

Eating Behaviors, Caregiver Feeding Interactions, and Dietary Patterns of Children Born Preterm: A Systematic Review and Meta-Analysis

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ABSTRACT

Infants born preterm (<37 weeks of gestation) often experience feeding problems during hospitalization. Whether difficulties persist or have long-term sequelae on childhood eating is unclear. We aimed to describe the oromotor eating skills (e.g., chewing/swallowing), eating behaviors (e.g., food neophobia), food parenting practices (e.g., pressure to eat), and dietary patterns of preterm children during late infancy (6–12 mo) and early childhood (>12 mo–7 y) and to determine whether these differed from those of term-born peers. We identified 67 articles (57 unique studies) for inclusion. We used random-effects meta-analysis of proportions to examine the prevalence of oromotor eating skill and eating behavior challenges among preterm children, standard meta-analysis for comparisons with term-born peers, and the Grading of Recommendations, Assessment, Development and Evaluation approach to assess the certainty of evidence. Forty-three percent (95% CI: 24%, 62%) of infants and 25% (95% CI: 17%, 33%) of children born preterm experienced oromotor eating difficulties and 16% (95% CI: 4%, 27%) and 20% (95% CI: 11%, 28%), respectively, exhibited challenging eating behaviors. During late infancy and early childhood, oromotor eating difficulties (OR: 2.86; 95% CI: 1.71, 4.77; $I^2 = 67.8\%$) and challenging eating behaviors (OR: 1.52; 95% CI: 1.11, 2.10; $I^2 = 0.0\%$) were more common in those born preterm than in those born term: however, the certainty of evidence was very low. Owing to the low number and heterogeneity of studies, we narratively reviewed literature on food parenting and dietary patterns. Mothers of preterm infants appeared to have heightened anxiety while feeding and utilized coercive food parenting practices; their infants reportedly received less human milk, started solid foods earlier, and had poorer diet quality than term-born peers. In conclusion, meta-analyses show preterm children experience frequent oromotor eating difficulties and challenging eating behaviors throughout the early years. Given preterm birth increases risk of later obesity and diet-related chronic disease, research examining the effects of caregiver–child interactions on subsequent diet is warranted. This review was registered at www.crd.york.ac.uk/prospero/ as CRD42020176063. *Adv Nutr* 2022;13:875–912.

Statement of Significance: Preterm children continue to experience frequent oromotor eating difficulties and challenging eating behaviors throughout the early years, more commonly than term-born peers.

Keywords: preterm birth, feeding and eating disorders of childhood, picky eating, feeding skills, oromotor skills, eating behaviors, parent–child interaction, food parenting, diet quality, meta-analysis

Introduction

Infants born preterm (<37 weeks of gestation) and at a very low birth weight (VLBW; <1500 g) experience high rates of feeding problems in hospital (1, 2). Eating is a neurodevelopmental process that requires motor organization, rhythmic

sucking, and a coordinated suck-swallow-breathe pattern while integrating incoming sensory components of both the food and the feeding environment (2, 3). Organ immaturity, birth complications, and medical interventions such as tube feeding interrupt the development of these necessary skills

and progression to complete oral feeding. Although often essential for survival, procedures in the neonatal intensive care unit (NICU) may limit opportunities for positive oral experiences and parent–child interaction, causing parental distress and negative feeding experiences (1, 4).

There is little consensus about the persistence of eating difficulties into late infancy and early development among children born preterm (5). Ross and Browne (2) conducted a systematic review qualitatively synthesizing the literature on breastfeeding, eating problems, and growth in preterm infants at, and post, NICU discharge, and concluded that preterm infants are slow to develop eating skills and that parental reports of eating challenges are prevalent. More recently, Pados et al. (6) conducted a meta-analysis examining the prevalence of problematic feeding (e.g., choking, food refusal) in preterm children and reported 42% (95% CI: 33%, 51%) exhibit such challenges in the first 4 y. Notably, neither of these reviews used exhaustive literature searches, included a term-born comparison group, or critiqued the certainty of evidence across studies. To our knowledge, this is the first systematic review and meta-analysis to explore the prevalence of oromotor eating difficulties and behavioral eating challenges among children born preterm, as well as the first to compare with term-born peers.

Early food and eating experiences have a powerful influence on food preferences, including interactions with others (7, 8). The current food parenting guidance is based on term-born children and, as such, may not be sufficient or appropriate for families with a child born preterm. When problematic behaviors and poor dietary intake recur without support or intervention, restrictive preferences and maladaptive habits become entrenched. The impact of eating and feeding challenges on preterm children's dietary patterns or nutritional status during the early years is relatively unknown (9, 10). As such, it can also be difficult for clinicians to determine whether parental concerns regarding preterm children's feeding/eating are truly problematic or, rather, reflective of the typical development of children's eating behaviors and food preferences (7, 11). Given that children born preterm experience higher rates of adiposity and chronic disease during young adulthood than their term-born peers (12), understanding the eating behaviors, food parenting practices, and dietary patterns of these children is crucial to supporting their long-term health. Elucidating whether the eating and feeding challenges experienced by

preterm infants are unique will help create tailored anticipatory guidance and nutritional supports for this vulnerable population.

We aimed to describe the oromotor eating skills (e.g., chewing, swallowing), eating behaviors (e.g., food neophobia), food parenting practices (e.g., pressure to eat), and dietary patterns of preterm children during late infancy (6–12 mo) and early childhood (>12 mo–7 y) and to determine whether these differed from those of children born at term. For clarification, throughout this review, “eating” refers to the child's actions and behaviors, whereas “feeding” refers to those of the parent.

Methods

We conducted a systematic review and meta-analyses according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (13); protocol registration can be found on the International Prospective Register of Systematic Reviews (PROSPERO; CRD42020176063).

Eligibility and literature search

We outlined our eligibility criteria using the Participants, Intervention (or Exposure), Comparator, Outcomes, Study Design (PICOS) format (Table 1). We formulated our PICOS statement a priori before systematically searching the electronic databases Medline, Embase, and PsycINFO (OVID); Cochrane (Wiley); CINAHL (EBSCO); and Scopus (Elsevier) using subject headings specific to each database and keywords on 22 April, 2020, with support from a research librarian (QM). We also searched the gray literature using Google Advanced Search, ProQuest Dissertation and Theses Global, and the clinicaltrials.gov registry (14). We updated all searches on 16 September, 2021. Search terms were related to 1) oromotor eating skills (e.g., eating skill, oromotor) and eating behaviors (e.g., food refusal, food neophobia), 2) food parenting (e.g., parent–child interactions, pressure to eat), 3) dietary patterns (e.g., diet quality), and 4) prematurity or low birth weight. The full Embase search is available in Supplemental Table 1 (See Supplemental Methods). After completing our initial screening, we reviewed the reference lists of all eligible studies to identify additional publications for inclusion.

Outcomes

Oromotor eating skills and eating behaviors.

Oromotor eating skills refer to the movement, strength, and coordination of the jaw, tongue, lips, and cheeks. These skills lay the foundation for eating-related tasks, including sucking, chewing, and swallowing. Oromotor eating difficulties among children may include chewing, swallowing or gagging concerns, excessive drooling, oral sensitivity, and avoidance of particular food textures (5). Eating behaviors refer to how one eats. During late infancy and early childhood examples include food responsiveness, emotional under- or over-eating, enjoyment of food, desire to drink, satiety responsiveness, slowness in eating, food fussiness, food

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Supplemental Methods and Supplemental Tables 1–4 are available from the “Supplementary data” link in the online posting of the article and from the same link in the online table of contents at <https://academic.oup.com/advances/>.

SLU and DLO contributed equally to this work as senior authors.

Abbreviations used: AAP, American Academy of Pediatrics; GRADE, Grading of Recommendations, Assessment, Development and Evaluation; NICU, neonatal intensive care unit; NOS, Newcastle-Ottawa Scale; PICOS, Participants, Intervention (or Exposure), Comparator, Outcomes, Study Design; VLBW, very low birth weight.

TABLE 1 PICOS criteria for inclusion and exclusion of studies examining the oromotor eating skills and eating behaviors, food parenting, and dietary patterns of children born preterm between the ages of 6 mo and 7 y

Criteria	Definition
Participants	Infants and children born preterm (<37 weeks of gestation) and aged 6 mo postnatal or corrected age to 7 y at the time of data collection
Intervention (or Exposure)	Preterm birth
Comparator	Full-term birth (>37 weeks of gestation), excluding those born small for gestational age
Outcomes (eligible studies had to examine ≥ 1)	Oromotor eating skills (e.g., chewing and swallowing) and Eating behaviors (e.g., food refusal, food neophobia) Food parenting (e.g., parent-child interactions, pressure to eat) Dietary patterns (e.g., diet quality)
Study design	Observational studies and intervention trials were included. Case studies, review articles and commentaries, studies that focused solely on children born full-term but small for gestational age, and studies examining nutrient intakes provided by mother's milk, donor human milk, or infant formula were excluded. We did not include any search restrictions related to publication language or date

neophobia, or food selectivity (15). Eating behaviors may be disruptive (e.g., tantrums, food refusal, throwing or pushing food away) or undesirable, like extended bottle use past the age of 2 y.

Food parenting.

This encompasses parents' knowledge, experiences, emotions, and responsivity related to feeding their child as well as behavioral strategies to influence what, how much, or whether their child eats (16, 17). For the current review, we explored parental concern and emotions during feeding, specific feeding practices, and parent-child interactions during mealtimes. Examples of feeding practices include coercive food parenting (e.g., pressuring a child to eat, restricting intake of or access to specific foods or food groups, using food as a reward for eating or behavioral control) and noncoercive food parenting (e.g., modeling and monitoring of intake, positive commenting, age-appropriate nutrition education, offering a variety of foods, frequent family meals).

Dietary patterns.

According to the Dietary Guidelines for Americans 2020–2025, a dietary pattern refers to the entirety of what individuals habitually eat and drink (18). The components of the pattern act synergistically to affect health (18). For this review, we chose to focus on aspects of dietary patterns pertinent to infants and young children, including human milk (mother's own or donor human milk) feeding duration and exclusivity, age at introduction to solid foods, food group consumption, and overall diet quality. The composition of human milk (e.g., macro- and micronutrients in mother's milk or human donor milk) fed to infants born preterm was outside the scope of this review.

Data management and extraction

Using Covidence online software (19), 2 independent reviewers (KW and AID) screened articles for inclusion based first on titles and abstracts, followed by a full-text review. Reasons

for excluding articles were documented and discrepancies between reviewers resolved in all instances.

Using a data extraction sheet created in the Research Electronic Data Capture (REDCap) software (20), the 2 reviewers independently extracted data from eligible studies including publication year; country; study setting (i.e., hospital, community, home); study design (i.e., cross-sectional, prospective cohort, retrospective cohort, other); sample size; child age; gestational age at birth; birth weight; sex; relationship of caregiver to child; and results related to child oromotor eating skills and eating behaviors, food parenting, and dietary patterns and details of how these data were obtained (e.g., direct observation, parental report, 24-h dietary recall). In articles with a term-born comparison, data were reported separately for preterm and term-born children. After reviewing for accuracy, extracted data from the 2 reviewers were combined.

Statistical analysis

We analyzed data in Stata version 16 (StataCorp LP). We conducted 3 different random-effects meta-analyses of proportions using *metaprop* and a maximum likelihood (ML) estimator to explore the prevalence of oromotor eating difficulties and eating behavior challenges among children born preterm in studies that examined 1) only oromotor eating difficulties; 2) only eating behavior challenges; or 3) any eating challenge, not specified (articles that did not differentiate oromotor difficulties and behavioral eating challenges) within the age categories 6–12 mo and >12 mo–7 y. Percentages and 95% CIs are displayed to represent the prevalence for each meta-analysis of proportions. We also conducted random-effects meta-analysis using a restricted maximum likelihood (REML) random-effects model to evaluate the odds of eating problems in children born preterm compared with those born at term. The ORs and 95% CIs are presented. We used random-effects models because they assume that study effect sizes differ and that the studies included represent a random sample from a larger set of studies (i.e., a population of studies). We estimated statistical heterogeneity

based on I^2 and considered values of 25%, 50%, and 75% as low, moderate, and high heterogeneity, respectively (21).

In prospective studies with 2 measurement points within the same age group (e.g., 6 and 8 mo corrected age), we used the earlier time point to allow for maximum sample size. We excluded articles with children that spanned the 2 age groups and could not be disaggregated ($n = 3$) (22–24). We also excluded studies from the meta-analysis that did not report prevalence of challenges, or where prevalence could not be discerned ($n = 12$) (25–36).

Risk of bias and certainty of evidence assessment

We utilized the Newcastle-Ottawa Scale (NOS) for non-randomized analyses (37) to assess the risk of bias of each eligible study. Two independent reviewers (KW and AID) achieved consensus 100% of the time. In our NOS-guided review, the following features of each study were assessed: representativeness of the study sample; method by which preterm birth was confirmed; how outcomes were assessed (e.g., blind independent observer, parental report); adequacy of cohort follow-up (e.g., study retention); and the comparability of the study (37). For the comparability category (whether individual studies adjusted for similar important confounding variables), we decided a priori to award 2 points to studies adjusting for parental educational attainment, family income (or a composite of socioeconomic status), parental weight status, gestational age and/or birth weight, and child sex, and 1 point to studies that adjusted for ≥ 4 other covariates (37). For our review, a sufficient follow-up period to observe our outcomes of interest was not required, and in cohort studies, feeding problems may have been present at the start of the study. Thus, we adapted the NOS such that scores for case-control studies ranged from 0 to 9 and for cohort studies from 0 to 7, with scores ≥ 7 and ≥ 5 indicating low risk of bias, respectively (37).

We assessed the certainty of evidence across studies included in the respective meta-analyses (as opposed to at the individual study level) using the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) approach (38). Evidence started at moderate quality because of the observational nature of studies included in this systematic review, and was downgraded based on the following 4 GRADE criteria: 1) risk of bias of individual studies included in the meta-analysis (study design or failing to blind birth groups for analysis could affect rating); 2) inconsistency (unexplained statistical heterogeneity in meta-analysis results); 3) indirectness [not using validated tools or assessments or failing to distinguish between types of eating problems (oromotor compared with behavioral)]; and 4) imprecision (wide CIs around the estimates or ORs in meta-analysis). An overall score for each outcome (high, moderate, low, or very low) was determined by considering certainty across all GRADE criteria (38).

