CME

Symptoms of Feeding Problems in Preterm-born Children at 6 Months to 7 Years Old

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ABSTRACT

Objectives: Describe symptoms of feeding problems in children born very preterm (<32 weeks gestation) and moderate to late preterm (32–37 weeks gestation) compared to children born full-term; explore the contribution of medical risk factors to problematic feeding symptoms.

Methods: The sample included 57 very preterm, 199 moderate to late preterm, and 979 full-term born children ages 6 months to 7 years. Symptoms of feeding problems were assessed using the Pediatric Eating Assessment Tool and compared between groups after accounting for the child's age and/or sex. With the sample of preterm children, we further analyzed 11 medical factors as potential risk factors affecting a child's feeding symptoms: feeding problems in early infancy and conditions of oxygen requirement past 40 weeks of postmenstrual age, congenital heart disease, structural anomaly, genetic disorder, cerebral palsy, developmental delay, speech-language delay, sensory processing disorder, vision impairment, or symptoms of gastroesophageal reflux.

Results: Compared to children born full-term, both very preterm and moderate to late preterm born children had significantly higher scores on the Pediatric Eating Assessment Tool total scale and all 4 subscales. More severe symptoms were noted in very preterm children, particularly in the areas of Physiologic Symptoms and Selective/Restrictive Eating. Among preterm children, all 11 medical factors were found to be associated significantly with increased symptoms of feeding problems.

Conclusion: Compared to children born full-term, preterm born children demonstrated greater symptoms of feeding problems regardless of their current age, suggesting children born preterm may require more careful monitoring of feeding throughout childhood.

Key Words: children, eating behavior, feeding behavior, premature infant

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What Is Known

- Preterm infants are at high risk for oral feeding difficulties during the neonatal period.
- Early feeding difficulties can persist into childhood for children who were born preterm.

What Is New

- Between the ages of 6 months and 7 years, both very preterm and moderate to late preterm children have greater symptoms of feeding problems compared to full-term children regardless of their current age or sex.
- Very preterm children demonstrated more severe symptoms of feeding problems, particularly in the areas of physiologic symptoms and selective/restrictive eating.

Preterm infants often experience difficulties with oral feeding while in neonatal care, including difficulty coordinating sucking, swallowing, and breathing, physiologic instability, and fatigue (1–3). Early feeding difficulty can persist into childhood and may manifest as delayed eating skill development, food refusal, and difficulty transitioning to textured foods (4–6). Feeding problems in early childhood may negatively affect a child's growth and development (7–9) as well as their family's well-being (10). Greater understanding of the symptoms of problematic feeding experienced by children who are born preterm will help to guide appropriate interventions and future research.

Previous research on feeding problems in preterm infants after the neonatal period has been limited by a lack of valid and reliable parent-report assessments of feeding (11–13). Moreover, previous studies have focused on a single age group and/or a group of very preterm infants (4–6,12,14,15). Additional research utilizing reliable and valid assessment tools, with a more diverse sample in terms of the child's age and degree of prematurity, is needed to further develop our understanding of problematic feeding in this population. The Pediatric Eating Assessment Tool (PediEAT) is a parent-report assessment of symptoms of problematic feeding in children ages between 6 months and 7 years with evidence of reliability and validity and norm-reference data to guide interpretation of scores (16–18). The purpose of this study was to describe symptoms of feeding problems, as measured by the PediEAT, in children born very preterm (<32 weeks gestational age [GA] at birth) and moderate to late preterm (32–36 weeks GA at birth) at 6 months to 7 years old, compared to a full-term reference group. Furthermore, we aimed to explore the contribution of medical risk factors to symptoms of feeding problems in preterm children.

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METHODS

This cross-sectional descriptive study was a secondary analysis of deidentified data from a series of studies conducted between May of 2015 and September of 2017 (17–19). The original studies from which these data were collected were approved by the institutional review board at the University of North Carolina at Chapel Hill. This secondary analysis of de-identified data was deemed not human subject research and did not require institutional review board approval.

