Published in final edited form as:

J Pediatr. 2015 December ; 167(6): 1347–1353. doi:10.1016/j.jpeds.2015.09.022.

Neurodevelopmental Profile, Growth, and Psychosocial Environment of Preterm Infants with Difficult Feeding Behavior at Two Years of Age

Tara L. Crapnell, OTD¹, Lianne J. Woodward, PhD², Cynthia E. Rogers, MD^{3,4}, Terrie E. Inder, MD², and Roberta G. Pineda, PhD^{1,3}

¹Program in Occupational Therapy, Washington University School of Medicine, St. Louis, MO

³Program in Pediatrics, Washington University School of Medicine, St. Louis, MO

⁴Program in Psychiatry, Washington University School of Medicine, St. Louis, MO

²Department of Pediatric Newborn Medicine, Brigham and Women's Hospital, Harvard Medical School, Boston, MA

Abstract

Objectives—To examine the association of difficult feeding behaviors in very preterm infants at two years of age with growth and neurodevelopmental outcomes and family factors and functioning.

Study design—Eighty children born 30 weeks gestation were studied from birth until two years of age. Feeding difficulties were assessed using the Eating Subscale of the Infant-Toddler Social Emotional Assessment at age two years alongside growth and developmental testing. Maternal mental health and family factors were assessed using standardized questionnaires. ANOVA and chi-square analyses were used to determine associations between feeding difficulties and growth, neurodevelopmental outcomes, and family characteristics.

Results—Twenty-one (26%) of the cohort were at risk for feeding difficulties, and an additional 18 (23%) had definite feeding difficulties at age two years. Those with feeding difficulties were more likely to be subject to a range of neurodevelopmental problems including impaired cognition ($p=0.02$), language ($p=0.04$), motor ($p=0.01$) and socio-emotional ($p<0.007$) skills. Parents of very preterm born children with feeding difficulties had higher parenting stress ($p=0.02$) and reported more difficulty managing their child's behavior ($p=0.002$) and more frequent parent-child interaction problems ($p=0.002$) than parents of children with fewer feeding difficulties. No associations were found between difficult feeding behaviors and growth, maternal mental health, and family factors.

Corresponding author: Dr. Roberta Pineda, Campus Box 8116, St. Louis Children's Hospital, 1 Children's Place, 10-109 Northwest Tower, St. Louis, MO 63110-1077, Telephone: (314) 286-1304, Fax: (314) 286-1261, Pineda_r@kids.wustl.edu.

The authors declare no conflicts of interest.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Conclusions—Difficult feeding behaviors in children born very preterm appear to be highly comorbid with other developmental and family challenges, including neurodevelopmental impairment and parent-child interaction difficulties. Focusing on improving feeding skills, in conjunction with supporting positive parent-child interactions, may be beneficial for improving outcomes.

Keywords

Neonatal intensive care unit; outcome; parenting; family functioning

Preterm infants often experience neurophysiological immaturity and decreased tone, which affect their ability to develop the skills needed for successful and enjoyable oral feeding (1–4). Previous studies have identified early medical factors that can influence feeding experiences (5–7) and shown links between developmental impairment and feeding difficulties (8–10). With the exception of our previous work that defined relationships between feeding difficulties and socioeconomic status (4), few studies have considered relations between family factors and the development of successful or problematic feeding behavior in the very preterm infant.

Early childhood feeding difficulties can be viewed as a transactional disorder, involving complex interactions between a child and their social environment (11–13). Feeding is an important part of growth and development, and can be a major source of social interaction within the family system. Caring for a child with feeding difficulties can be distressing for parents and may alter the parent-child relationship (14, 15). Reactions and responses to feeding difficulties can also further exacerbate an existing feeding problem (16). Key to developing effective interventions is the need to develop a better understanding of the neurodevelopmental profile of problem feeders and the broader psychosocial context in which feeding difficulties occur. This study describes 1) growth and neurodevelopmental characteristics of a cohort of very preterm infants with varying levels of feeding difficulty at age two years, and 2) examines relations between early childhood feeding difficulties and family characteristics and functioning. We hypothesized that infants with more feeding difficulties would have poorer growth and would have higher rates of comorbid neurodevelopmental difficulties. We also anticipated that the families of infants with feeding difficulties would be characterized by higher levels of maternal psychological distress and problems with parent-child interaction.

