older. Seven of these found no association between picky eating or food neophobia and weight status; two found a positive association with overweight or obesity; five found a negative association with overweight; two found a positive association with underweight, and four found a negative association with BMI or BMI z-score (Fig. 4). Of the 21 studies, including children younger than 6 years of age, 10 of these found no association between picky eating or food neophobia and weight status; 4 found a positive association with underweight, and 7 found a negative association with BMI or BMI z-score (Fig. 4).

No clear relationship was found between picky eating or food neophobia and weight status based on type of study (9 longitudinal, 31 cross sectional, and 1 case-control) or whether anthropometrics were obtained via parent report

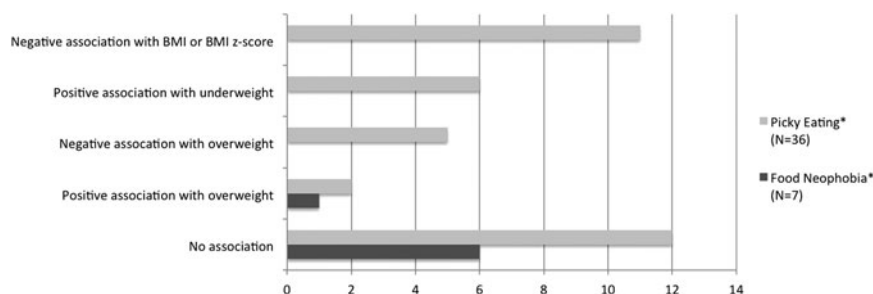


Figure 3. Association of picky eating (N = 36) and food neophobia (N = 7) with weight. *Two studies examined both picky eating and food neophobia.

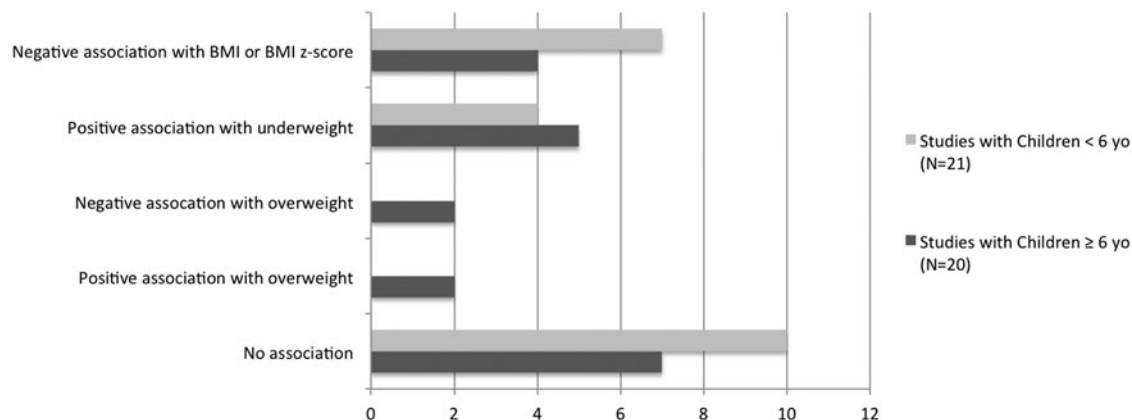


Figure 4. Association of picky eating or food neophobia with weight, by age.

or directly measured. When studies were examined based on the type of questionnaire used, 16 studies assessed food fussiness with the CEBQ, 7 studies assessed food neophobia with the CFNS, 4 studies assessed picky eating with the CFQ, 2 studies assessed picky eating with the SFQ, and 6 studies asked parents directly whether the child is a picky eater. There was no clear relationship between picky eating and weight status based on the questionnaire type. When examining severity of picky eating, only three studies classified children as severe (*e.g.*, referred to a feeding specialist) or persistent (*e.g.*, for 3 years in a row) picky eaters, and all of these studies found increased odds or proportion of underweight status among severe picky eaters.^{12,17,24} In addition, the studies of severe picky eaters had lower prevalence estimates (10%–21%) than most of the studies not examining severe picky eaters.

Strength of the Evidence

All studies in this review are observational and many were rated as having at least medium risk of bias (Table 3). All studies were at risk for bias due to their reliance on parental report to define picky eating or food neophobic behavior, as child weight status could potentially influence parental perceptions of children's eating behaviors. For example, parents might be more likely to describe an underweight child as a picky eater compared to a child with normal weight, independent of actual eating behavior, as a means of justifying the former child's low-weight status. Conversely, parents of a child with overweight may justify offering more high calorie, palatable foods if they believe the child is a picky eater. Different means of determining picky eating status may therefore contribute to risk of bias and variability in results across studies. Furthermore, many studies solicited parent report of child height and weight (rather than direct measurements), which is known to often be incorrect, resulting in weight status misclassification.⁵⁴

Most studies attempted to correct for potential confounders such as demographics, family income, and parental education. However, many other important factors were often missing, such as parental weight status, feeding styles,

and community characteristics, which led to at least a medium risk of confounding in most identified studies. When studies with high risk for bias ($n = 1$) or confounding ($n = 6$) were excluded from analysis, results did not differ (results not shown, please see Tables 2 and 3 for additional details).