For the original studies, parent(s) or primary caregivers (hereafter referred to as ''parents'') of children with and without feeding problems between 6 months and 7 years were recruited from a variety of sources, including but not limited to: a feeding specialty clinic; parent online support groups; and national health volunteer research registries. In order to participate, parents had to be over 18 years old, have access to the Internet, and self-report as being literate in English. A total of 1826 parents completed a Web-based survey which included the PediEAT and questions about demographic information and the child's health. For this secondary analysis, survey data from 1235 parents were selected based on complete data for the 2 questions ''Was your child born before 37 weeks?'' and ''How many weeks before the due date was your child born?'' To be included in the preterm group, the child had to be born before 37 weeks GA. To be included in the full-term reference group, the child had to be born full-term (≥37 weeks GA at birth) and could not have any of the following parent-reported conditions: speech language or development delay; hearing or vision impairment; structural abnormality of the mouth, face, or gastrointestinal tract; or significant health conditions (eg, congenital heart disease, genetic disorder, autism spectrum disorder, cerebral palsy).

Pediatric Eating Assessment Tool

The PediEAT is a 78-item measure of symptoms of problematic feeding in infants and children between 6 months to 7 years old. The PediEAT has 4 subscales: Physiologic Symptoms (27 items), Problematic Mealtime Behaviors (23 items), Selective/Restrictive Eating (15 items), and Oral Processing (13 items). The Physiologic Symptoms subscale measures observable symptoms of biological distress associated with food or mealtime, such as difficulty maintaining physiologic stability, swallowing dysfunction, and gastrointestinal dysfunction. The Problematic Mealtime Behavior subscale measures difficult behaviors observed during mealtime, such as refusing to eat or insisting on being fed a certain way. The Selective/Restrictive Eating subscale measures symptoms of preference toward specific types, textures, or temperature of foods. Finally, the Oral Processing subscale measures symptoms of difficulty managing food, such as pocketing of food (16–18).

Parents are asked to rate the frequency or severity of symptoms for each item of the PediEAT on a 6-point Likert scale (Never, Almost Never, Sometimes, Often, Almost Always, Always). The total possible score ranges from 0 to 390 with higher scores indicating more symptoms of problematic eating. The PediEAT has evidence of content validity (16), acceptable internal consistency reliability (Cronbach $\alpha = 0.95$), and test-retest reliability ($r = 0.87$) (17). Construct validity of the PediEAT has been demonstrated through correlations with scores of the Mealtime Behavior Questionnaire ($r = 0.77$, $P < 0.001$) and known-group validation ($t = 18.97$, $P < 0.001$) (17). In the current sample, Cronbach α was 0.95 for the PediEAT total, 0.92 for Physiologic Symptoms, 0.92 for Problematic Mealtime Behavior, 0.82 for Selective/Restrictive Eating, and 0.84 for Oral Processing. For the analysis, total sums and subscale scores of the PediEAT were calculated. In addition, *z* sores (number of standard deviations above or below the population mean) were calculated for the total scale and each subscale based on age-specific means and standard deviations derived from a sample of 1110 typically developing children (18).

Medical Risk Factors

Medical risk factors were derived from questions answered by parents about the child's feeding history and current or past health conditions. The child's feeding history included parent's concerns about their child's feeding during infancy (0–12 months), including difficulty with breast- or bottle-feeding, spitting up or vomiting regularly, or changing formula multiple times. The following health conditions were selected for consideration in this analysis based on the literature (6,7,14,20) and adequate representation ($n \geq 20$) to provide statistical power: oxygen requirement past 40 weeks postmenstrual age, congenital heart disease, structural anomaly, genetic disorder, cerebral palsy, developmental delay, speech language delay, vision impairment, sensory processing disorder, and gastroesophageal reflux (acid reflux). For each health condition, parents indicated whether the condition was present or absent. Lastly, to explore the contribution of multiple health conditions to symptoms of feeding problems in children born preterm, we calculated a total number of conditions based on ten health conditions listed above.

Statistical Analysis

Data were analyzed using SPSS version 24 (IBM Corp, Armonk, NY). Descriptive statistics were used to detail demographic and clinical characteristics of the sample and outcomes. All statistical tests were nondirectional, with statistical significance set at 0.05. Demographic characteristics of the sample were first compared according to the groups (very preterm children, moderate to late preterm children, full-term children) using Chi-square test to assess whether the groups were comparable as well as to identify potential covariates. Then, analysis of variance (ANOVA) with post hoc pairwise comparisons using *t* test adjusted for multiple comparisons with Tukey Honest Significant Difference was used to compare the PediEAT total score and each of the 4 subscale scores among the 3 groups, controlling for significant covariates. Lastly, with the sample of children born preterm, we further assessed associations of medical risk factors with the PediEAT total and subscale scores by computing ANOVA models separately for each factor and the variable of multiple health conditions after controlling for the child' age, sex, and preterm group, either being born as very preterm or moderate to late preterm.