METHODS

The study sample consisted of 136 children born very preterm who were part of an overarching study investigating brain development. Consecutive new admissions to a level III-IV neonatal intensive care unit (NICU) were recruited by the third day of life between 2007 to 2010. Inclusion criteria were birth 30 weeks estimated gestational age and no documented congenital anomaly. At two years of age, infants returned for developmental testing, and physical growth was assessed. Parents were also asked to complete a battery of standardized assessments about their child's health and social emotional adjustment, as well as their own well-being and family situation. All study procedures were approved by the

Human Research Protection Office at the study site. Written informed consent was obtained from all parents/guardians.

One hundred thirty-six infants were enrolled, of whom seven withdrew, one transferred to another hospital, and one was withdrawn following diagnosis of a congenital anomaly. Of the remaining 127 infants, 20 infants died during their NICU hospitalization. Following discharge, an additional two infants died and one infant withdrew, leaving 104 in the cohort who were eligible for follow-up testing. Out of the 104 infants, 86 returned for follow up at age two years. Eighty infants (77%) had feeding outcome measured using the Infant-Toddler Social Emotional Assessment (ITSEA) Eating Subscale at age two years. There were no missing data points under the Eating Subscale among parents who completed it. There were no significant differences in medical and social factors between the infants who did and did not complete the ITSEA.

Feeding difficulties

Feeding difficulties were assessed at age two years using the Eating Subscale of the ITSEA (17). This subscale consists of nine items assessing typical (i.e., picky eating, reluctance to accept new foods) and atypical eating behaviors (i.e., spitting out food, holding food in cheeks, refusing to eat foods that requiring chewing, gagging, and choking on food; [17]). Parents rated the frequency with which their child engaged in each feeding behavior on a scale ranging from 0 (never/rarely) to 2 (often). Parents were also able to document “no opportunity.” Missing responses as well as items with “no opportunity” were coded as missing data. A score is not calculated if there are two or more missing data points. Children whose mean score exceeds 0.95 for girls and 0.97 for boys (10th percentile of the normative sample) were defined as “of concern” or as having atypical feeding behaviors (2). Based on the ITSEA manual, feeding difficulties, such as picky eating or food refusal, may be associated with sensory sensitivities or may reflect relational disturbance between the parent and child (17). Associations between the ITSEA and evaluator ratings and parental ratings of child behaviors and parental distress demonstrate acceptable validity of the ITSEA (18). Based on feeding data generated by this cohort, a Cronbach’s $\alpha=0.82$ was computed for the Eating Subscale, demonstrating high internal consistency.

To understand better the extent of feeding difficulties in this sample, we transformed raw scores from the Eating Subscale of the ITSEA into a 3-level ordinal variable. The 3-level ordinal variable included: No Feeding Difficulties (n=41; > 50th percentile) with a cut-off raw score of <0.44, At-Risk for Feeding Difficulties (n=21; 20th – 50th percentile) with a cut-off raw score ranging from 0.56 to 0.88, and Definite Feeding Difficulties (n=18; < 20th percentile) with a cut-off raw score of > 1.00. Children who were identified as “of concern” (n=18), based on standard ITSEA scoring (17), were all represented in the Definite Feeding Difficulties group using the new ordinal variable. In order to determine the relationship between feeding difficulties and 1) growth, 2) neurodevelopmental outcome, 3) family characteristics, and 4) parent perceptions of the parent-child interaction, a wide range of measures were examined and investigated using the 3-level ordinal feeding variable. Key measures found to be important and included in this analysis are described below.

Growth

At birth and term equivalent, length and weight were recorded and converted into z-scores using the LMS (lambda-mu-sigma) Growth software (19, 20). Height and weight were measured at age two years and entered into the World Health Organization Anthropometric software (WHO Anthro version 3.2.2.) to obtain z-scores for weight-for-age. Growth from birth to age two years was determined by subtracting z-scores at birth from z-scores at age two years. Growth from term equivalent age to age two years was determined by subtracting z-scores at term from z-scores at age two years.