Results

Our search of 6 electronic databases, the gray literature, and reference lists identified 6221 abstracts after the removal of duplicates (Figure 1). We examined the eligibility of 232 full-text articles. In cases where we could not locate full-text articles ($n = 4$), we attempted to contact the corresponding authors but did not receive any responses. Of the full texts reviewed, 67 articles reporting on 57 unique studies met our inclusion criteria for this systematic review (Table 2); in 10 cases, articles (i.e., published manuscripts) originated from the same study sample but reported on different outcomes. Supplemental Table 2 provides relevant results from each article. These 57 unique studies reported on a total of 11,728 children born preterm, with mean gestational age at birth ranging from 25.9 to 36.6 wk and mean birth weight ranging from 453 to 2526 g. Fifteen articles (22% of articles; $n = 13$ unique studies) reported exclusively on children born preterm and VLBW. Twenty-six articles (39%) provided data on infants between 6 and 12 mo of age, 28 (42%) on children > 12 mo–7 y of age, and 13 (19%) spanned both age groups. Few articles included data on children older than 2 y of age ($n = 14$; 21%). Where articles included information on who the caregiver was ($n = 60$, 90%), most identified the child's mother as the caregiver.

Thirty-four of the 67 articles (51% of articles; $n = 30$ unique studies) included a term-born comparison group. These studies reported on a total of 40,257 children born at ≥ 37 weeks of gestation, with mean birth weight > 3000 g. Of the articles with a term-born comparison group, 19 (56%) were prospective cohorts, 13 (38%) cross-sectional, and 2 (6%) retrospective cohorts.

Based on the available studies, we conducted our meta-analysis with articles that provided data on children's oromotor eating skills and eating behaviors. The methodology and outcomes of studies examining food parenting and dietary patterns were highly varied and were thus only discussed narratively.

Oromotor eating skills and eating behaviors

We included 32 articles (28 unique studies) in our meta-analysis of children's oromotor eating skills and eating behaviors (Figure 1). The majority ($n = 21$, 66%) of these articles were based on caregiver report (survey or interview) to quantify eating skills and behaviors. Next, we discuss our findings related to oromotor eating difficulties and eating behavior challenges.

Oromotor eating difficulties.

Twenty-two articles (20 unique studies) were included in our exploration of oromotor eating difficulties. Areas of oromotor concern identified among infants included coordination of the suck-swallow-breathe pattern, lip, and jaw movements; coughing while eating purees; and difficulties self-feeding (e.g., coordinating utensils with the lips and mouth, particularly with pureed foods) (70, 75). Among children, common challenges included food loss/dribbling and coughing or gagging (5, 45, 66).

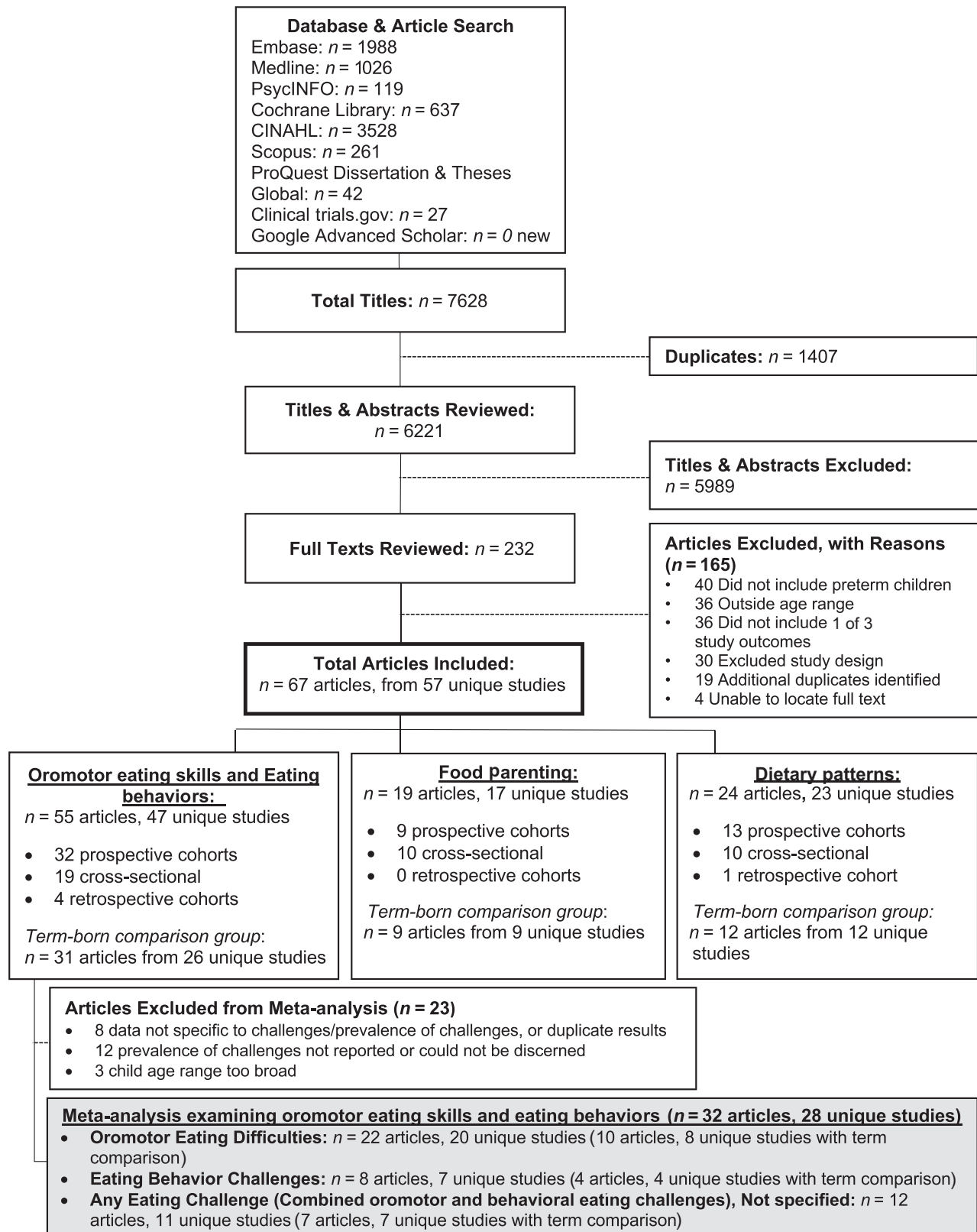


FIGURE 1 Systematic review study selection process to examine the oromotor skills, eating behaviors, food parenting, and dietary patterns of children born preterm compared with term-born peers.

TABLE 2 Summary of included articles examining the oromotor skills, eating behaviors, food parenting, and dietary patterns of children born preterm between the ages of 6 mo and 7 y¹

Authors, citation	Country	Study design	Preterm sample characteristics	Age group	Term comparison?	Outcomes assessed	Measures
Abily-Donval et al. (39)	France	Prospective cohort	n = 536 infants born at <33 weeks of gestation; n = 431 followed to 2 y	>12 mo–7 y	No	Oromotor eating skills and eating behaviors	Study-developed questionnaire. Eating problems categorized as no problem; small problem, easily solved; moderate difficulties requiring special involvement of parents to manage; major difficulties: daily concern to tolerable limits for parents
Adams-Chapman et al. (40)	USA	Prospective cohort	n = 1477 preterm infants participating in a clinical trial with follow-up to 18 mo CA. Infants with congenital anomalies or infection excluded	>12 mo–7 y	No	Oromotor eating skills and eating behaviors	Neonatal unit–developed questionnaire (parent report). Dysfunctional eating was defined as any of the following: 1) physician order not to ingest feedings by mouth; 2) need for gastrostomy or tube feedings; 3) gags/chokes or coughs with oral feeds; 4) documented history of aspiration; 5) excessive drooling during feeds; or 6) difficulty swallowing. Type and consistency of food were also recorded
Adams-Chapman et al. (41)	USA	Retrospective cohort	n = 467 infants born at <1000 g and without major congenital anomalies or infection. Follow-up at 18 and 30 mo CA	>12 mo–7 y	No	Oromotor eating skills and eating behaviors	Eating behaviors assessed by a certified examiner. Abnormal eating behaviors were coded when the child 1) was unable to tolerate foods by mouth; 2) required nasogastric or G-tube feeds for >50% of intake; 3) choked, gagged, coughed, or gasped with solids; or 4) drooled continuously. History of dysphagia or aspiration in fluoroscopic swallow studies was coded as abnormal
Amarger et al. (42)	France	Prospective cohort	n = 217 infants born at <33 weeks of gestation with eating behavior data at 2 y CA. Same sample as Migraine et al. (30)	>12 mo–7 y	No	Oromotor eating skills and eating behaviors	Child Eating Difficulties Questionnaire (parent report) which assesses 4 constructs of eating difficulties: neophobia, pickiness, low appetite, and low enjoyment of food. Neophobia and pickiness were combined to create a “narrow food repertoire” dimension. Low appetite and enjoyment of food were combined for a low drive to eat dimension. The 2 dimensions were then summed for an “Eating Difficulty”; higher scores indicate more difficulties (range: 2–10)

(Continued)

TABLE 2 (Continued)

Authors, citation	Country	Study design	Preterm sample characteristics	Age group	Term comparison?	Outcomes assessed	Measures
Anderson et al. (43)	USA	Cross-sectional	n = 41 preschool children (mean age: 47 mo) who were singletons born at ≤30 weeks of gestation to English-speaking parents. Children that were blind, deaf, or tube fed were excluded	>12 mo–7 y	No	Oromotor eating skills and eating behaviors	"Problematic Mealtime Behaviours" domain of the Meals in Our Household Questionnaire (parent report), which measures the frequency and intensity of 10 problematic mealtime behaviors (e.g., refuses what is served) over the past 3 mo. Responses to 20 statements are summed to generate a problematic mealtime behavior score; higher scores indicate more severe problems
Barnard et al. (25)	USA	Prospective cohort	n = 88 infants born at ≤34 weeks of gestation without Down syndrome, central nervous system dysfunction, and not requiring assisted respiration, to mothers with no history of late-pregnancy substance addiction. Observed at 4 and 8 mo of age	6–12 mo	n = 166 term-born infants were recruited from a parallel cohort study that began in 1973. Infants were born to mothers with "excellent prenatal and postnatal care." This sample was a comparatively well-educated, healthy, and middle-class sample	Oromotor eating skills and eating behaviors Food parenting	Infant eating behavior (e.g., state while eating, affect, visual attentiveness to mother, infant control) was observed during clinic visits for preterm infants and at home for term infants. Maternal food parenting was observed including adequacy of positioning of the infant; attentiveness to the infant and to feeding; kinesthetic, visual, and tactile stimulation; amount/variety of verbal stimulation; level of affect expressed; and responsiveness to the infant's distress or satiation cues
Bilgin and Wolke (44)	United Kingdom	Prospective cohort	n = 73 infants born at ≤32 weeks of gestation at <1500 g. Exclusion criteria: transfer out of unit before discharge, living ≥2 h from the hospital, foster care. Followed up at 3, 6 and 18 mo CA. Same sample as Bilgin and Wolke (45)	6–12 mo and >12 mo–7 y	n = 105 infants born between 37 and 42 weeks of gestation at the same hospitals. Matched to preterm infants by SES, sex, and multiple birth. Exclusion included a neonatal medical problem recorded at recruitment	Oromotor eating skills and eating behaviors Dietary patterns	A structured interview of child eating behaviors was developed for the study. Questions assessed oromotor eating problems (e.g., excessive dribbling/difficulty swallowing). At 6 mo, faddy eating/food refusal was measured with 1 item (fighting against the bottle/breast) and at 18 mo, children's eating behaviors (e.g., eats too little, poor appetite, picky eater).
Bilgin and Wolke (45)	United Kingdom	Prospective cohort	n = 73 infants. Same sample as Bilgin and Wolke (44)	>12 mo–7 y	n = 105 term infants. Same hospitals. See Bilgin and Wolke (44)	Oromotor eating skills and eating behaviors	Breastfeeding was measured by maternal report at each time point See Bilgin and Wolke (44)

(Continued)

TABLE 2 (Continued)

Authors, citation	Country	Study design	Preterm sample characteristics	Age group	Term comparison?	Outcomes assessed	Measures
Burklow et al. (46)	USA	Retrospective cohort	n = 83 children born preterm (<38 weeks of gestation) attending an initial outpatient clinic appointment with an interdisciplinary feeding team. Mean ± SD age: 31.8 ± 20.2 mo	>12 mo–7 y	n = 60 children born at >38 weeks of gestation presenting to the same feeding clinic	Oromotor eating skills and eating behaviors Dietary patterns	History of bottle feeding and breastfeeding, solid food introduction, previous and current eating difficulties (i.e., poor sucking skills, emesis), and current eating (i.e., tube feeding supplementation) by parent report. Medical record documentation of nonexclusive problems including structural/mechanical, neurologic, behavioral, cardiorespiratory, and metabolic conditions causing eating issues
Buswell et al. (47)	United Kingdom	Retrospective cohort	n = 15 infants born at <37 weeks of gestation. Infants were free of congenital problems, significant parenchymal hemorrhage or leukomalacia, visual impairment, aspiration risk precluding oral feeding, and foster care. Age 10 mo at time of study	6–12 mo	No	Oromotor eating skills and eating behaviors	Age at which infants were weaned (parent report). An independent blind observer coded videos of infants eating during home visits using the SOMA to measure infants' oral motor skills
Cerro et al. (8)	South Australia	Cross-sectional	n = 95 children born at <32 weeks of gestation or weighing <1500 g without congenital abnormalities or neurologic impairment. Aboriginal and Torres Strait Islander children were excluded (questionnaire was not culturally appropriate). Children were recruited from the NICU follow-up clinic and 1.5–3 y old at time of study	>12 mo–7 y	Every 7 th name was selected from the 1996 birth registry at the same hospital. Recruitment letters were sent to the parents of those who were born singletons at >37 weeks of gestation and without congenital abnormalities (n = 143 responded). At the time of the study, term children were significantly younger than preterm (CA; difference of ~8 mo)	Oromotor eating skills and eating behaviors Food parenting Dietary patterns	Questionnaire developed for study (parent report) assessing 1) Eating behaviors (e.g., vomiting, reflux requiring medication, picky/fussy eating, food refusal, ability to self-feed); 2) Food parenting (perceptions of when children should eat, how much they should eat, what they should eat, mealtime environment, duration of meals, restriction of specific foods, parent feelings when child refuses food, pressure to eat/coaxing, use of nonfood reward and food reward, and bribes and threats to prompt child to eat); and 3) Dietary patterns (range and textures of foods eaten, age at