Discussion

No clear association can be determined between childhood weight status and picky eating among the 41 studies included in this systematic review. Our findings indicate a wide range of conflicting evidence, with results ranging from “no association” between picky eating and weight status, to associations with either overweight or underweight. In addition, results of some individual studies were mixed, with varying associations found depending on baseline BMI,³² gender,¹⁹ or the persistence of picky eating.^{11,24} Definitions of picky eating varied significantly between studies, varying from parental report of “is your child a picky eater?” to referral to a subspecialist due to picky eating behaviors that interfered with daily routines. These inconsistencies in the conceptualization and measurement of picky eating contribute to the large discrepancies in reported prevalence of picky eating and association with weight. In contrast, food neophobia was consistently defined as a fear of trying new foods and was measured in each study using the CFNS.⁵⁵ This resulted in more narrow prevalence estimates (40%–60%) and a more consistent finding of no association with food neophobia and weight status.

Most of the studies in this review were cross-sectional, preventing the ability to infer causal relationships. It is especially important to note that the odds ratios are not comparable in magnitude across study designs—for example, one study finding that overweight kids are five times as likely to be picky does not mean that picky kids are five times as likely to be overweight. Even in studies that found a relationship between picky eating and overweight, it is not possible to determine if picky eating behaviors predisposed children to overweight, if the overweight preceded picky eating, or if another confounding factor is responsible for

Table 3. Risk of Bias and Confounding of Included Studies

First author (year)	Study design	Bias ^a	Confounding ^b
Antoniou (2015) ³²	Longitudinal	Medium	Medium
Brown (2015) ³³	Cross sectional	Medium	Medium
Cao (2012) ³⁴	Cross sectional	Low	Medium
Carruth (1998) ²⁵	Longitudinal	Medium	Low
Carruth (2000) ¹⁷	Longitudinal	Medium	Medium
Carruth (2004) ¹⁸	Cross sectional	Low	Medium
Chatoor (2000) ²²	Cross sectional	High	High
Dubois (2007) ¹¹	Longitudinal	Low	Medium
Ekstein (2010) ¹²	Cross sectional	Medium	High
Equit (2013) ³⁵	Cross sectional	Low	High
Faith (2013) ²⁶	Cross sectional	Low	Medium
Ferreira (2008) ²⁷	Cross sectional	Medium	Medium
Finistrella (2012) ¹³	Cross sectional	Low	Medium
Galloway (2005) ²⁸	Cross sectional	Low	Medium
Gregory (2010) ³⁶	Longitudinal	Low	Low
Hittner (2011) ³⁷	Longitudinal	Low	Low
Jacobi (2003) ¹⁹	Longitudinal	Low	Medium
Jansen (2012) ³⁸	Cross sectional	Low	Medium
Jiang (2014) ³⁹	Cross sectional	Low	Medium
Johnson (2015) ⁴⁰	Cross sectional	Low	Low
Laureati (2015) ⁴¹	Cross sectional	Low	High
Lewinsohn (2005) ⁴²	Cross sectional	Low	High
Li (2008) ⁵³	Cross sectional	Low	Medium
Loh (2013) ⁴³	Cross sectional	Low	Medium
Mackenbach (2012) ⁴⁴	Cross sectional	Low	Medium
Mascola (2010) ²⁰	Longitudinal	Medium	Medium
Moroshko (2013) ⁴⁵	Cross sectional	Medium	Low
Morrison (2013) ²⁹	Cross sectional	Low	High
Mosli (2015) ⁴⁶	Cross sectional	Low	Medium
Perry (2015) ⁴⁷	Cross sectional	Medium	Medium
Rodenburg (2012) ⁴⁸	Longitudinal	Low	Low
Sleddens (2008) ⁴⁹	Cross sectional	Medium	High
Spence (2011) ⁵⁰	Cross sectional	Medium	Medium
Svensson (2011) ⁵¹	Cross sectional	High	Medium
Tan (2012) ³⁰	Cross sectional	Low	Medium
Tharner (2014) ³¹	Cross sectional	High	Medium
Webber (2009) ⁵²	Cross sectional	Low	Medium
Werthmann (2015) ¹⁶	Cross sectional	Low	High
Wright (2007) ²¹	Cross sectional	Medium	Medium

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Table 3. Risk of Bias and Confounding of Included Studies continued

First author (year)	Study design	Bias ^a	Confounding ^b
Xue, Lee (2015) ²³	Cross sectional	Low	Medium
Xue, Zhao (2015) ²⁴	Cross sectional	Low	Medium

As determined by the Agency for Healthcare Research and Quality RTI Item Bank,¹⁵ an item was low risk of no affirmative answers, medium risk if one affirmative answer, and high risk if more than one affirmative answer.