Neurodevelopmental outcome

At age two years, development was assessed with the Bayley Scales of Infant and Toddler Development, Third Edition (Bayley-III; [21]). Composite scores for Cognitive, Language and Motor were computed. Information about child social and emotional adjustment was also collected using the parent-report measure, ITSEA, which provided Internalizing, Externalizing, and Competence domain scores (17). The Dysregulation domain was not examined, because the Eating Subscale is contained within this domain.

Family characteristics

Family factors were investigated for relationships to feeding difficulties, including: maternal age, ethnicity (Caucasian or non-Caucasian), family structure (married, separated with dual custody, or single parent), level of education of primary caregiver (college education, completed high school, or completed less than 12 years of school), occupation of primary income earner (professional/skilled, semiskilled, or unskilled), and employment status (full-time, part-time, or unemployed). Maternal depression was assessed using the 21-item Beck Depression Inventory, second edition (BDI-II; 22) with scores >13 indicating clinical depression. Maternal anxiety was assessed using the Hospital Anxiety and Depression Scale (HADS; 23, 24), which is a 14-item self-report screening tool for anxiety, depression, and emotional distress. The subscale score for Anxiety ranges from 0 to 21 with scores >7 indicating anxiety. For purposes of this study, the Anxiety Subscale score was only used. Maternal depression and anxiety measures were completed when the child was two years of age.

Parent-child relationship

The Parenting Stress Index-Short Form (PSI-SF) was used to assess the parent-child relationship when the child returned for two-year developmental follow-up testing. The PSI-SF (25) is a 36-item self-report measure of parenting stress that consists of three subscales: Parent Distress (stress related to personal parent factors, such as depression or lack of social support), Parent-Child Dysfunctional Interaction (indication of the parents dissatisfaction with interactions with their child), and Difficult Child Characteristics (parents perception of the child and their child's ability to self-regulate). In addition, the PSI-SF provides a Total Stress score, which measures parenting stress. Higher scores indicate higher levels of parenting stress or dysfunction within the parent-child relationship. The PSI-SF has high internal consistency (0.80 – 0.91) and good to excellent test-retest reliability (0.68 – 0.85; 25).

Statistical analyses

One-way ANOVA with a test for linearity was used for continuous variables and chi-square analyses for categorical variables to investigate associations between feeding difficulties and 1) growth, 2) neurodevelopmental outcome, 3) family characteristics, 4) and the parent's perception of the parent-child interaction using an $\alpha < 0.05$. Sibling status of the multiples as well as other risk factors were accounted for by using a mixed model. Statistical analyses were conducted using IBM SPSS (version 21).

RESULTS

Children with no feeding difficulties had a mean (SD) gestational age at birth of 26.6 (1.9) weeks, 26.6 (2.0) weeks for children at-risk for feeding difficulties, and 26.7 (1.7) weeks for children with definite feeding difficulties. Forty-four (56%) of the children were female and 23 (29%) were Caucasian.

The distribution of very preterm children's feeding difficulties on the nine items of the Eating Subscale of the ITSEA have been previously reported (4). For most children, feeding difficulties were relatively low in frequency and mild in nature, with the mean (SD) Eating Subscale score being 1.28 ± 0.23 (range: 1.00 – 1.67). However, for 23% ($n=18$), feeding difficulties fell within the clinical range for feeding difficulties according to the ITSEA Eating Subscale at age two years.

See Tables I and II for the distribution of feeding difficulties related to growth and neurodevelopmental profiles at two years.

Growth

With respect to growth outcomes, children with definite feeding difficulties weighed less at two years ($p=0.02$) with a mean (standard deviation) of 12 (1.5) kilograms (kg) for children with no feeding difficulties, 12.03 (1.8) kg for children at-risk for feeding difficulties, and 10.73 (1.5) kg for children with definite feeding difficulties. To determine if feeding difficulties were independently related to weight at age two years, we adjusted for language, motor, and cognitive outcome using multivariate regression, and the findings remained unchanged. There were no significant differences in height at age two years among those with and without feeding problems. Weight z-scores from birth to age two years and weight z-scores from term equivalent age to two years were not different among those with and without feeding problems (Table I).