(Continued)

TABLE 2 (Continued)

Authors, citation	Country	Study design	Preterm sample characteristics	Age group	Term comparison?	Outcomes assessed	Measures
Cho et al. (48)	Korea	Cross-sectional	n = 390 infants born at <37 weeks of gestation at <2500 g without chromosomal aberrations, congenital metabolic/endocrine disorders, major congenital anomalies, or surgery for gastrointestinal anomalies. Data extracted for n = 263 infants aged ≥8 mo at the time of data collection (8, 12, or 18 mo CA)	6–12 mo and >12 mo–7 y	No	Oromotor eating skills and eating behaviors Food parenting	introduction to solids, breastfeeding duration, amount of junk food eaten, amount of food eaten as snacks and meals) Parents’ “concerns” about their preterm child using an open-ended question on a survey developed for the study. Concerns were subsequently coded by the research team
Chung et al. (49)	USA	Cross-sectional	n = 76 infants at 2–23 mo CA attending NICU follow-up in New York. Non-English-speaking families were excluded	6–12 mo and >12 mo–7 y	No	Oromotor eating skills and eating behaviors Food parenting	Child’s developmental readiness to start solids (e.g., trouble controlling head and neck) (parent report) and avoidant eating behaviors (e.g., push food away). Children categorized as developmentally ready or not for starting solid foods. Parental feeding attitudes/satisfaction on the Delighted-Terrible scale (e.g., “When you first introduced solids, how comfortable did you feel feeding your infant?”)
Crapnell et al. (1)	USA	Prospective cohort	n = 80 consecutive infants born at ≤30 weeks of gestation without congenital anomalies in a level 3 NICU. Recruited by day 3 of life and followed until 2 y of age. Same sample as Crapnell et al. (50)	>12 mo–7 y	No	Oromotor eating skills and eating behaviors	Eating subscale of the Infant-Toddler Social Emotional Assessment (ITSEA) at 2 y of age (parent report): gagging and choking on food, refusing to eat, and refusing to eat foods that require chewing, spitting out food, accepting foods right away, whether child is considered a good eater or a picky eater, refusing to eat certain foods for ≥2 d, and holding food in cheeks

(Continued)

TABLE 2 (Continued)

Authors, citation	Country	Study design	Preterm sample characteristics	Age group	Term comparison?	Outcomes assessed	Measures
Crapnell et al. (50)	USA	Prospective cohort	n = 86 infants. Same sample as Crapnell et al. (1)	>12 mo–7 y	No	Oromotor eating skills and eating behaviors	See Crapnell et al. (1)
Davenport et al. (51)	United Kingdom	Cross-sectional	n = 38 infants born at ≤37 weeks of gestation at ≤2499 g. Recruited at 3–4 y of age from a previous case-control study examining the relation between periodontal disease and delivery of a preterm LBW infant. Participants lived close to the dental institute and most were of Bengali origin	>12 mo–7 y	n = 62 infants born at >37 weeks of gestation and weighing >2500 g were recruited from the same maternal periodontal disease study	Dietary patterns	Children's dietary patterns were measured by 24-h recall to collect information about the numbers and types of snacks children consumed per day, their amount of sugar consumption, and the types of beverages consumed. Parents reported on the duration of breastfeeding
DeMauro et al. (52)	USA	Prospective cohort	n = 890 infants born at between 25 and 36 weeks of gestation without any major congenital or chromosomal abnormalities. Followed up at 3, 6, and 12 mo CA	6–12 mo	No	Oromotor eating skills and eating behaviors Food parenting	Infant's appetite; trouble with sucking, swallowing, choking; length of feeding and whether the infant is feeding enough; frequency infant pushes food away; turns head, closes mouth, gags, holds food in mouth, spits, and cries when food is offered; and if infant had been seen in a specialty feeding clinic (yes/no) (all parent-report) Food parenting (parent report): Are feeding times (very relaxed, relaxed, average, stressful, very stressful); How comfortable are you in feeding baby?
den Boer and Schipper (53)	Netherlands	Cross-sectional	n = 47 infants born at <32 weeks of gestation and/or weighing <1500 g. Infants were 9 mo CA at time of assessment	6–12 mo	n = 52 infants born at >37 weeks of gestation without any complications recruited randomly from the hospital database	Oromotor eating skills and eating behaviors	Infants were observed by a Speech Language Pathologist while eating in the clinic at 9 mo CA. Observations included sufficient postural balance, drinking independently from bottle, choking while drinking, gagging during meal, eating bread with crust, accepting teeth brushing, keeping tongue in mouth, lip closure while eating, lateral tongue movements, and drooling

(Continued)

TABLE 2 (Continued)

Authors, citation	Country	Study design	Preterm sample characteristics	Age group	Term comparison?	Outcomes assessed	Measures
Dodrill et al. (26)	Australia	Cross-sectional	n = 20 infants born at between 32 and 37 weeks of gestation. Infants living within a 50-km radius of the study hospital were recruited from the hospital database at 11–17 mo CA. Excluded if any history of structural lesions to the swallowing mechanism; or respiratory, cardiac, gastrointestinal, or neurologic conditions	>12 mo–7 y	n = 10 infants born at >37 weeks of gestation were recruited using noticeboards in childcare centers and playgroups within a 50-km radius of the hospital. Matched to preterm infants on gender and CA at assessment	Oromotor eating skills and eating behaviors	Observations using the Royal Children's Hospital OSC and the PSAS. The OSC measures 1) child's facial defensiveness and 2) oral sensitivity indicated by response to stimulation in the oral region. The PSAS provides a rating of a child's functional feeding abilities. Each subset of the PSAS lists a variable number of rankings based on normal developmental milestones
Duran et al. (27)	Turkey	Cross-sectional	n = 79 children born at 32–36.6 weeks of gestation and treated in the recruiting hospital's NICU. Infants were excluded if they had major structural or chromosomal anomalies. Infants were followed up at 2 y CA	>12 mo–7 y	n = 79 infants born at 37–41.6 weeks of gestation at the same hospital and treated in the NICU over the same time frame. Term-born infants were also excluded if they had structural or chromosomal abnormalities	Oromotor eating skills and eating behaviors Dietary patterns	The Children's Eating Difficulties Questionnaire (CEDQ) was used to assess neophobia, pickiness, low appetite, and low enjoyment of food. Frequency of vegetable, fruit, meat, fish, ready meals, desserts, cereals, potatoes, milk, and cheese consumption over previous month (parent report)
Ericson et al. (54)	Sweden	Prospective cohort	n = 281 infants born at <37 weeks of gestation recruited from 6 NICUs 48 h after birth. Born to mothers who provided breast milk regardless of amount or method. Excluded if terminally ill, transferred, or where language barriers existed. Followed at 6 and 12 mo postnatal age	6–12 mo	No	Dietary patterns	Parental report of breastfeeding duration by telephone call and mailed surveys. Exclusive breastfeeding defined as feeding with breast milk only regardless of feeding method (eg, breast, bottle, tube, or cup) in previous 24 h. Partial breastfeeding was defined as feeding with breast milk in combination with formula and/or solid food in previous 24 h

(Continued)

TABLE 2 (Continued)

Authors, citation	Country	Study design	Preterm sample characteristics	Age group	Term comparison?	Outcomes assessed	Measures
Ernst et al. (55)	USA	Prospective cohort	n = 122 infants born at ≤35 weeks of gestation, weighing <1500 g, and admitted to the NICU at <48 h of age. Feeding information was collected among n = 89 infants at term, 3, 6, 9, and 12 mo postnatal age	6–12 mo	No	Dietary patterns	During interview with Registered Dietitian, parents were asked the child's age at introduction to solid foods, cow milk introduction, when chopped table foods were introduced, and the types of foods that were introduced at each time
Flacking et al. (56)	Sweden	Prospective cohort	n = 2093 infants born singletons at ≤37 weeks of gestation identified from the Child Health Centre registers on breastfeeding in Örebro and Uppsala counties with data in the Medical Birth Registry in Sweden. Followed at 2, 4, 6, 9, and 12 mo postnatal age	6–12 mo	n = 35,250 infants born singletons at >37 weeks of gestation also with data both in the same Child Health Centre registers and in the Medical Birth Registry in Sweden	Dietary patterns	Mothers were asked at each visit to the Community Health Centre whether their infant was being breastfed (exclusively or partially)
Forcada-Guex et al. (28)	Switzerland	Prospective cohort	n = 47 infants born at <34 weeks of gestation and admitted to the NICU over a 12-mo period at a university hospital. Followed at 6 and 18 mo CA. Same sample as Pierrehumbert et al. (32)	6–12 mo and >12 mo–7 y	n = 25 infants born at >37 weeks of gestation recruited from the maternity ward in the same hospital	Oromotor eating skills and eating behaviors	At 6 mo CA, mother–infant 10-min play interactions were coded using the Care Index by 2 blinded, independent coders to assess the mother's (sensitivity, control, and unresponsiveness) and the child's (cooperation, compliance, difficulty, and passivity) interactional behavior. At 18 mo CA, The SCL was completed by a semistructured interview with the mother. The SCL focuses on eating problems (refusal to eat, meal as a negative experience, vomiting, and the overall consequence of these problems)

(Continued)

TABLE 2 (Continued)

Authors, citation	Country	Study design	Preterm sample characteristics	Age group	Term comparison?	Outcomes assessed	Measures
Francis et al. (9)	Canada	Prospective cohort	n = 300 infants born weighing < 1500 g, admitted to the NICU, and expected to begin enteral feeding within 7 d of birth. Infants with chromosomal abnormalities, severe birth asphyxia, or who were transferred to a nonparticipating NICU were excluded. Same sample as McGee et al. (57)	6–12 mo	No	Dietary patterns	Parents were contacted by telephone monthly after discharge from the NICU and were asked whether they were providing mother's milk, infant formula, or cow milk and the frequency of provision. If mother's milk was discontinued, they were asked to recall the last date provided. Date solid foods were introduced was also collected
Gibson and DeWolfe (58)	Canada	Prospective cohort	n = 33 infants (mean birth weight: 1800 g; mean gestational age: 33 wk). Infants were followed at 1, 3, 6, and 12 mo of age	6–12 mo	n = 29 infants born at between 38 and 42 weeks of gestation and weighing > 2500 g were recruited from the same hospital	Dietary patterns	At 6 and 12 mo, 3-d food records were used to assess infants' diets
Hawdon et al. (59)	United Kingdom	Prospective cohort	n = 35 infants admitted to the NICU at University College London Hospital over a 3-mo period and followed up at 6 and 12 mo	6–12 mo	No	Oromotor eating skills and eating behaviors Food parenting Dietary patterns	A feeding assessment by a trained observer using the Neonatal Oral Motor Assessment Scale to categorize infants as normal, disorganized, or dysfunctional feeders. At 6 and 12 mo of age, parents were interviewed about breastfeeding; age at introduction to solids; food eaten; coughing, spitting, or vomiting during drinking or solid feeds; both the parent's and infant's enjoyment of feeding; feeding environment; and concerns about feeding
Hill (60)	USA	Prospective cohort	n = 120 infants born at between 20 and 32 weeks of gestation and weighing < 1500 g.	6–12 mo	No	Oromotor eating skills and eating behaviors	Parents completed the Pediatric Assessment Scale for Severe Feeding Problems to assess progress and development of oral eating skills

(Continued)

TABLE 2 (Continued)

Authors, citation	Country	Study design	Preterm sample characteristics	Age group	Term comparison?	Outcomes assessed	Measures
Holditch-Davis et al. (61)	USA	Cross-sectional	<p>Infants were born to English-speaking mothers who could attend follow-up at 2, 4, 6, and 12 mo of age. Excluded if infant had craniofacial abnormalities</p> <p>n = 29 infants born weighing <1500 g and/or mechanically ventilated in the NICU</p>	6–12 mo	No	<p>Oromotor eating skills and eating behaviors</p> <p>Food parenting</p>	<p>Mother–child interactions were observed over the span of 1 h during feeding and nonfeeding interactions by a single observer when infants were 6 mo of age. The coding scheme was developed for the study and examined both maternal (e.g., feeding, playing, talking, touching, positive affect) and child (e.g., movement, vocalization, positive affect, playing, self-feeding, interactive states, alertness) behaviors</p>
Hoogewerf et al. (62)	Netherlands	Prospective cohort	<p>n = 251 infants born at <36 weeks of gestation admitted to the NICU for ≥4 d. Infants with chromosomal abnormalities were excluded</p>	>12 mo–7 y	<p>n = 127 born at between 37 and 42 weeks of gestation and treated in the NICU over the same time. Same exclusion criteria.</p> <p>A reference population of n = 771 term-born, healthy Dutch children who were between 8 and 30 mo old at the time of assessment was also included to compare the NICU sample (preterm and term-born infants treated in the NICU) with the healthy term-born sample</p>	<p>Oromotor eating skills and eating behaviors</p>	<p>When infants were 1–2 y of age, parents completed the 14-item SEP, a Dutch translation of the Montreal Children's Hospital Feeding Scale which examines both oromotor and behavioral eating challenges</p>

(Continued)

TABLE 2 (Continued)

Authors, citation	Country	Study design	Preterm sample characteristics	Age group	Term comparison?	Outcomes assessed	Measures
Howe et al. (29)	Taiwan	Cross-sectional	n = 239 children born at <37 weeks of gestation and weighing <1500 g attending NICU follow-up appointments at a large urban hospital. Children were recruited for the study when they were <2 y of age	6–12 mo and >12 mo–7 y	n = 181 children born at >37 weeks of gestation and recruited from well-baby visits at the same hospital	Oromotor eating skills and eating behaviors Dietary patterns	Child eating behaviors/skills were measured by the Behavior Based Feeding Questionnaire (parent-report), which assesses feeding endurance, Gastrointestinal-related issues, muscle tone, oral motor function, respiration/sensory regulation, and frequency and duration of feeding. Parents also reported duration of breastfeeding and types of foods fed to child at introduction to solids
Hubl et al. (63)	Germany	Prospective cohort	n = 40 infants born at between 24 and 34 weeks of gestation. Infants were excluded if they had congenital malformations, chromosomal abnormalities, or acute illness or had not started oral feeds by 34 wk. Assessments were conducted at 6, 9, 12, and 24 mo PMA	6–12 mo and >12 mo–7 y	No	Oromotor eating skills and eating behaviors Dietary patterns	Children's eating behaviors/skills were measured by observation by 2 independent observers using the Neonatal Oral Motor Assessment Scale at 34, 37, and 44 wk PMA; the Observation List Spoon Feeding (OSF) at 6, 9, and 12 mo PMA; and the Mastication Observation and Evaluation Instrument (MOE) at 9, 12, and 24 mo PMA
Husk and Keim (64)	USA	Cross-sectional	n = 189 children participating in 1 of 2 ongoing clinical trials. All children had been previously admitted to the NICU or scheduled for a neonatal follow-up appointment. Children in trial 1 were born at ≤29 weeks of gestation and in trial 2 at ≤35 weeks of gestation. Data for the current study were collected when infants were 1–3 y of age	>12 mo–7 y	No	Dietary patterns	Parents completed the Harvard Semi-quantitative FFQ which examines food intake over the last month. Parents also reported breastfeeding duration