RESULTS

Sample Characteristics

The study sample included data from 256 preterm children (<37 weeks GA at birth) and 979 healthy full-term children. Preterm children were further categorized into either moderate to late preterm (32–36 weeks GA at birth; n = 199) or very preterm (<32 weeks GA at birth; n = 57). In the preterm sample, 61 parents (23.8%) reported that their child had seen a feeding specialist in the previous 6 months. Specific sample characteristics are available in Supplementary Material 1 (Supplemental Digital Content 1, *http://links.lww.com/MPG/B533*).

The analysis comparing demographic characteristics of the sample between the full-term and 2 preterm groups revealed that these groups were comparable in terms of the family type ($X^2_4 = 1.1$, $P = 0.90$), family income ($X^2_{10} = 8.5$, $P = 0.58$), parent's education ($X^2_4 = 5.1$, $P = 0.27$), child's sex ($X^2_2 = 0.6$,

$P = 0.75$), and child's race ($X^2_{10} = 9.4$, $P = 0.50$). However, the groups differed significantly by the child's current age ($X^2_4 = 14.9$, $P = 0.01$) and respondent's relationship to the child ($X^2_4 = 11.4$, $P = 0.02$), with proportionally more children in younger age group (6–15 months) and more fathers in the full-term sample compared to the preterm sample.

Symptoms of Feeding Problems

Based on the results of the demographic comparison analyses and the literature support (14,21), the child's age (6–15 months, 15 months–2.5 years, 2.5–7 years), sex, and respondent's relationship to the child were considered as covariates for the analyses when they had a significant effect on a given outcome. Figure 1 presents means for the adjusted PediEAT total and subscale scores according to the groups compared, as generated by ANOVA after controlling for significant covariates. Detailed statistical results are available in Supplementary Material 2 (Supplemental Digital Content 2, *http://links.lww.com/MPG/B534*).

The PediEAT total score was significantly different among the 3 groups ($F_{2,1232} = 154.2$, $P < 0.001$), with very preterm children having the most symptoms of problematic feeding, followed by moderate to late preterm born children and then full-term born children. For the Physiologic Symptom subscale, the child's age and sex were found to be a significant covariate. That is, compared to children aged 6 to 15 months, those in the older age groups ($t = -5.8$, $P < 0.001$ for 15 months–2.5 years; $t = -6.8$, $P < 0.001$ for 2.5–7 years) and female ($t = -2.5$, $P = 0.014$) had significantly lower scores. After controlling for the effects of the child's age and sex, there was a significant difference in physiologic symptoms between the groups ($F_{2,1229} = 140.4$, $P < 0.001$), with very preterm children having the most physiologic symptoms, followed by moderate to late preterm children, and then full-term born children. For the rest of the subscales, the child's age was a significant covariate, in which compared to children aged 6 to 15 months, those in the older groups had significantly higher scores on Problematic Mealtime Behavior symptoms ($t = 6.4$, $P < 0.001$ for 15 months–2.5 years; $t = 11.7$, $P < 0.001$ for 2.5–7 years), and lower scores on selective/restrictive eating ($t = -6.1$, $P < 0.001$ for 15 months–2.5 years; $t = -9.3$, $P < 0.001$ for 2.5–7 years) and oral processing symptoms ($t = -3.1$, $P = 0.002$ for 15 months–2.5 years; $t = -10.5$, $P < 0.001$ for 2.5–7 years). After controlling for the effect of the child's age, there were significant differences in problematic mealtime behavior ($F_{2,1230} = 73.9$, $P < 0.001$), selective/restrictive eating ($F_{2,1230} = 109$, $P < 0.001$), and oral processing symptoms ($F_{2,1230} = 89.1$, $P < 0.001$) between the groups, with very preterm children having the most symptoms of problematic feeding in these domains, followed by moderate to late preterm children, and then full-term born children having the least symptoms of problematic feeding in these domains.