Neurodevelopmental outcome

As shown in Table II, feeding difficulties and being at-risk for feeding difficulties were more common in children with lower Bayley-III scores, with lower Cognitive ($p=0.02$), Language ($p=0.04$) and Motor scores ($p=0.01$). These children also had higher Internalizing domain scores ($p=0.004$), including Depression/Withdrawal ($p=0.001$) and General Anxiety ($p=0.03$). Children with feeding difficulties and at risk for feeding difficulties also had lower Competence domain scores ($p=0.007$), specifically within the areas of Compliance ($p=0.02$) and Mastery Motivation ($p=0.004$). Finally, no association was found with Externalizing

domain scores. These findings were unchanged after statistical control for birth weight, gestational age at birth, and socioeconomic status at term equivalent age, as well as when controlling for sibling status among multiple births. No relationships between brain injury (having either cystic periventricular leukomalacia, intraventricular hemorrhage grade III-IV, or cerebellar hemorrhage) and feeding difficulties have been previously reported (4). Current findings also remained unchanged after controlling for brain injury.

Family characteristics and parent-child interaction

See Table III for descriptive data related to the family background and functioning of infants in the three feeding groups. Increased severity of feeding difficulties was associated with the following PSI-SF domains: total (parental) Stress ($p=0.02$), Difficult Child ($p=0.002$), and Parent-child Dysfunctional Interaction ($p=0.002$). No associations were found between feeding difficulties and family factors, maternal anxiety, or depression. These findings were unchanged after statistical control for birth weight, gestational age at birth, and socioeconomic status at term equivalent and accounting for siblings in multiple births. To aid our understanding of whether feeding difficulties were independently related to stress, we controlled for language, motor and cognitive outcome in a multivariate model, and the findings remained unchanged.

DISCUSSION

The findings of this study reveal that very preterm children with feeding difficulties during their first two years of life have poorer cognitive, language, and motor functioning at two years of age compared with very preterm children without feeding difficulties. Children with definite feeding difficulties and those who were at-risk for feeding difficulties were also reported by their parents to have more internalizing behaviors and to be less socially competent. Further, parents of children with feeding difficulties reported higher levels of (parenting) stress and greater dissatisfaction with interactions with their child. Lastly, this study found no associations between children with difficult feeding behaviors and growth, family factors, maternal anxiety, or depression.

It is well known that feeding difficulties can result in growth deficiencies and health problems. However, although children in the at-risk and definite feeding difficulties group were found to weigh less than those without feeding difficulties, there were no significant differences in growth velocity among children with and without feeding difficulties. Children with feeding difficulties might not eat a wide variety of foods, but may eat a high enough volume. Alternatively, they may be placed on nutritional supplements in order to make up for gaps in nutritional intake, decreasing their risk for growth deficiency (26). However, the use of nutritional supplements was not collected as part of this study and, thus we are unable to interpret if early supplementation may have confounded our findings and resulted in not seeing differences in growth among those with and without feeding problems.

Children with feeding difficulties and who were at risk for feeding difficulties had lower cognitive, language, and motor scores compared with those without feeding difficulties at age two years. During the first year of life, children are most vulnerable to feeding difficulties because they are progressing from eating an exclusively liquid diet to eating

purees and solids. They are also undergoing changes in oral motor musculature and function (27). To progress successfully to eating a variety of textured foods, a child must physically and behaviorally adapt to new oral motor and sensory experiences (27, 28). Having developmental challenges can make this transition difficult, as they may not have the developmental skills or ability to overcome and adapt to new feeding demands (27). This can potentially lead to feeding difficulties (10), which can negatively affect development and parent-child relations (15).