(Continued)

TABLE 2 (Continued)

Authors, citation	Country	Study design	Preterm sample characteristics	Age group	Term comparison?	Outcomes assessed	Measures
Johnson et al. (65)	United Kingdom	Prospective cohort	n = 628 infants born at between 32 and 36.6 weeks of gestation to mothers living in the East Midlands (England). Excluded if major structural or chromosomal abnormalities including cardiovascular malformations and neurosensory impairments. Assessed at 2 y of age	>12 mo–7 y	n = 759 infants born at 37.0–42.6 weeks of gestation were recruited during the same time and from the same geographical region. Term infants were selected by random sampling of dates/times in computerized birth records during the previous year	Oromotor eating skills and eating behaviors	Children's eating behaviors/skills were measured using a questionnaire previously validated by the group (parent report). Questionnaire assessed the presence of eating difficulties across 4 domains: 1) refusal/picky; 2) oral motor problems; 3) oral hypersensitivity; 4) eating behavior problems (tantrums or makes a mess during meal). Scores at the 90th percentile of term-born scores were used to identify clinically significant eating difficulties overall
Jonsson et al. (66)	Sweden	Prospective cohort	n = 27 infants born at between 28 and 33 weeks of gestation and cared for in the Umeå University Hospital. At the time of assessment, infants were aged 34–42 mo	>12 mo–7 y	n = 29 healthy infants born at between 38 and 41 weeks of gestation. Matched to preterm infants on gender and birth date (within 3 d)	Oromotor eating skills and eating behaviors Dietary patterns	Parents reported their child's eating habits on a questionnaire developed by the authors. Parents were also asked to report on their experiences with mealtimes from hospital discharge through to introduction to solids
Kirk et al. (67)	Rwanda	Cross-sectional	n = 86 infants born at <37 weeks of gestation and weighing <2000 g, identified in patient registers. Excluded if they had genetic dysmorphologies, congenital heart disease, or birth asphyxia. Assessed at 17.5–30.5 mo of age	>12 mo–7 y	No	Oromotor eating skills and eating behaviors	Child eating skills were measured by parental report on a questionnaire developed for the study. Parents were asked whether the child displayed any eating difficulties including choking, coughing, or gagging
Kmita et al. (68)	Poland	Prospective cohort	n = 40 infants born at <35 weeks of gestation. Secondary data analysis, infants were included if	6–12 mo	No	Oromotor eating skills and eating behaviors Dietary patterns	Mothers and fathers were interviewed together when infants were 1, 4, 6, and 12 mo CA using a semistructured interview developed for the study.

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TABLE 2 (Continued)

Authors, citation	Country	Study design	Preterm sample characteristics	Age group	Term comparison?	Outcomes assessed	Measures
Litt et al. (69)	USA	Prospective cohort	they had full data and both the mother and father participated. Exclusion criteria included having a teenage parent and being born with a congenital malformation or genetic syndrome n = 50 infants born singletons at ≤ 35 weeks of gestation recruited from an academic hospital. Excluded if parents did not speak/read English or child was in foster care. Infants were followed up at 1, 3, and 6 mo of age	6–12 mo	No	Oromotor eating skills and eating behaviors	Questions were related to concerns about child's eating behaviors and skills as well as breastfeeding Feeding Difficulty Scale (parent report). Scores from the 17 items represent 6 domains related to appetite, oromotor skills, avoidant eating behaviors, and family distress related to the child's eating to create an overall composite score
Mathisen et al. (70)	Australia	Cross-sectional	n = 20 infants born at 23–29 weeks of gestation weighing <1000 g. Recruited through the Growth and Development clinic at 2 hospitals in Brisbane. Excluded if they had intraventricular hemorrhage, necrotizing enterocolitis, bronchopulmonary dysplasia, chromosomal abnormalities, were born small for gestational age, or were still receiving supplemental oxygen at the time of recruitment	6–12 mo	n = 20 infants born at >38 weeks of gestation were recruited from well-baby visits at the same hospitals. Term infants were matched to preterm infants on age, race, gender, and SES and excluded if they had a history of feeding problems, reflux, or neurologic impairments. Infants had to be eating solids for ≥ 2 wk at time of recruitment	Oromotor eating skills and eating behaviors Food parenting Dietary patterns	Infant Feeding Questionnaire (maternal report) which asks about maternal enjoyment, anxiety, and special concerns regarding the feeding of the infant. Direct observation using The Feeding Environment Checklist to assess contextual features such as lunch timing, light, noise, distraction, and the suitability of positioning and the food and equipment used to feed the infant. The Feeding Assessment Schedule (FAS) and SOMA assessed oromotor skills

(Continued)

TABLE 2 (Continued)

Authors, citation	Country	Study design	Preterm sample characteristics	Age group	Term comparison?	Outcomes assessed	Measures
McComish (71)	USA	Prospective cohort	n = 42 African-American infants born at <35 weeks of gestation and weighing <1500 g or requiring mechanical ventilation. Exclusion criteria: congenital neurologic problems, substance exposure, hospitalized for >2 mo postterm, mothers <15 y old with substance abuse challenges, who did not have custody of the infant, had history of a mental health diagnosis, or did not speak English	6–12 mo	No	Oromotor eating skills and eating behaviors	Children's eating skills were measured by observation using a modified version of the SOMA. Mealtime communication "red flags" (e.g., lack of infant engagement, responding, vocalizing, or imitating) and oral motor "red flags" (e.g., choking, coughing, or gagging; liquid or food loss; panic reactions) during feeding interactions were coded
McGee et al. (57)	Canada	Cross-sectional	n = 158 children born at <37 weeks of gestation and weighing <1500 g. This was a 5.5-y follow-up of a previous RCT. See Francis et al. (9)	>12 mo–7 y	No	Dietary patterns	At 5.5 y of age, diet quality [Healthy Eating Index (HEI)-2010] and usual intakes of fruits and vegetables and added sugars were determined from 2 dietary recalls analyzed using the Automated Self-Administered 24-hour (ASA24®) Dietary Assessment Tool
Menezes et al. (22)	Brazil	Cross-sectional	n = 38 infants born at <37 weeks of gestation recruited from an outpatient clinic following high-risk newborns. Infants with craniofacial malformations, heart disease, and severe respiratory diseases that prevented them from eating safely or infants with oropharyngeal or esophageal dysphagia were excluded. Infants were 6 mo–2 y old at time of data collection	6–12 mo and >12 mo–7 y	No	Oromotor eating skills and eating behaviors Dietary patterns	Structured interview developed for the study (parent report) on child's behavior and oromotor skills. An affirmative response to any item on the checklist was considered to indicate eating difficulty. For the food refusal item, if the infant presented a refusal at any meal of the day during the last month, it was considered difficulty in the introduction of complementary feeding. Parents also reported on breastfeeding duration

(Continued)

TABLE 2 (Continued)

Authors, citation	Country	Study design	Preterm sample characteristics	Age group	Term comparison?	Outcomes assessed	Measures
Milton and King (72)	United Kingdom	Prospective cohort	n = 169 infants born at <34 weeks of gestation and admitted to an NICU. Infants were between 12 and 18 mo old at the time of data collection	>12 mo–7 y	No	Oromotor eating skills and eating behaviors Dietary patterns	Parents completed a questionnaire that asked about age at cup introduction, frequency of cup and bottle use, types of drinks consumed, cups used, and vitamin supplements given. Appropriateness of vitamin use was assessed by examining combination of cow milk provision, formula provision, and supplementation use Mothers completed the Children's Eating Difficulties Questionnaire. Children in the upper 2 quintiles for each of the 2 overall dimensions were defined as having eating disorders. Mothers also completed an FFQ. Children's preferences for each food on the FFQ were assessed on a 4-point Likert scale (1 = child turns head away/spits out; 4 = child accepts food/asks for more)
Migraine et al. (30)	France	Prospective cohort	n = 234 infants born at <33 weeks of gestation. At follow-up, infants were 2 y of age. Same sample as Amarger et al. (42)	>12 mo–7 y	n = 245 infants were participating in a different RCT (Opaline trial) where mothers were recruited before delivery through advertisements in maternity waiting rooms	Oromotor eating skills and eating behaviors Dietary patterns	Children reported their children's eating behaviors/skills on the Children's Feeding Disorder Questionnaire. The questionnaire examines eating behaviors, eating tension, physical eating challenges, food variety, and mother's satisfaction with child eating
Mokhlesin et al. (73)	Iran	Retrospective cohort	n = 38 children born at between 28 and 32 weeks of gestation. Those with oral or neurologic problems or whose mothers had depression or other psychological problems were excluded. Children were 2 y old at the time of assessment	>12 mo–7 y	n = 38 two-year-old children born at between 38 and 41 weeks of gestation, recruited from the same hospital by random sampling, and matched to preterm infants on age, gender, SES, and maternal education level	Oromotor eating skills and eating behaviors	Parents reported their children's eating challenges on the 14-item SEP, a Dutch translation of the Montreal Children's Hospital Feeding Scale
Nieuwenhuis et al. (74)	Netherlands	Cross-sectional	n = 35 children born before 32 weeks of gestation admitted to the NICU. At the time of	>12 mo–7 y	n = 248 infants born at >37 weeks of gestation recruited from local health care	Oromotor eating skills and eating behaviors	Parents reported their children's eating challenges on the 14-item SEP, a Dutch translation of the Montreal Children's Hospital Feeding Scale

(Continued)

TABLE 2 (Continued)

Authors, citation	Country	Study design	Preterm sample characteristics	Age group	Term comparison?	Outcomes assessed	Measures
Park et al. (31)	USA	Cross-sectional	assessment, children were 3 y of age n = 256 children born at <37 weeks of gestation. Parents of children with and without feeding problems were recruited from a variety of sources including feeding clinics, online parent support groups, and research registries. Children were between the ages of 6 mo and 7 y at the time of data collection	6–12 mo and >12 mo–7 y	centers. Exclusion criteria: mothers had severe complications during pregnancy, born by emergency cesarean delivery, resuscitated at birth, tube fed, or had any congenital anomalies and syndromes n = 979 children born at ≥37 weeks of gestation recruited using the same methods. Exclusion criteria included if the child had any language or development delay; hearing or vision impairment; structural abnormality of the mouth, face, or gastrointestinal tract; or significant health conditions (e.g., congenital heart disease, autism, cerebral palsy)	Oromotor eating skills and eating behaviors	which examines both oromotor and behavioral eating challenges Parents reported their children's eating behaviors and skills using the PediEAT. PediEAT is a 78-item questionnaire with 4 subscales: Physiologic Symptoms (27 items), Problematic Mealtime Behaviors (23 items), Selective/Restrictive Eating (15 items), and Oral Processing (13 items)
Philip and Vijay Kumar (75)	India	Cross-sectional	n = 25 infants born at between 30 and 34 weeks of gestation with a birth weight appropriate for gestational age. Excluded if they had any craniofacial abnormalities. Infants were 6 mo CA at time of data collection	6–12 mo	n = 25 term infants born with an appropriate birth weight and without craniofacial abnormalities or any neurologic, cardiologic, or vital organ issues	Oromotor eating skills and eating behaviors	Questionnaire developed for the study (parent report) asking about child's feeding history, current eating status, age of solid food introduction, current eating behavior, eating difficulties, and duration of meals

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TABLE 2 (Continued)

Authors, citation	Country	Study design	Preterm sample characteristics	Age group	Term comparison?	Outcomes assessed	Measures
Pierrehumbert et al. (32)	Switzerland	Prospective cohort	n = 50 infants born at <33 weeks of gestation and admitted to an NICU. Excluded if any malformations, chromosomal abnormalities, fetopathy, neurodevelopmental complications, parental psychiatric illness and/or drug abuse, or their parents had difficulty speaking French. Same sample as Forcada-Guex et al. (28)	>12 mo–7 y	n = 25 term infants were recruited from the maternity ward of the same hospital. Infants were excluded if there were any problems during pregnancy or delivery, the infant had somatic abnormalities, or the parents had psychiatric problems or language difficulties	Oromotor eating skills and eating behaviors	At 18 mo, the SCL was completed by a semistructured interview with the infant's mother
Pridham et al. (33)	USA	Cross-sectional	n = 47 born at <32 weeks of gestation with weight appropriate for gestation and a history of lung disease. Infants were recruited from 3 NICUs in a Midwestern city. Infants with congenital or medical conditions that could interfere with oral intake (e.g., heart defect or gastrointestinal system defect requiring surgery) were excluded or if their mothers were <17 y of age, not able to read English, or were not involved in care. Followed up at 12 mo postnatal age. Same sample as other Pridham et al. articles (76, 77)	6–12 mo	n = 52 full-term infants were recruited from family practice clinics, a pediatric primary care clinic, and a Women, Infants and Children (WIC) clinic in the area	Oromotor eating skills and eating behaviors Food parenting	The Parent-Child Early Relational Assessment tool was used to observed child eating behaviors and food parenting. This tool assesses both positive (e.g., responsiveness) and negative affect (e.g., avoiding or averting behavior) behaviors of the infant during feeding as well as the positive (e.g., warmth) and negative (e.g., frustration) affect of the mother during feeding

(Continued)

TABLE 2 (Continued)