Figure 2 presents means for the adjusted PediEAT total and subscale z scores according to the groups compared, as generated by ANOVA after controlling for the same covariates controlled in each of the models for the PediEAT raw scores. As expected, the same results were found in which z scores were significantly different from one group to another for PediEAT total and each of the 4 subscales ($P < 0.001$), with very preterm children having the most symptoms of problematic feeding, followed by moderate to late preterm children, and then full-term born children. However, as Figure 2 shows, although very preterm and moderate to late preterm children showed significantly greater symptoms of problematic feeding across all domains compared to the full-term born children, increased symptoms were noted particularly for Physiologic Symptoms and Selective/Restrictive Eating symptoms, with very preterm born children having more severe symptoms (z score >2).

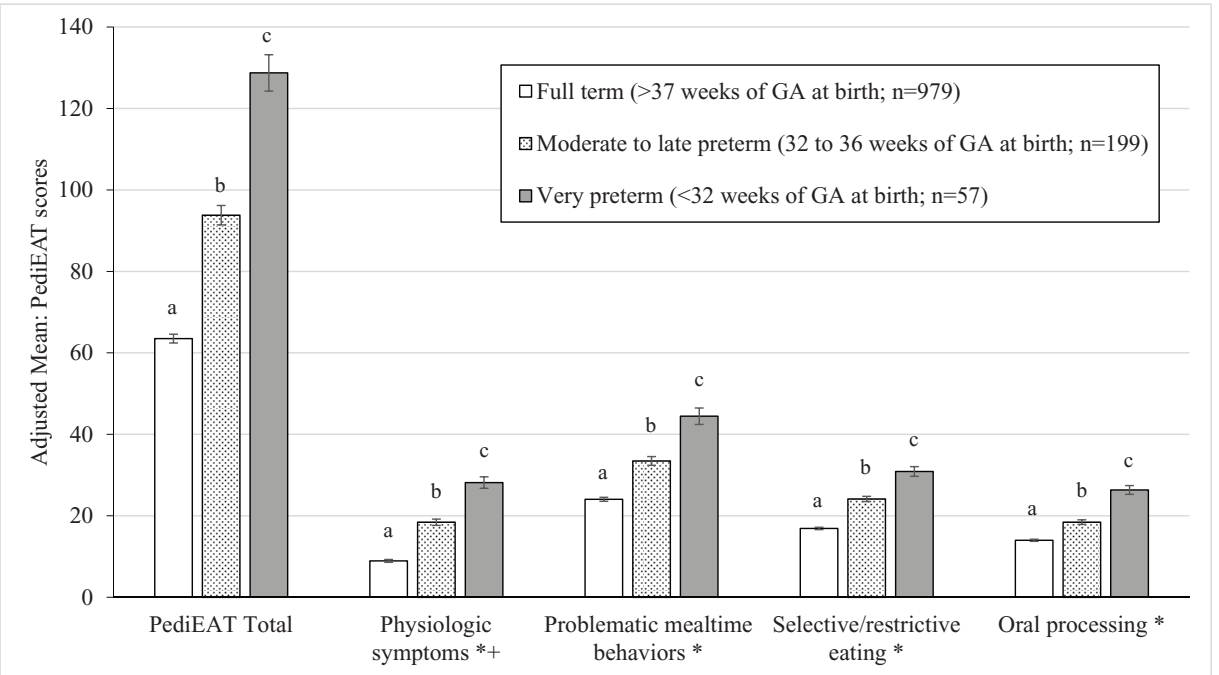

FIGURE 1. Comparison of the Pediatric Eating Assessment Tool (PediEAT) Total and Subscale Scores Among Children Born Very Preterm, Born Moderate to Late Preterm, and Born at Term. Error bars indicate standard errors. Different letters indicate significant difference by analysis of variance (ANOVA) with a post-hoc pairwise comparison via Tukey Honest Significant Difference at *P* value of 0.05 (2-tailed) after accounting for significant covariates (* = child's age; + = child's sex).