^aBias = Q 1,3,7,8,9,11.

^bConfounding = Q 6,12,13.

both. Also, most studies did not clearly report possible effect modifiers (*e.g.*, types of foods offered to the child, parenting styles, parent weight status) that could affect the relationship between eating behaviors and weight status. Other limitations that may affect the cumulative evidence in this systematic review include publication bias and the risk of selective reporting within studies. As null articles may be less likely to be published, the category of studies reporting “no association” is probably underrepresented.

Although 20 studies in this review included children older than 6 years old, only three of these were longitudinal studies, and none of the longitudinal studies followed children beyond 11 years old. A growth velocity nadir occurs in children between 2 and 6 years old, which is then followed by a period of adiposity rebound (the period during which BMI increases from its nadir).⁵⁶ Children who experience adiposity rebound at earlier ages are at higher risk for increased BMI during adolescence⁵⁷; thus, accounting for adiposity rebound in study designs is crucial in the interpretation of findings regarding the cross-sectional association between childhood eating behaviors and weight status, and to our understanding of how early childhood eating behaviors influence weight trajectories over time. Longitudinal studies with longer follow-up periods are needed to assess picky eating behaviors and weight during a child’s growth velocity nadir, adiposity rebound, and then into adolescence, to better understand how these behaviors affect long-term growth trajectories. In addition, longitudinal studies should adjust for baseline BMI or BMIz in their analysis, as this was not commonly done by studies in this review. In the case of Rodenburg *et al.*,⁴⁸ there was an overall negative association between food fussiness and BMIz (beta = -0.08, $p < 0.01$); however, when baseline BMIz was adjusted for, this association was no longer significant.

Our finding that severe or persistent picky eating is associated with increased odds of underweight suggests that these studies are describing different eating behaviors than many of the other studies. A recent review article by Kerzner⁵⁸ describes a new classification of feeding problems commonly described in children and a systematic approach to management that incorporates severity of feeding problems

and parent feeding style. Kerzner describes feeding problems as a pyramid, with “feeding disorders” at the top as the most severe, followed by “milder feeding difficulties,” “mis-perceived feeding problems,” and finally “normal” at the bottom of the pyramid. Although this conceptualization nicely distinguishes categories of child feeding behaviors by severity and consequences, there remains a need for more universally accepted definitions of picky eating as well as a determination of where certain eating behaviors should be classified within Kerzner’s pyramid. This information would indeed help clinicians in appropriately classifying pediatric patients and providing counsel for parents.

The existing literature supports that food neophobia is common in children and does not put children at increased risk for being underweight. The longitudinal studies in this review do not show consistent relationships between pickiness and weight status, likely due to inconsistent definitions. A more recent longitudinal study published after our search⁵⁹ narrowly defined picky eating by incorporating several CEBQ subscales, with a resulting group representing <6% of the population, and found that picky eating increases the risk of underweight. However, given the variety of available definitions for picky eating, it is unclear if this finding would stand up for all. A more uniform definition of picky eating and a better understanding of the pathology of picky eating in various age groups are needed to clarify this literature. Further research also is warranted to examine how picky eating affects the timing of the BMI nadir between 2 and 6 years old, and subsequent adiposity rebound. In addition, more information is needed regarding the role of environment as a determinant of parents’ and children’s food preferences and whether these environmental influences are responsible for maladaptive nutrition practices during childhood.

Conclusions

No consistent definition exists for picky eating throughout the literature. This has, in turn, led to very different conclusions regarding the prevalence of picky eating and whether picky eating may affect current or future weight status. The relationship between picky eating and weight has significant clinical implications, as parents’ concerns about picky eating may potentially change how they feed their children. This may increase the frequency of pediatric medical visits and also may lead to disagreements between caregivers regarding management of children’s eating behaviors. If uniform definitions of picky eating are established and if picky eating is then shown to have no association with weight status, then physicians and parents may be able to reduce related anxiety and interventions. Should additional evidence show that such traits are predictive of children’s weight trajectories, primary care providers should prioritize anticipatory guidance and counseling about management of picky eating behaviors. Equipped with definitive empirical evidence regarding the role of picky eating in determining childhood weight tra-

jectories, pediatricians and childhood healthcare providers can better support parents and children in transitioning from picky eating to appropriate self-regulation of childhood nutrition behaviors.

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Author Disclosure Statement

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