Authors, citation	Country	Study design	Preterm sample characteristics	Age group	Term comparison?	Outcomes assessed	Measures
Pridham et al. (76)	USA	Prospective cohort	n = 45 infants born singletons and weighing <1250 g and without medical complications. See other Pridham et al. articles (33, 77)	6–12 mo	No	Oromotor eating skills and eating behaviors Food parenting	Mother–infant dyads were observed during feeding interactions. Infant eating skills were measured on the Child Feeding Skills Checklist, which was created for the study to quantify skills observed during the observation or reliably reported by the mother. Mother–infant interactions were coded by the Parent-Child Early Relational Assessment tool Maternal food parenting was observed using the Parent-Child Early Relational Assessment tool. Mothers' feeding competencies were structured into 2 factors: Parental Positive Affective Involvement, Sensitivity, and Responsiveness (PPAISR; e.g., warmth toward infant) and Parental Negative Affect and Behavior (PNAB; e.g., ability to regulate negative tone toward infant)
Pridham et al. (77)	USA	Prospective cohort	n = 41 infants born at <32 weeks of gestation and with a weight appropriate for their gestational age. See the previous Pridham et al. (33, 76) studies. In the current study, infants were followed up at 1 and 8 mo of age	6–12 mo	No	Food parenting	Maternal food parenting was observed using the Parent-Child Early Relational Assessment tool. Mothers' feeding competencies were structured into 2 factors: Parental Positive Affective Involvement, Sensitivity, and Responsiveness (PPAISR; e.g., warmth toward infant) and Parental Negative Affect and Behavior (PNAB; e.g., ability to regulate negative tone toward infant)
Ribas et al. (78)	Brazil	Cross-sectional	n = 108 infants born VLBW and at <32 weeks of gestation. Infants were followed up at 2 y CA from a specialized outpatient clinic. Exclusion criteria included conditions that affect fetal growth or situations that may interfere with anthropometric and dietary parameters (e.g., major malformations, chromosomal disorders) as well as missing dietary records after introduction of solids	6–12 mo and > 12 mo–7 y	No	Dietary patterns	Dietary data were collected from 24-h recalls completed during clinic visits between 4 and 24 mo CA. Data on type and time of exclusive and total breastfeeding and composition of complementary foods were also collected. Diet quality was assessed using a tool created by the authors, the IMQCF, which is based on the Brazilian Food Guide for children aged <2 y. The IMQCF has 9 items which are scored from the 24-h recalls providing an overall score out of 100; higher scores indicate higher diet quality

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TABLE 2 (Continued)

Authors, citation	Country	Study design	Preterm sample characteristics	Age group	Term comparison?	Outcomes assessed	Measures
Saleska et al. (79)	USA	Cross-sectional	n = 331 children born at <35 weeks of gestation and enrolled into the Omega-Tots RCT. Children were mean (SD) 15.1 (1.7) mo CA at baseline. Only data from the 60-d time point are used in the current study	6–12 mo and >12 mo–7 y	No	Food parenting	Chadn
Salvatori et al. (34)	Italy	Prospective cohort	n = 27 infants born at ≤32 weeks of gestation or with a birth weight < 1500 g. Excluded if major cerebral damage (intraventricular hemorrhage > III or IV grade), periventricular leukomalacia, retinopathy of prematurity, and hydrocephalus or genetic syndrome, if parent had a past/present psychiatric history, neurologic disorders, disordered eating, or was not fluent in Italian. Measured at 18 and 24 mo of age	>12 mo–7 y	n = 20 term-born infants were recruited from preschools in the same area. Excluded if they had birth complications, cerebral damage, disabilities, or genetic syndromes	Oromotor eating skills and eating behaviors Food parenting	The Feeding Scale—Italian version (direct observation; blinded by birth group), which assesses mother and child dysfunctional behaviors during the meal via 46 items across 4 dimensions: Affective State of the Mother (e.g., presence of sadness, anger, distress), Interactional Conflict (e.g., forcing child to eat), Food Refusal Behavior of the Child (e.g., spitting out food), and Affective State of the Dyad (e.g., level of reciprocity, mother not supporting child's autonomy)
Samara et al. (80)	United Kingdom and Ireland	Cross-sectional	n = 223 children born at ≤25.6 weeks of gestation and known to be alive at 30 mo of age owing to their participation in the EPICure study [see Wood et al. (81)]. Children were 6 y of age	>12 mo–7 y	n = 148 age- and sex-matched term-born children were recruited from mainstream schools	Oromotor eating skills and eating behaviors	Questionnaire developed for the study (parent report) assessing problems related to food refusal/faddy eating (e.g., refuses food; 7 items), oral-motor problems (e.g., dribbles when drinking; 6 items), oral hypersensitivity (e.g., does not like things put in mouth; 2 items), and behavioral problems during meals (e.g., makes a mess, has tantrums; 4 items)

(Continued)

TABLE 2 (Continued)

Authors, citation	Country	Study design	Preterm sample characteristics	Age group	Term comparison?	Outcomes assessed	Measures
Sanchez et al. 2016 (82) and 2017 (83)	Australia	Prospective cohort	n = 90 infants born at <30 weeks of gestation. Infants with congenital abnormalities known to affect neurodevelopment or non-English-speaking parents were excluded. Infants were followed until 12 mo CA. Same sample as Sanchez et al. (5)	6–12 mo	n = 137 term infants recruited from the maternity wards in the same hospitals over the same time period. The same exclusion criteria were applied	Oromotor eating skills and eating behaviors	At 12 mo of age, infant eating skills were measured by observation using the SOMA tool
Sanchez et al. (5)	Australia	Prospective cohort	n = 111 children born at <30 weeks of gestation. Infants with congenital abnormalities known to affect neurodevelopment or non-English-speaking parents were excluded. Infants were followed until 36 mo CA. See other Sanchez et al. studies (82, 83)	>12 mo–7 y	n = 106 term infants were recruited from the maternity wards in the same hospitals over the same time period. The same exclusion criteria were applied	Oromotor eating skills and eating behaviors Food parenting	BPFAS (parent report). The BPFAS consists of 35 questions related to child eating (eg, takes longer than 20 min to finish a meal; enjoys eating; has problems chewing foods) and food parenting behaviors (eg, I get frustrated and/or anxious when feeding my child; I feel confident my child gets enough to eat)
Sauve and Geggie (84)	Canada	Prospective cohort	n = 118 infants born in Alberta weighing <1500 g or requiring mechanical ventilation during initial hospitalization. All birth weights were appropriate for gestational age. Infants with evidence of chronic lung disease were excluded. Infants were followed from 4 to 24 mo CA	6–12 mo and >12 mo–7 y	n = 114 term infants matched to preterm infants on age, sex, and year of birth recruited from well-baby visits over the same time period. Term infants had to be born at a birth weight appropriate for their gestational age	Oromotor eating skills and eating behaviors	Parents reported on their infants' eating behaviors and skills during a structured interview at each time point. Details of the questions asked were not provided. Eating problems were considered present only if they were a major concern to parents or if they led to some form of therapy or investigation

(Continued)

TABLE 2 (Continued)

Authors, citation	Country	Study design	Preterm sample characteristics	Age group	Term comparison?	Outcomes assessed	Measures
Silberstein et al. (85)	Israel	Prospective cohort	n = 76 low-risk infants born preterm at <36 weeks of gestation. Recruited within the first 2 wk of life from a tertiary NICU. Excluded if intraventricular hemorrhage (grade 3 and 4); perinatal asphyxia; metabolic, genetic, or syndromic disease; or if parents met any psychosocial criteria: teenage pregnancy, single parenthood, or unemployment of both parents. Followed for the first 12 mo of life	6–12 mo	No	Oromotor eating skills and eating behaviors Food parenting	Structured interview (parent report) at 12 mo, about children's eating behaviors, mealtime environment (e.g., where meals are eaten, screen use), rules (e.g., routines), picky eating, feeding interaction, and maternal/child enjoyment during meals. Direct observation of mother-child feeding interactions at 12 mo using the Coding of Interactive Behavior-Newborn tool, which assesses mother's touch, gaze to infant, and infant feeding performance and maternal adaptation (e.g., degree to which the mother adjusts to infant signals)
Singer et al. (85)	USA	Prospective cohort	n = 171 infants born at <36 weeks of gestation weighing <1500 g. Infants were divided into high risk (lung concerns; n = 103) and low risk (no lung concerns; n = 68). Excluded if evidence of drug exposure, major congenital malformations, mothers with psychiatric or physical illness, HIV, mental disabilities, or if living >2 h from hospital. Followed at term, 8, and 12 mo CA	6–12 mo	n = 117 infants born at >36 weeks of gestation weighing >2500 g from the newborn nurseries at the same hospital. Infants were included if they had no diagnosis of medical abnormalities or illness at birth. The same exclusion criteria applied	Oromotor eating skills and eating behaviors Food parenting	Direct observation using the NCFAS. The NCFAS includes 76 dichotomous items to quantify the presence or absence of parent or infant behaviors including parent "Sensitivity to Cues," "Response to Distress," "Social-emotional Growth Fostering," "Cognitive Growth Fostering," and Infant's behaviour ("Responsivity to Parent" and "Clarity of Cues")

(Continued)

TABLE 2 (Continued)

Authors, citation	Country	Study design	Preterm sample characteristics	Age group	Term comparison?	Outcomes assessed	Measures
Steinberg et al. (23)	Brazil	Cross-sectional	n = 62 infants born preterm without metabolic diseases or medical diagnosis of neuropathies, syndromes, craniofacial malformations, heart disease, or severe respiratory disease that prevented safe oral eating. Infants were recruited from an outpatient high-risk infant follow-up clinic if <24 mo CA and had started solid foods	6–12 mo and >12 mo–7 y	No	Oromotor eating skills and eating behaviors Food parenting Dietary patterns	Checklist (maternal report) of infant's defensive behaviors during mealtimes (e.g., arching back, crying, mealtimes lasting ≥40 min, texture/food selectivity, food refusal, difficulty chewing or swallowing). Oromotor skills observed by an adapted version of the Protocol for Pediatric Dysphagia (PAD-PED) while mother fed infant. Parent report of feelings of difficulty feeding child and age of infant at introduction of solids
Weber and Harrison (36)	USA	Prospective cohort	n = 61 infants born at <32 weeks of gestation with respiratory distress syndrome. All birth weights were appropriate for gestational age. Excluded if infants had physiological conditions that could interfere with eating or digestion, if mothers didn't speak English, or if mothers were <18 y old. Followed at 1, 4, 8, and 12 mo CA	6–12 mo	n = 53 healthy infants born at 38–42 weeks of gestation with Apgar scores ≥7 at 1 min and >9 at 5 min and no medical complications during hospitalization. Recruited from the same hospital	Oromotor eating skills and eating behaviors Food parenting	Direct observation using the Child Feeding Skills Checklist, which is based on the presence of 4 subsets of skills (oral-motor, hand-eye, head/trunk, and communicative-social) at 1, 4, 8, and 12 mo. Direct observation using the Parent-Child Early Relational Assessment tool. Only the PNAB scale was used
Wood et al. (81)	United Kingdom and Ireland	Prospective cohort	n = 283 infants born at ≤25 weeks of gestation. Infants were excluded if they had lethal congenital abnormalities. Data collected at 30 mo CA. Same sample as Samara et al. (80)	>12 mo–7 y	No	Oromotor eating skills and eating behaviors	Semistructured interview (parent report) about child's eating behaviors and skills including swallowing issues and food refusal

(Continued)

TABLE 2 (Continued)

Authors, citation	Country	Study design	Preterm sample characteristics	Age group	Term comparison?	Outcomes assessed	Measures
Yatziv et al. (86)	Israel	Prospective cohort	n = 70 infants born singletons at between 28 and 34 weeks of gestation with a birth weight > 1000 g and low medical risk on the Nursery Neurobiological Risk Score. All infants were born to 2-parent Hebrew-speaking homes. Data collected at 6 and 12 mo CA	6–12 mo	n = 64 infants born at > 37 weeks of gestation were recruited from maternity wards in the same medical center. The same inclusion and exclusion criteria applied	Food parenting Dietary patterns	"Pressure to eat" and "Concern about child undernourishing or becoming underweight" subscales of the Child Feeding Questionnaire (parent report at 6 mo CA). Mothers reported if they breastfed their infants at 6 mo CA and the duration at 12 mo CA. Direct observation using the Mother-Infant/Toddler Feeding Scale at 12 mo CA
Zimmerman and Rosner (24)	USA	Cross-sectional	n = 37 infants born preterm by (mean ± SD) 2.47 ± 1.70 wk. Recruited by convenience using study flyers, social media, and pregnancy-related groups. Exclusion criteria: nonmother caregivers or children older than 3 y	6–12 mo and > 12 mo–7 y	n = 167 term-born infants were recruited by the same methods	Oromotor eating skills and eating behaviors	Online questionnaire developed for the study (parent report). Eating difficulties were categorized if children were reported to have ≥ 1 of the following: difficulties in sucking, difficulties in food transitions, gastroesophageal reflux, food selectivity, salivary control issues, or poor growth

¹n = 67 articles, 57 unique studies. BPFAS, Behavioural Pediatrics Feeding Assessment Scale; CA, corrected age; IMQCF, Index for Measuring the Quality of Complementary Feeding; LBW, low birth weight; NCFAS, Nursing Child Assessment Feeding Scale; NICU, neonatal intensive care unit; OSC, Oral Sensitivity Checklist; PNAB, Parental Negative Affect and Behavior Scale; PediEAT, Pediatric Eating Assessment Scale; PMA, postmenstrual age; RCT, Randomized controlled trial; PSAS, Pre-Speech Assessment Scale; SCL, Symptoms Checklist; SEP, Screeningslijst Eetgedrag Peuters; SES, socioeconomic status; SOMA, Schedule for Oral Motor Assessment; VLBW, very low birth weight (< 1500 g).