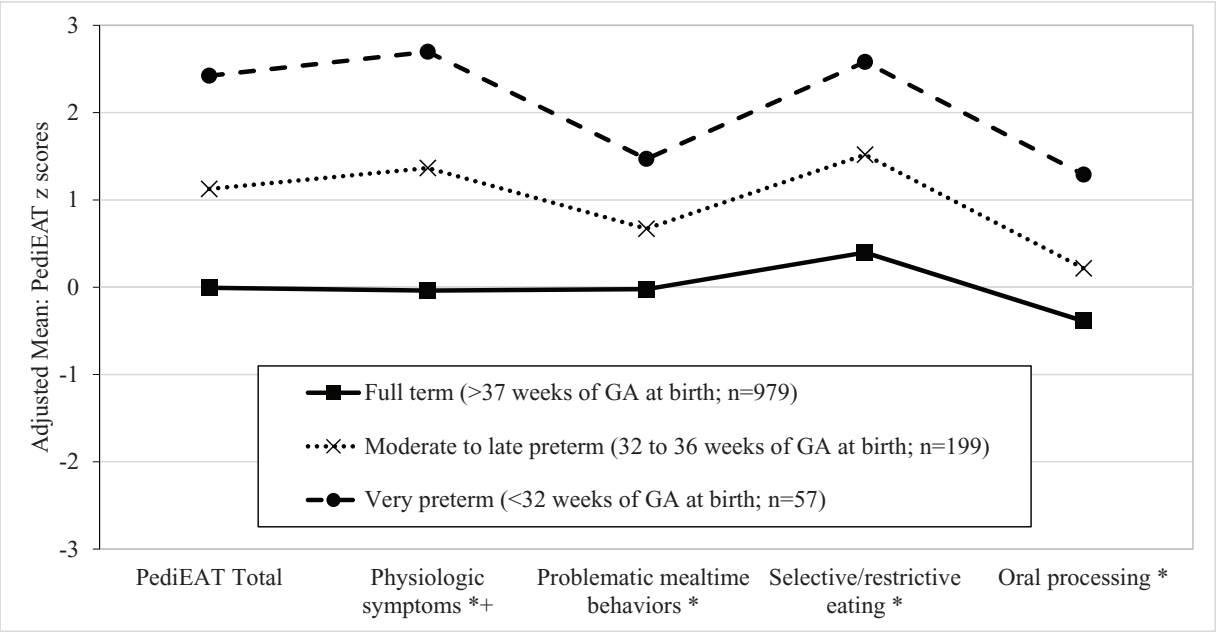

FIGURE 2. Comparisons of the Pediatric Eating Assessment Tool (PediEAT) *z* scores Among Children Born Very Preterm, Born Moderate to Late Preterm, and Born at Term. *Z* scores were calculated based on age-specific means and standard deviations of the PediEAT scores derived from 1110 typically developing children ages between 6 months and 7 years (18). Significant covariates controlled (* = child's age; + = child's sex).

Medical Risk Factors Associated With Symptoms of Feeding Problems

With the sample of preterm born children (n = 257), we explored medical risk factors associated with greater symptoms of feeding problems (Table 1). Each of 11 medical risk factors considered in the analysis were found to significantly contribute to increased PediEAT total scores after controlling for the child's age, sex, and preterm group. Analysis of the subscale scores revealed that all medical risk factors, except for the conditions of cerebral palsy and vision impairment, also significantly contributed to increased symptoms of problematic feeding significantly across all 4 subscales of the PediEAT. Lastly, we found that as the number of child's health conditions increases, symptoms of feeding problems increased after controlling for the child's age, sex, and preterm group. Specifically, as the number of conditions increased by 1, the score significantly increased by 13.9 on the PediEAT total scale ($t = 10.2$, $P < 0.001$), 4.7 on the Physiologic Symptoms subscale ($t = 9.3$, $P < 0.001$), 3.7 on the Problematic Mealtime Behavior subscale ($t = 6.2$, $P < 0.001$), 3.4 on the Selective/Restrictive Eating subscale ($t = 10.7$, $P < 0.001$), and 2.2 on the Selective/Restrictive Eating subscale ($t = 7.3$, $P < 0.001$).

DISCUSSION

In this cross-sectional study of children 6 months to 7 years old, we found that both very preterm children and moderate to late preterm children demonstrated significantly greater symptoms of feeding problems in the PediEAT total scale and all 4 subscales compared to full-term children, after accounting for their current age and/or sex. In addition, the results of *z* scores of the PediEAT revealed that preterm children exhibited increased symptoms, particularly in the areas of Physiologic Symptoms and Selective/Restrictive Eating, with very preterm born children showing significantly more severe symptoms (*z* scores > 2). The results of our study are consistent with previous studies which demonstrated that preterm infants continue to have increased feeding difficulties into early childhood, evidenced by food refusal, oral motor problems, choking and gagging, and behavioral problems during meals (4,6,22,23). In addition, our study extends previous findings by specifying the Physiologic Symptoms and Selective/Restrictive Eating Symptoms as areas in need of further clinical attention and research.

The results of the significant covariates controlled in the models suggest that a child's age and sex may influence different types of problematic feeding symptoms in early childhood. Specifically, we found that both full-term and preterm children in the younger age group (6–15 months) had significantly higher scores on the subscales of the Physiologic Symptoms, Selective/Restrictive Eating, and Oral Processing compared to those in the older age groups (15 months–2.5 years and 2.5–7 years). In the first 2 years of life, feeding skills change considerably as children transition from consuming only breast milk or formula to pureed solid foods, and then on to more complex foods that require chewing. Our findings indicate that for both full-term and preterm children, this is a challenging period that may require further attention and support. In contrast, we found that both full-term and preterm children in the younger age group had significantly lower scores on the Problematic Mealtime Behaviors subscale compared to those in the older age groups. This finding may be reflective of typical childhood development where toddlers establish their food preferences, assert their independence, and increase negative affective responses (neophobia) to novel foods and flavors (24). Or it may be because behavioral problems develop later as a result of repeated exposure to negative mealtime experiences and discomfort during feeding in early life. Lastly, boys had significantly higher scores on the Physiologic Symptoms subscale than girls. Multiple studies have shown that among preterm infants, boys have increased risk for prenatal morbidity and poor health outcomes at post-discharge follow-up compared to girls (25,26); the underlying mechanisms

TABLE 1. Association of medical risk factors with feeding problems in children born preterm (N = 256)

	PediEAT total	Physiologic symptoms	Problematic mealtime behavior	Selective/restrictive eating	Oral processing
Feeding concerns during infancy					
Yes (n = 169)	121.4 ± 4.3***	27 ± 1.6***	41.2 ± 1.8***	29.9 ± 1.0***	23.4 ± 0.9***
No (n = 87)	73.9 ± 5.8	10.9 ± 2.1	26.5 ± 2.4	19.5 ± 1.4	17 ± 1.3
Oxygen requirement past 40 weeks postmenstrual age					
Yes (n = 57)	128.9 ± 6.9***	29.9 ± 2.5***	42.4 ± 2.8*	31.9 ± 1.6***	24.6 ± 1.4**
No (n = 199)	95.7 ± 5.1	18.1 ± 1.8	33.8 ± 2.0	24.1 ± 1.2	19.7 ± 1.1
Congenital heart disease					
Yes (n = 32)	136.3 ± 9.1***	30.6 ± 3.3**	45.6 ± 3.6**	33.9 ± 2.1***	26.1 ± 1.9**
No (n = 224)	102.4 ± 4.4	20.8 ± 1.6	35.3 ± 1.7	25.7 ± 1.0	20.7 ± 0.9
Structural anomaly					
Yes (n = 29)	141.1 ± 9.7***	33.3 ± 3.5**	45.5 ± 3.9*	33.9 ± 2.3**	28.4 ± 2.0***
No (n = 227)	103.2 ± 4.3	20.9 ± 1.6	35.8 ± 1.7	26 ± 1.0	20.6 ± 0.9
Genetic disorder					
Yes (n = 25)	149.3 ± 10.7***	36.4 ± 3.9***	46 ± 4.3*	40.4 ± 2.4***	26.5 ± 2.2*
No (n = 231)	104.7 ± 4.2	21.3 ± 1.5	36.2 ± 1.7	26.0 ± 1.0	21.1 ± 0.9
Cerebral palsy					
Yes (n = 24)	127.9 ± 10.6*	29.2 ± 3.8*	39.3 ± 4.2 ns	31.1 ± 2.5 ns	28.4 ± 2.1***
No (n = 232)	104.3 ± 4.5	21.2 ± 1.6	36.4 ± 1.8	26.2 ± 1.1	20.5 ± 0.9
Developmental delay					
Yes (n = 63)	135.7 ± 6.5***	31.6 ± 2.4***	43.2 ± 2.7**	36.3 ± 1.4***	24.8 ± 1.4**
No (n = 193)	94.0 ± 4.7	17.9 ± 1.7	33.8 ± 1.9	22.5 ± 1.0	19.9 ± 1.0
Speech language delay					
Yes (n = 54)	145.9 ± 7.1***	35.0 ± 2.6***	46.3 ± 2.9***	36.8 ± 1.6***	27.7 ± 1.5***
No (n = 202)	95.3 ± 4.3	18.2 ± 1.6	33.8 ± 1.8	23.7 ± 1.0	19.5 ± 0.9
Vision impairment					
Yes (n = 27)	136.3 ± 10.0**	33.2 ± 3.6**	41.7 ± 4.0 ns	33.9 ± 2.4**	27.5 ± 2.0**
No (n = 229)	103.1 ± 4.4	20.6 ± 1.6	36.1 ± 1.8	25.8 ± 1.0	20.6 ± 0.9
Sensory processing disorder					
Yes (n = 37)	155 ± 8.5***	37.8 ± 3.1***	51.8 ± 3.4***	35.7 ± 2.1***	29.8 ± 1.8***
No (n = 219)	98.8 ± 4.2	19.5 ± 1.5	34.1 ± 1.7	25.3 ± 1.0	20 ± 0.9
Gastroesophageal reflux (N = 253)					
Yes (n = 83)	144.2 ± 5.1 ***	35.2 ± 1.9***	48.3 ± 2.2***	34.5 ± 1.3***	26.2 ± 1.2***
No (n = 170)	83.4 ± 4.3	14.1 ± 1.6	29.2 ± 1.8	21.7 ± 1.1	18.4 ± 1.0