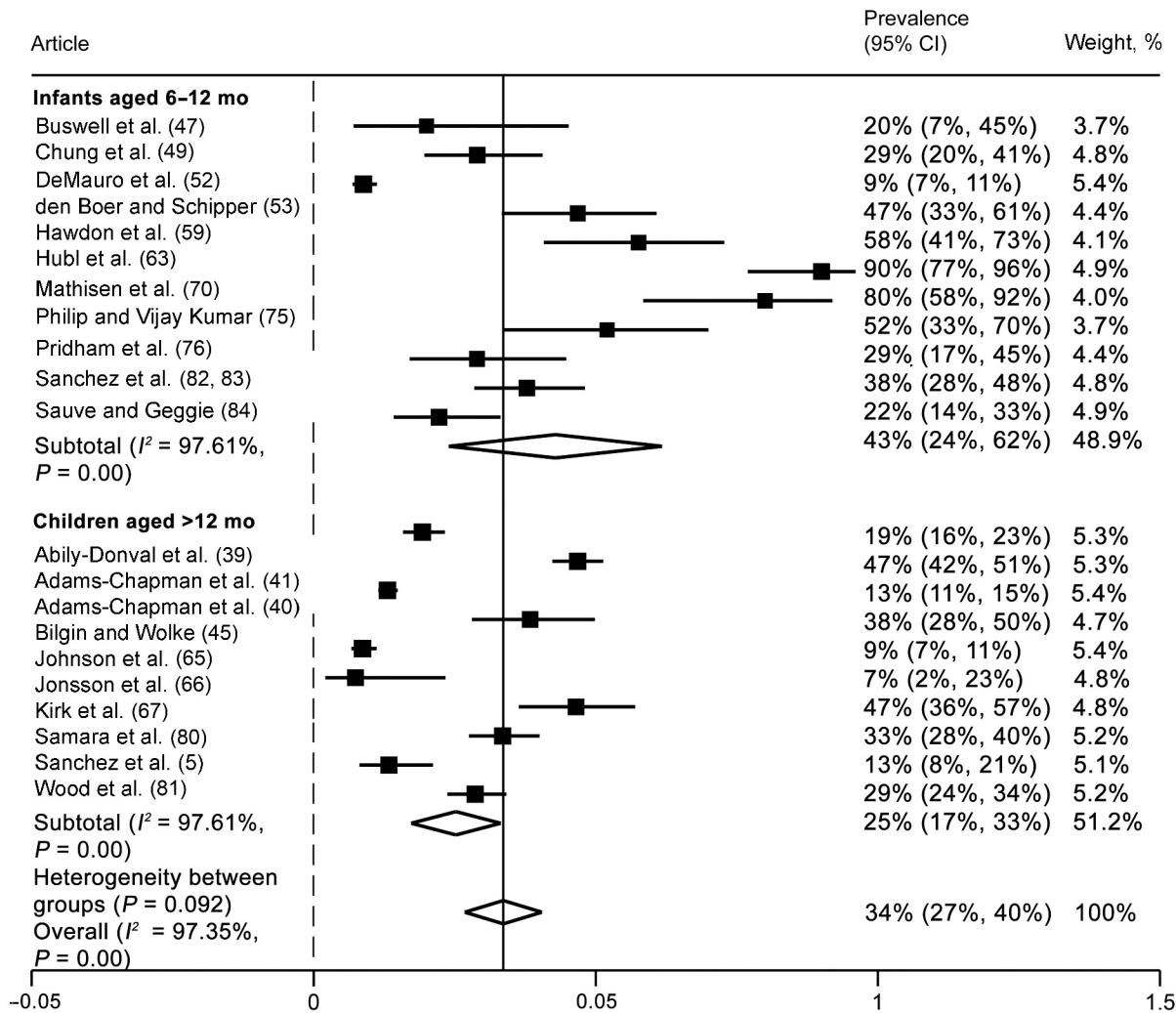


FIGURE 2 Prevalence of oromotor eating difficulties among infants and children born preterm. Random-effects meta-analysis of proportions using a maximum likelihood estimator. Results are expressed as prevalence (95% CI). The weighting for each study is the inverse of the total variance. I^2 = the percentage of variation across studies that is due to heterogeneity rather than chance. Values of 25%, 50%, and 75% were considered as low, moderate, and high heterogeneity, respectively.

Pooled results showed that 34% (95% CI: 27%, 40%) (Figure 2) of children born preterm experienced oromotor eating difficulties between 6 mo and 7 y of life. Among infants aged 6–12 mo, 43% (95% CI: 24%, 62%) exhibited an oromotor eating difficulty. The prevalence decreased among children >12 mo–7 y old with 25% (95% CI: 17%, 33%) experiencing oromotor eating difficulties. The heterogeneity between studies was high (I^2 values > 97%) in both subgroups.

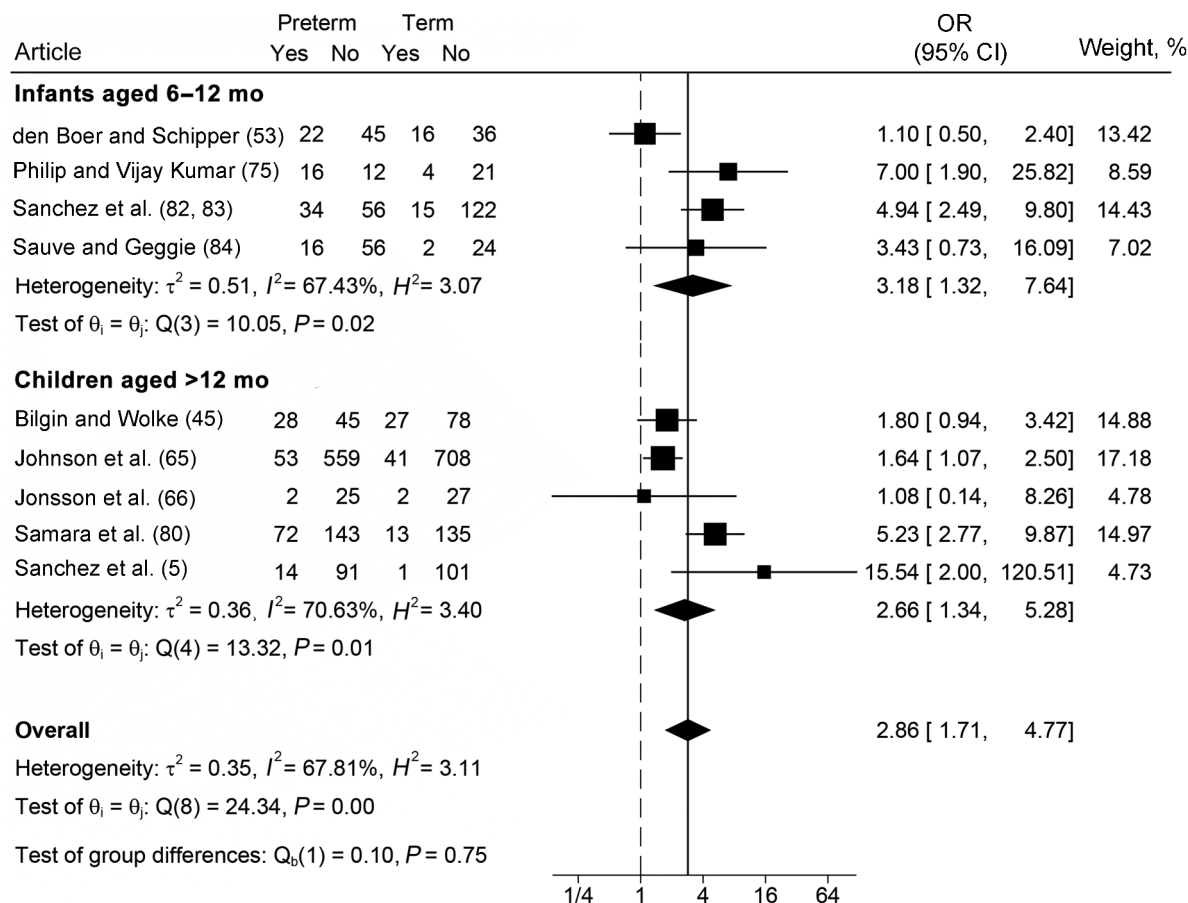
Compared with term-born counterparts (Figure 3), children born preterm were 2.86 times more likely to experience oromotor eating difficulties between the ages of 6 mo and 7 y (OR: 2.86; 95% CI: 1.71, 4.77; $I^2 = 67.8\%$). Findings were generally consistent between both age groups. Heterogeneity between studies was moderate to high (I^2 values ranging from 67% to 70%). Among articles that were excluded from the meta-analysis because prevalence of oromotor eating

difficulties was not reported ($n = 4$), all suggested that children born preterm had significantly worse oromotor eating skills than children born at term across both age groups (26, 29, 31, 36).

Eating behavior challenges.

We included 8 articles (7 unique studies) in our meta-analysis of eating behavior challenges. Eighteen percent (95% CI: 12%, 24%) (Figure 4) of children born preterm exhibited eating behavior challenges in the early years, such as picky eating, food refusal, or tantrums during meals; however, heterogeneity between studies was high (I^2 values > 92%). These estimates were consistent between the 2 age groups.

In comparison with term-born peers, results showed that those born preterm were 1.5 times more likely to present with challenging eating behaviors (OR: 1.52; 95% CI: 1.11, 2.10; $I^2 = 0.0\%$), with homogeneity between individual



Random-effects REML model

FIGURE 3 Odds of oromotor eating difficulties: comparison of infants and children born preterm and at term. Random-effects meta-analysis using a REML model. Results are presented as ORs (95% CIs). The weighting for each study is the inverse of the total variance. I^2 = the percentage of variation across studies that is due to heterogeneity rather than chance. Values of 25%, 50%, and 75% were considered as low, moderate, and high heterogeneity, respectively. REML, restricted maximum likelihood.

studies (Figure 5). Only 1 study of infants compared the odds of eating behavior challenges among those born preterm with term-born peers. Results showed no significant difference between the groups. Among children, results were similar to the pooled estimate. Nine studies presented mean differences, rather than prevalence of eating behavior challenges. Six articles spanning both age groups reported that children born preterm had significantly higher eating behavior challenge scores than term-born peers, indicating more eating behavior challenges such as food refusal and tantrums (27, 28, 31, 34, 35, 70), and 3 found no significant differences (25, 30, 33).

Any eating challenge, not specified.

We included 12 articles (11 unique studies) in our analysis that reported on any eating challenge (i.e., studies that did not differentiate between oromotor or eating behavior challenges). Results showed that, overall, 28% (95% CI: 21%, 35%) of those born preterm experienced eating challenges during the early years, although heterogeneity between studies in all groups was high (I^2 values >93%) (Figure 6).

Subgroup analyses showed that 34% (95% CI: 11%, 56%) of infants and 26% (95% CI: 18%, 34%) of children born preterm experienced some type of eating challenge.

In comparison with term-born peers, those born preterm were nearly 1.7 times more likely (OR: 1.68; 95% CI: 1.25, 2.26; $I^2 = 50.7\%$) to exhibit some type of eating challenge (Figure 7). Results were similar in subgroup analyses; however, only 1 article reported on any eating challenges among infants. Two articles presented mean differences, rather than prevalence, of any type of eating challenge experienced by those born preterm and at term. One study spanning both age groups reported that preterm children experienced significantly more eating challenges than those born at term (31). The other study, conducted among children at 18 mo of age, reported no statistically significant differences (32).

Results suggest that children born preterm commonly experienced difficulties with oromotor eating skills and eating behaviors across the early developmental years, and more frequently than term-born peers. The findings related to behavior lacked consistency.

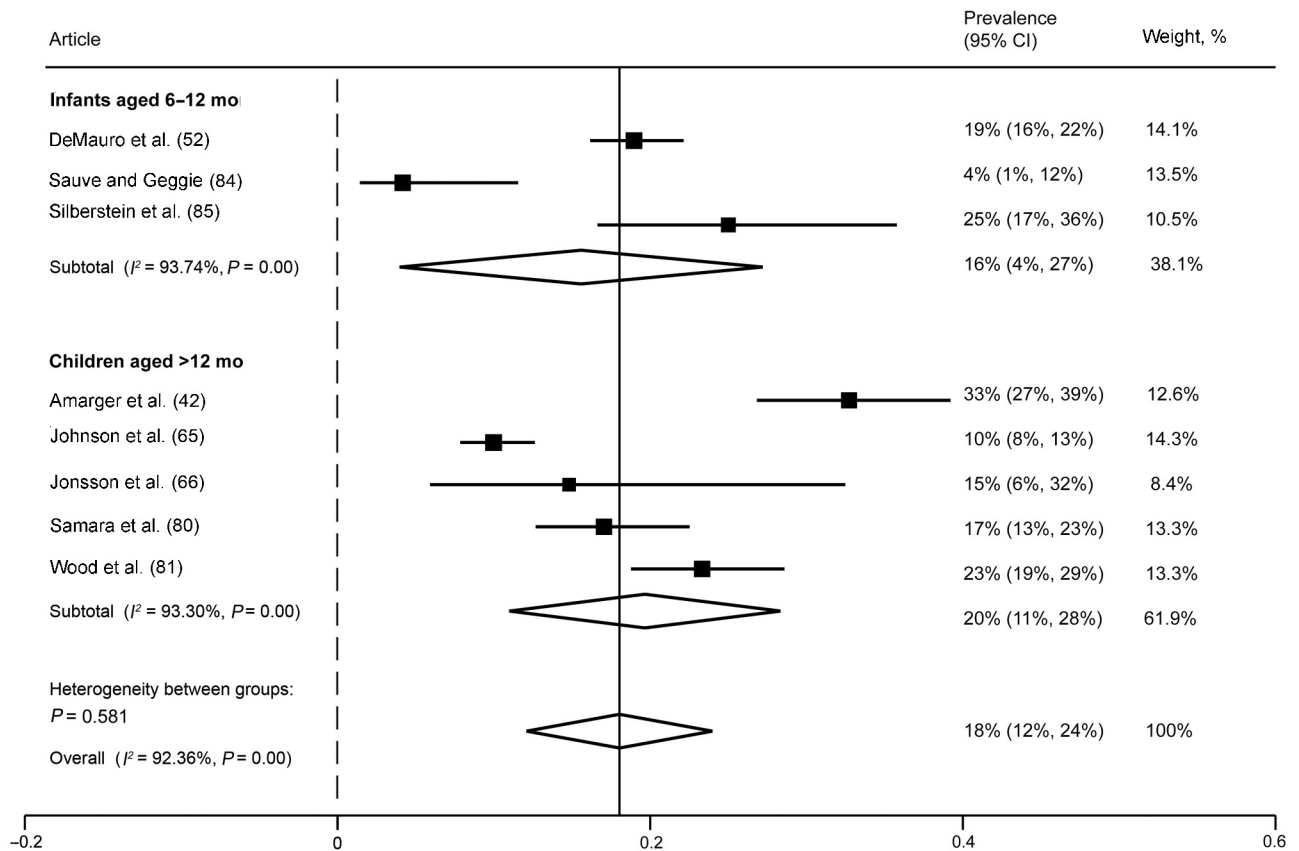


FIGURE 4 Prevalence of eating behavior challenges among infants and children born preterm. Random-effects meta-analysis of proportions using a maximum likelihood estimator. Results are expressed as prevalence (95% CI). The weighting for each study is the inverse of the total variance. I^2 = the percentage of variation across studies that is due to heterogeneity rather than chance. Values of 25%, 50%, and 75% were considered as low, moderate, and high, respectively.