Data were presented as adjusted mean ± standard deviation after controlling for the child's current age, sex, and preterm group, either being born as very preterm or moderate to late preterm.

ns = nonsignificant difference ($P > 0.05$); PediEAT = Pediatric Eating Assessment Tool.

***$P < .001$.

**$P < 0.01$.

*$P < 0.05$.

for these differences may also contribute to the differences found in this study with regards to Physiologic Symptoms.

In our sample of preterm born children, we found multiple medical risk factors that further increase symptoms of feeding problems. These factors included early feeding problems during infancy, oxygen requirement past 40 weeks postmenstrual age, congenital heart disease, structural anomaly, genetic disorders, cerebral palsy, developmental delay, speech language delay, sensory processing disorder, vision impairment, and gastroesophageal reflux. The results of our study are in line with previous studies demonstrating the associations of multiple medical and developmental conditions with the severity of feeding problems (7,20,21,27). One interesting finding of our study was that children with cerebral palsy and children with vision impairment showed greater symptoms only in certain subscales of the PediEAT. Given the exploratory nature of this aim of the study and the small sample size with these conditions, further investigations with larger and more targeted groups are needed to confirm our findings.

The strengths of this study include both the use of a standardized measure with strong psychometric properties to assess feeding and a sample of preterm children representing a wide age group. However, there are also several limitations to this study. The study findings have limited generalizability because the sample is primarily White (>70%) with highly educated parents. Also, given the relatively small number of very preterm born children, the study sample may not adequately represent the prevalence of comorbid conditions in the preterm population. For example, preterm born children with sensory processing disorder may be underrepresented in our sample (14%), when compared to previously reported incidence in preterm-born children ranging from 39% to 52% (28–30). Replication using a more diverse sample with regards to degree of prematurity, race, ethnic, and educational background is needed. In addition, the data for medical risk factors were collected via parent report and the degree of impact on the child was not assessed. A future study incorporating clinical verification of child medical factors is needed. Lastly, this was a cross-sectional study that measured symptoms of feeding problems once per child. A longitudinal study is necessary to understand how symptom profiles change over time and what factors facilitate or interfere with symptom alleviation.

In conclusion, this study suggests that between the ages of 6 months and 7 years, both very preterm and moderate to late preterm children had greater symptoms of feeding problems compared to full-term children, regardless of their current age and/or sex. More severe symptoms were noted in very preterm children, particularly in the areas of the Physiologic Symptoms and Selective/Restrictive Eating. Multiple medical risk factors were associated with increased symptoms of feeding problems in preterm children. Early and frequent assessment of feeding across early childhood in preterm-born children is needed to optimize care and long-term outcomes.

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