Food parenting

Nineteen articles (17 unique studies) reported on food parenting. Nine articles were based on parental report of feeding, 7 articles used direct observation, and 3 used a mixed-methods approach. In most articles ($n = 13$; 68%), “parent” referred to the child’s mother. **Table 3** provides a narrative summary of findings related to parental concern and emotions during feeding, specific feeding practices, and parent–child interactions during mealtimes. Results suggested mothers of children born preterm had significant concerns about their children’s eating, experienced negative emotions, and used coercive feeding practices during mealtimes, which in many cases contextualized negative feeding interactions overall. When compared with term-born mother–child dyads, these food parenting factors seemed to be more frequently reported as more severe among preterm-born mother–child dyads.

Dietary patterns

Twenty-four articles (23 unique studies) explored the dietary patterns of those born preterm. Almost all articles relied on parent report using nonstandardized methods to assess dietary patterns. **Table 4** summarizes results related to human

milk feeding duration and exclusivity, age at introduction to solids, food group consumption, and overall diet quality. Results suggested that infants and children born preterm were not meeting nutritional recommendations and that their dietary patterns were poorer than for those born at term.

Risk of bias and certainty of evidence assessment

Risk of bias assessed by the NOS suggested that 0 of 14 articles from case-control studies and 10 of 53 articles from cohort studies had low risk of bias (**Supplemental Table 3**). Limitations included recruiting only children presenting to a feeding clinic, using nonstandardized or unvalidated assessments for outcomes of interest, not controlling for clinically important covariates, follow-up rates <80% in prospective cohorts, and failing to blind assessors to birth groups in studies with a term-born comparison group.

Our GRADE assessment (38) indicated that both the proportion of infants and children born preterm with oromotor eating difficulties and eating behavior challenges and the odds of children born preterm experiencing such problems compared with term-born peers are based on very-low-quality evidence (**Supplemental Table 4**). Individual

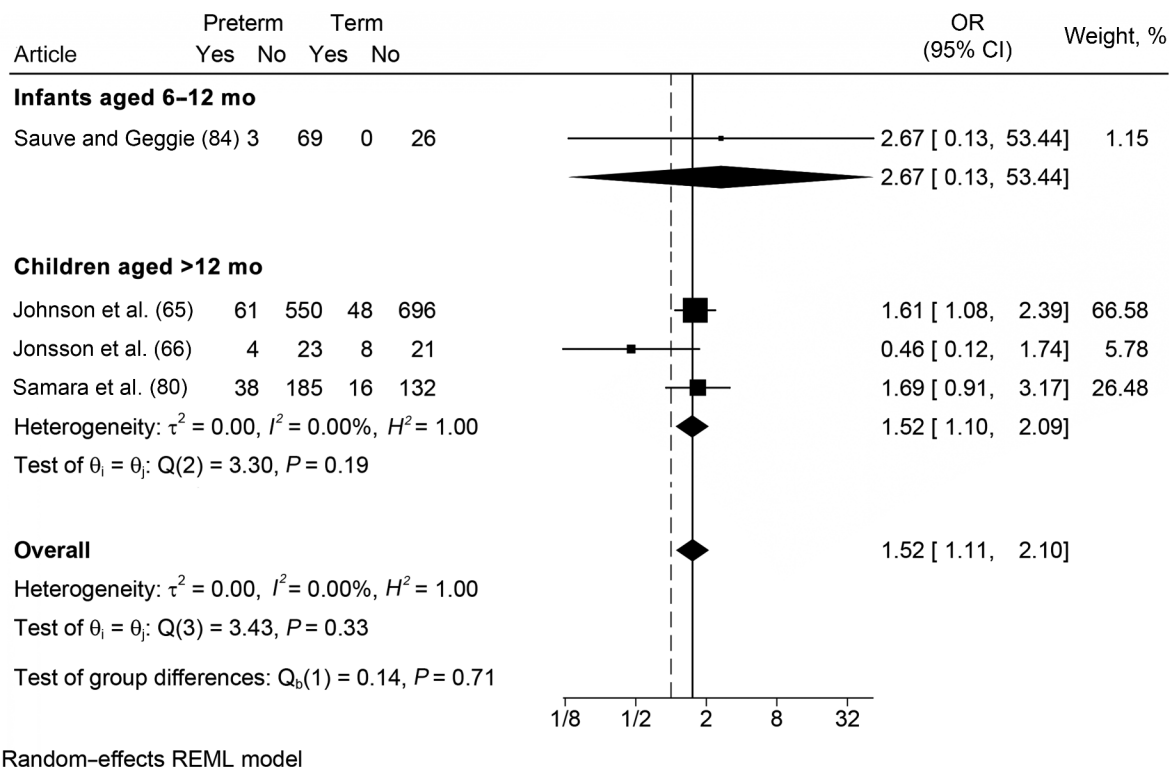


FIGURE 5 Odds of eating behavior challenges: comparison of infants and children born preterm and at term. Random-effects meta-analysis using a REML model. Results are presented as ORs (95% CIs). The weighting for each study is the inverse of the total variance. I^2 = the percentage of variation across studies that is due to heterogeneity rather than chance. Values of 25%, 50%, and 75% were considered as low, moderate, and high heterogeneity, respectively. REML, restricted maximum likelihood.

study risk of bias was serious or very serious for all outcomes. Where we could compute I^2 values, we found a substantial amount of unexplained statistical heterogeneity, leading to a downgrade in the certainty of evidence. Other concerns included a large proportion of studies using nonstandardized questionnaires to quantify eating challenges, different methodologies for assessing behavioral eating challenges, and individual studies not distinguishing between types of eating challenges (oromotor compared with behavioral).

Discussion

This systematic review and meta-analysis revealed that infants born preterm continue to experience high rates of oromotor eating difficulties and behavioral eating challenges throughout the early developmental years. Although it was not possible to conduct meta-analyses examining food parenting practices or dietary patterns owing to the small number of studies and heterogeneity of outcome assessment, our narrative review of the literature showed that mealtimes with preterm children are characterized by parental anxiety and coercive, negative feeding interactions. Consistent with these findings, we also found the dietary patterns of children born preterm to be poor and often falling short of recommendations. Overall, we found a higher incidence of eating, feeding, and dietary challenges among children born

preterm than among those born at term. To our knowledge, this is the first systematic review and meta-analysis to explore the prevalence of oromotor eating difficulties and behavioral eating challenges among children born preterm, as well as the first to compare with term-born peers. Further, this was the first systematic review we know of to consider the context in which children born preterm are fed (food parenting) and associated dietary patterns.

Our meta-analysis found that children born preterm experienced high rates of oromotor eating difficulties during late infancy and throughout childhood (34%) and had 2.86 times the odds (95% CI: 1.71, 4.77) of experiencing such difficulties compared with term-born peers, although the quality of evidence was found to be very low. The American Academy of Pediatrics' (AAP's) *Textbook of Pediatric Care* suggests that those with cardiorespiratory or chronic lung disease, neurologic impairments, repeated intubations, extended tube feeding, and severe reflux are at highest risk of feeding problems (87). This guidance is general, however, and does not focus on types of eating challenges. Our research has real-world implications for NICU follow-up care, in that it highlights the prevalence of oromotor eating difficulties in children born preterm. Our findings lay the groundwork for future research to determine what should be screened at critical points in time, including coordination of the suck-swallow-breathe pattern, lip, and jaw movements;

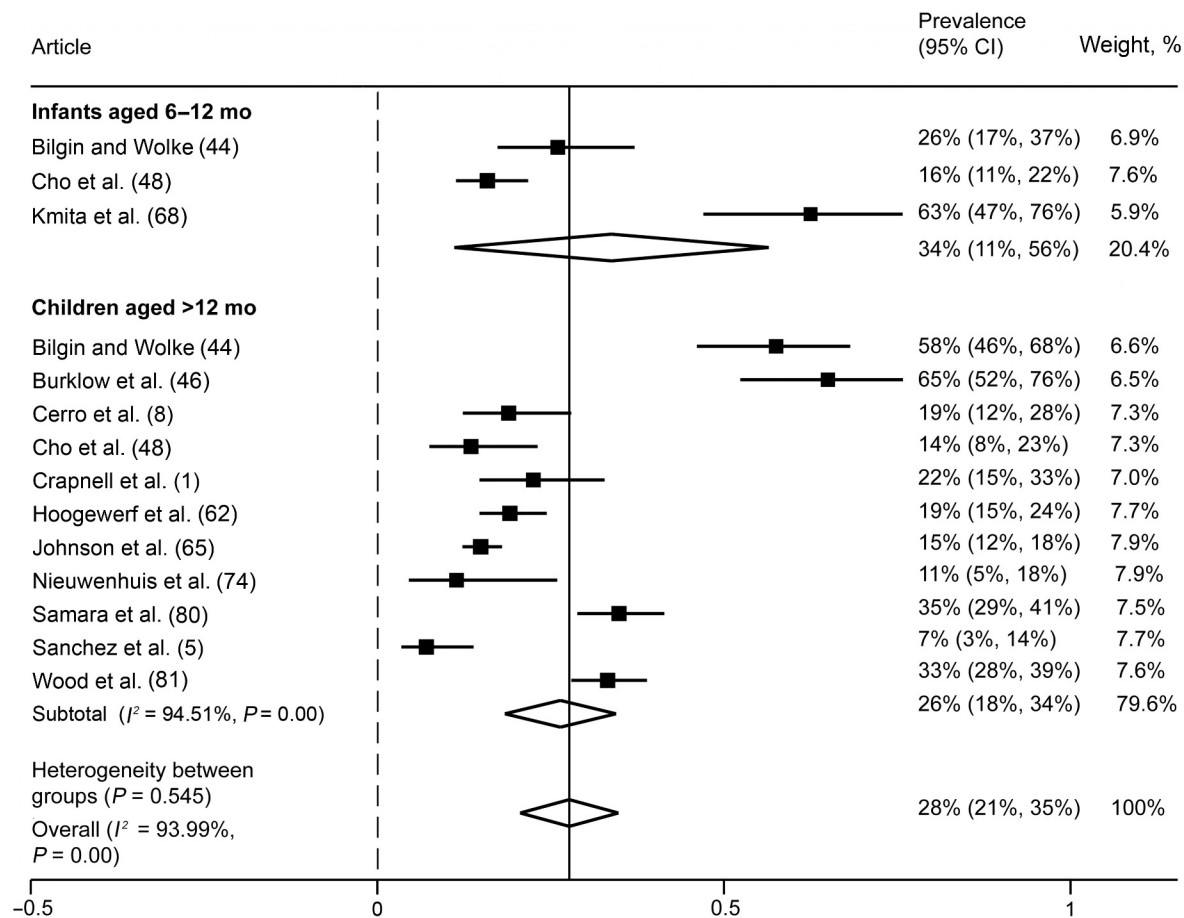


FIGURE 6 Prevalence of any eating challenge, not specified among infants and children born preterm. Any eating challenge refers to articles that did not differentiate between oromotor eating difficulties or eating behavior challenges. Random-effects meta-analysis of proportions using a maximum likelihood estimator. Results are expressed as prevalence (95% CIs). The weighting for each study is the inverse of the total variance. I^2 = the percentage of variation across studies that is due to heterogeneity rather than chance. Values of 25%, 50%, and 75% were considered as low, moderate, and high heterogeneity, respectively.

coughing while eating purees; difficulties self-feeding (e.g., coordinating utensils with the lips and mouth); and coughing or gagging. Our findings also revealed that the prevalence of oromotor eating difficulties likely drops as children age, suggesting that all children learn to eat. Those born preterm appear to take longer to master the skills necessary for successful oral eating, which would require more support to earlier close this gap between them and peers and to ensure difficulties do not persist. This information has bearing on clinician education practices, because it emphasizes specific areas for surveillance and oral sensorimotor intervention in this population. Future research utilizing standardized assessments will be beneficial in identifying those at highest risk as well as the specific eating challenges experienced.

Our meta-analysis found that 18% of those born preterm experienced eating behavior challenges such as food refusal or tantrums during mealtimes during the developmental years and children born preterm had 1.5 times higher odds (OR: 1.52; 95% CI: 1.11, 2.10) of such difficulties than term-born peers, although the quality of the evidence was very low.

This highlights the need to specifically consider the impact of birth gestation on the development of eating habits among children and warrants future exploration into strategies to both prevent and reduce challenging mealtime behaviors given the unique challenges this vulnerable population may experience. In the only other meta-analysis known to explore eating behaviors among preterm children, Pados et al. (6) estimated the prevalence of “problematic feeding” to be 42% among preterm children <4 y of age; a comparison with term-born peers was not conducted. Notably, Pados et al. (6) did not differentiate between eating challenges (oromotor compared with behavioral). By contrast, our results looking at “any eating challenge” found 28% of children born preterm experienced some type of oromotor eating difficulty or behavioral eating challenge. Reasons for these differences in estimates are likely attributable to definition differences and methods, because our review used a more exhaustive literature review. Consistently defining eating challenges and differentiating between concerns will be an important step in advancing both research and clinical practice (88).

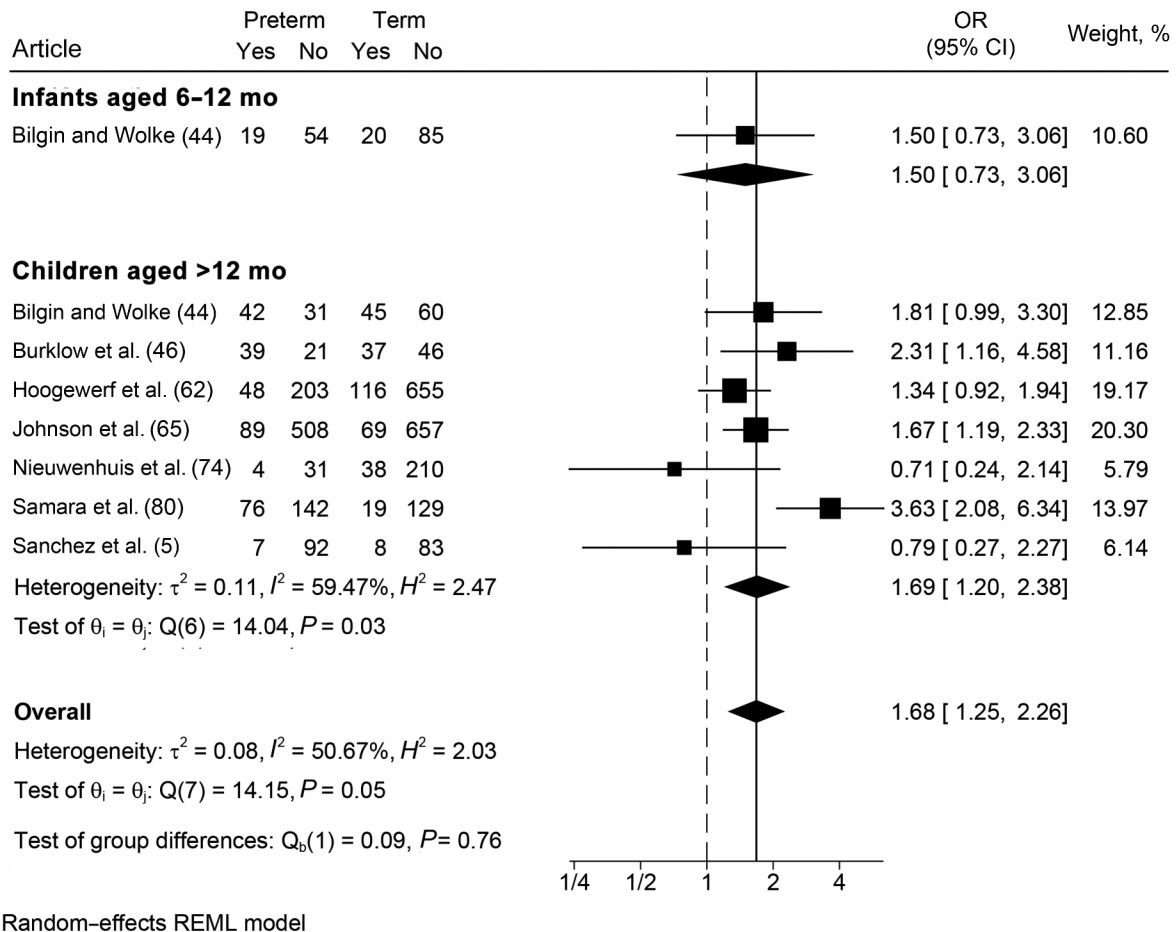


FIGURE 7 Odds of any eating challenge, not specified: comparison of infants and children born preterm and at term. Any eating challenge refers to studies that did not differentiate between oromotor eating difficulties or eating behavior challenges. Random-effects meta-analysis using a REML model. Results are presented as ORs (95% CIs). The weighting for each study is the inverse of the total variance. I^2 = the percentage of variation across studies that is due to heterogeneity rather than chance. Values of 25%, 50%, and 75% were considered as low, moderate, and high heterogeneity, respectively. REML, restricted maximum likelihood.

Importantly, most studies included in our review were based on parental report of child eating behaviors. Parent report is susceptible to bias, and many of the behaviors parents consider challenging are developmentally appropriate (e.g., initial food refusal as children discern preferences for flavor and textures) (7, 89). Future research should utilize observational methods to elucidate the extent and severity of challenging eating behaviors among children born preterm.

We found that mothers of preterm infants expressed more concern, experienced heightened anxiety, and presented with more coercive and negative interactions while feeding compared with term mother–child dyads. Considering the likely stress experienced when giving birth to a child preterm, there is significant potential for sustained impact on parental mental health and parent–child attachment, and an overall negative outlook on a child’s health and developmental outcomes in the parent (60). Indeed, from a bidirectional perspective, early child oromotor eating difficulty and lower infant engagement likely reinforce stress

and negative feelings about feeding. Heightened negative parental expectations may then influence specific feeding practices (e.g., pressure to eat due to concerns about weight) and, in turn, influence child outcomes, perpetuating the cycle. Our narrative review also showed that parental concerns (e.g., choking) may delay introduction to solids and texture progression, inadvertently contributing to further oromotor difficulties (49, 63). However, positive parent–child interactions may be protective against eating challenges (28). Future research and intervention initiatives should focus on positive parent–child relationships as children learn to eat and as parents learn to feed to help children born preterm meet oromotor milestones and reduce challenging mealtime interactions. Although the AAP’s *Textbook of Pediatric Care* highlights including evaluations of parent–child interaction as part of ongoing surveillance for preterm infants, no guidance for supporting families is provided, nor is the association between feeding outcomes and nutrition discussed (87). Further research is crucial for informing

TABLE 3 Summary of food parenting results¹

Food parenting subtheme	Findings for infants and children born preterm ²	Term-born comparison ³
Parental concern and emotions during feeding: 9 articles, 9 unique studies (5, 8, 23, 48, 49, 52, 59, 70, 86)	<ul style="list-style-type: none"> • 6 of 9 articles suggested parents had significant concerns about their child's eating behaviors and skills or dietary patterns (e.g., frequency of eating, range and quality of foods, amount of junk food) (5, 8, 48, 59, 70, 86). • 5 of 9 articles reported parents expressed feelings of "stress," "anger," "frustration," "less enjoyment," and "difficulty" during mealtimes (8, 23, 49, 52, 59). • Infants' early feeding skills and medical course may have affected parents' concerns and emotions toward feeding (5, 52, 59). 	<ul style="list-style-type: none"> • 4 of 9 articles included a term-born comparison group. • 2 articles (5, 86) reported parents of preterm children to have significantly greater or more frequent concerns about their child's eating than parents of term-born children and the other 2 reported no significant differences (8, 70).
Specific feeding practices: 5 articles, 5 unique studies (8, 61, 70, 79, 85)	<ul style="list-style-type: none"> • Parents of preterm infants seemed more involved during feeding than during nonfeeding interactions (61), but infant eating difficulties need to be considered. Mothers of infants with eating difficulties were reportedly more intrusive (85). • 1 article found concern for preschoolers' weight was not associated with cross-sectionally reported feeding practices (e.g., pressure to eat) (79). 	<ul style="list-style-type: none"> • 2 of 5 articles included a term-born comparison (8, 70). • Parents of preterm children in both articles reportedly used suboptimal feeding practices more often than term parents including: <ul style="list-style-type: none"> ◦ less mealtime structure (i.e., not at table); ◦ food as a reward for eating or behavior control; ◦ deciding how much child should eat (less child autonomy).
Parent-child interactions during mealtimes: 10 articles, 8 unique studies (25, 33-36, 61, 76, 77, 85, 86)	<ul style="list-style-type: none"> • All 10 articles used direct observation of feeding interactions; 1 was conducted among children >12 mo of age. • Feeding interactions were bidirectional. Mothers of difficult feeders were more intrusive, and infants were less involved and more withdrawn during feeding at 12 mo (85). • 1 article showed individual and family-level factors seemed to influence interactions. Mothers experiencing depressive symptoms and those living in poverty were more negative and intrusive during feeding (77). • 1 article demonstrated preterm birth indirectly predicted difficult meal interactions through maternal distress and concerns about the child's eating and vulnerability at 6 mo CA. Eating concerns predicted less mealtime reciprocity (e.g., synchrony) at 12 mo CA, and perceptions of vulnerability predicted more meal conflict (86). 	<ul style="list-style-type: none"> • 6 of 10 articles included a term-born comparison (25, 33-36, 86). • Differences in responsive feeding between birth groups were found to increase over time. Maternal responsiveness was not found to differ between birth groups at 6-12 mo (25, 33, 36, 86). At 18-24 mo of age, 1 study suggested less dyadic reciprocity among preterm dyads than among term dyads (34). • Term-born infants were reportedly more responsive to their mothers and clearer in their eating cues than preterm infants, with differences increasing over the first 12 mo of life (35). • 2 of 10 articles reported parents of preterm children display more negative affect (e.g., irritation, intrusiveness) during feeding than term-born mothers (33, 34).

¹*n* = 19 articles, 17 unique studies. CA, corrected age.²Summary of results for all articles reporting on food parenting (articles with and without a term-born comparison group), highlighting findings relevant to preterm infants/children only.³Summary of results for articles reporting on food parenting that included a term-born comparison group, highlighting birth group comparisons (preterm compared with term) only.

and updating these guidelines to educate clinicians and in turn, to support these children and their families. Updates may include information on oromotor eating milestones and best practices for child feeding, as well as anticipatory feeding guidance for families. Importantly, only 1 study in our review examined parent-child interactions among children older than 12 mo of age. Given that we found the prevalence of challenging eating behaviors to be high in this age group, future research should explore parent-child

mealtime interactions of children, and not just infants, born preterm.

Our narrative review suggested that the dietary patterns of children born preterm were poor from late infancy throughout early childhood; this finding is not surprising given the high prevalence of both oromotor eating difficulties and eating behavior challenges found. Low human milk feeding initiation, duration, and exclusivity are multifactorial but are likely due in part to early oromotor eating difficulties,

TABLE 4 Summary of dietary patterns results¹

Dietary pattern subtheme	Findings for infants and children born preterm ²	Term-born comparison ³
Human milk feeding duration and exclusivity: 10 articles, 10 unique studies (9, 22, 44, 54, 56, 58, 64, 68, 78, 86)	<ul style="list-style-type: none"> Breastfeeding duration and exclusivity were reportedly short (64, 78). No articles examined human milk feeding after 12 mo. The percentage of preterm infants who received any human milk at 6 mo CA (9, 44, 68) or postnatal age (54, 56) ranged from 10% to 60%. The prevalence of exclusive human milk feeding until 6 mo CA ranged from 6% among a VLBW cohort (9) to 44.7% among preterm infants in general (22). By 12 mo postnatal age, the prevalence of receiving any mother's milk ranged from 0% among infants born weighing <1800 g (58) to 21% among preterm infants in general (54). 	<ul style="list-style-type: none"> 5 of 10 articles included a term-born comparison. 4 of 5 articles reported fewer preterm infants received exclusive or partial mother's milk at 6 (44, 56, 58) and 12 mo of age (56). Only 1 article reported a similar duration between birth groups (86).
Age at introduction to solids: 11 articles, 11 unique studies (8, 9, 23, 29, 46, 55, 59, 63, 66, 78, 84)	<ul style="list-style-type: none"> 9 of 11 articles found that infants started eating solid foods before the recommended 6 mo CA (8, 9, 23, 29, 55, 63, 66, 78, 84). Introduction to solids usually occurred between 4 and 6 mo CA, but could take place as early as 2 mo CA (55) and 3.5 mo postnatal age (8). 1 article showed no difference in the age at which solids were introduced between preterm infants categorized as normal vs. dysfunctional feeders in the NICU (59). 2 articles reported slowed or delayed progression through textures (55, 63). 	<ul style="list-style-type: none"> 4 of 11 articles included a term-born comparison. 2 articles reported that those born preterm were introduced to solid foods earlier than term-born peers (8, 66); 1 article reported no statistical difference between birth groups (46). The only article reporting that preterm infants started solid foods later than term-born infants did not correct for birth gestation (29).
Solid food group consumption and overall diet quality: 7 articles, 7 unique studies (27, 30, 51, 57, 64, 72, 78)	<ul style="list-style-type: none"> 2 of 7 articles explored diet quality and reported the overall diet quality of infants and children to be poor (57, 78). 1 article reported exclusive human milk feeding among preterm infants to be positively associated with dietary variety and inversely associated with sweets consumption among 1- to 3-y-olds (64). 1 article reported that vitamin and mineral supplements were often given inappropriately based on children's diets (72). 	<ul style="list-style-type: none"> 3 of 7 articles included a term-born comparison. 2 of 3 articles found differences in dietary intake including less fruit, cereals, and prepared dishes; less overall variety within each food group; and more cow milk and potatoes (30), as well as more sugar (51), among those born preterm; 1 article found no dietary differences between birth groups (27).

¹n = 24 articles, 23 unique studies. CA, corrected age; NICU, neonatal intensive care unit; VLBW, very low birth weight (<1500 g).

²Summary of results for all articles reporting on dietary patterns (articles with and without a term-born comparison group), highlighting findings relevant to preterm infants/children only.

³Summary of results for articles reporting on dietary patterns that included a term-born comparison group, highlighting birth group comparisons (preterm compared with term) only.

parental frustration, and anxiety over child growth and development. Similarly, early introduction to solid foods may be due to parental concern over child growth. Findings from Francis et al. (9) highlight low adherence to infant feeding recommendations overall and underscore the importance of including nutrition as a focus in neonatal follow-up. Few studies have explored the dietary patterns of children born preterm. Still, our results showed inadequate dietary patterns present in infants born preterm persist throughout childhood and may be worse than those of term-born peers. Although not included in this review owing to our age restriction, limited research suggests that inadequate dietary intake among children born preterm tracks into young adulthood (90, 91). Infants born preterm are at high risk of metabolic disturbances and chronic disease in

adulthood (12). Thus, providing parents of preterm infants with anticipatory guidance and support to promote healthy dietary patterns is essential, focusing on improving children's eating and parents' feeding.

Limitations

Despite many strengths, this systematic review has limitations to consider. First, most individual articles (84%) were deemed to have a high risk of bias and the certainty of evidence for our meta-analysis of oromotor eating difficulties and eating behavior challenges was deemed very low. Second, several articles did not differentiate between oromotor or eating behavior challenges. It is imperative that future research clearly and consistently defines eating difficulties. A consensus statement was recently published

presenting a comprehensive definition of pediatric feeding disorders (88). Like our study, this definition explores feeding skills, psychosocial factors (including parent–child interactions), and nutritional factors separately. Consistent language will help identify those most at risk and create tailored interventions to support the healthy development of eating habits among the vulnerable preterm population. Third, owing to the limited number of and heterogeneity among studies, we narratively reviewed the literature on food parenting and dietary patterns. Fourth, most articles utilized maternal report, which is susceptible to bias. Focusing solely on the maternal perspective is not reflective of a typical home environment because mothers are not the only caregivers engaging in child feeding. Finally, it is also possible that differences found between those born preterm and their term-born peers may be attributed to sociodemographic disparities. At an individual article level, however, many matched their birth groups on sociodemographic characteristics, used random sampling to recruit term-born comparisons, or used similar inclusion and exclusion criteria to assess eligibility for each group. Future research should use rigorous recruitment and matching methods to enroll term-born comparison groups.

Conclusions

Our results demonstrate higher rates of oromotor difficulties and behavioral eating challenges during late infancy and early childhood among children born preterm than among their term-born peers. However, the certainty of this evidence is very low. Based on narrative review, children born preterm seemed to experience more coercive and negative feeding interactions with caregivers, and these interactions are associated with high rates of maternal anxiety. We also narratively observed poorer dietary patterns among preterm children including low human milk feeding duration and exclusivity, early introduction to solids, and poor diet quality. Poor dietary patterns likely contribute to the heightened risk of presenting with chronic disease in adulthood, thus following the nutrition outcomes of this population post–NICU discharge throughout the developmental years is essential. Research examining the role of caregiver–child interactions in eating, feeding, and nutrition/dietary outcomes in this vulnerable population is needed.

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Data Availability

Data described in the article, code book, and analytic code will be made available upon request pending application and approval.

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