Findings from this study indicated that parents of children with feeding difficulties and who were at-risk for feeding difficulties had higher stress related to parent-child interactions, perceived their child to have characteristics or behaviors that are difficult to manage, and reported lower levels of satisfaction with interactions with their child. Successful feeding is a reciprocal process that is dependent upon the child providing the parent with clear social cues and the parent responding in an emotionally and developmentally appropriate manner (29). This process may be compromised in preterm infants, as they frequently have early feeding complications (1–3, 30), and social cues may be less evident (31, 32). As a result, feeding can become less infant-regulated and more parent-driven, shifting the focus from socializing and bonding to nutrition and volume. This can place significant pressure on the child to eat, which has been found to contribute not only to aversive mealtime behaviors, but also to parent stress and dysfunctional parent-child interactions (16). Elevated stress levels can potentially also result in less sensitive or more intrusive parenting, which in turn may negatively influence child well-being and the development of social competence (11, 33–35).

This study found that children with feeding difficulties and children who were at-risk for feeding challenges had lower social competence and demonstrated more internalizing behavior at two years of age. Social competence encompasses the social, emotional, and cognitive skills and behaviors needed for social adaptation and for developing healthy relationships (36). Although there are a myriad of factors that influence the development of social competence, a healthy parent-child relationship is a key component. Findings from this study support other research showing that children with feeding difficulties also experience difficulties with emotional regulation, anxiety (11, 32), and emotional under eating and food enjoyment (37). It is speculated that a cyclical relationship likely exists whereby child feeding difficulties and high levels of parental stress and negative child perceptions potentially reinforce and exacerbate feeding difficulties over time. Further follow-up will be important to understand better the developmental course for these children and families.

This study did not find any associations between feeding difficulties and maternal well-being or family social risk factors. The evidence regarding maternal well-being and socio-demographic factors and its influence on childhood feeding difficulties is variable, with some suggesting associations between feeding difficulties and maternal psychosocial functioning, and others reporting no association (38, 39). One study examining the effects of maternal characteristics found that maternal depression had only a transient effect on feeding and weight (38). Therefore, although the lack of association in this study may be reflective of the measures used to identify maternal psychosocial dysfunction, it may also

indicate that the quality of the parent- child relationship may be more important than maternal depression or anxiety in supporting adaptive feeding and predicting child feeding outcomes in children born very preterm.

There were limitations to this study. First, the ITSEA Eating Subscale consists of only nine items with most questions tapping into behavioral aspects of feeding, rather than sensorimotor aspects of feeding. However, there are few tools available to evaluate feeding difficulties at this age (40–45). Second, this study relied on parent-report measures of child and maternal adjustment, as well as parenting stress. Further studies with greater measurement independence should help clarify the nature of relations between family factors and feeding difficulties in the very preterm infant. Lastly, out of the 104 infants who remained in the study at age two years, 80 (77%) of the infants had feeding outcome measured using the ITSEA. These findings are also limited by a small sample size.

Overall, this study highlights the complexity of feeding and the transactional relationship that occur between the child and their social context. This study found that very preterm children with difficult feeding behaviors at two years of age might be at heightened risk for neurodevelopmental delay, poor social competence and emotional dysregulation, and dysfunctional parent-child interactions. Although the cross-sectional nature of our analyses make it challenging to interpret the direction of causation, it can be speculated that a cyclical relationship exists where difficult feeding behaviors, parental stress, and negative child perceptions potentially reinforce and exacerbate difficult feeding behaviors over time. Based on these findings, nutrition and volume should not be the primary focus of feeding therapy. Rather, feeding interventions should aim to support positive social interactions between the parent and child. Focusing on improving the feeding skills and neurodevelopmental status of the child in conjunction with supporting positive parent-child interactions during mealtimes may be beneficial for improving parent-child interactions, optimizing childhood feeding outcome, and enhancing growth, development and social-emotional competence.

Acknowledgments

Supported by the National Institute of Health (NIH; ROI HD 057098), the Doris Duke Charitable Foundation, the Washington University Intellectual and Developmental Disabilities Research Center from NIH/Eunice Kennedy Shriver National Institute for Child Health and Human Development (NICHD) (P30 HD062171), NIH/National Center for Medical Rehabilitation Research, NICHD, National Institute of Neurological Disorders and Stroke (K12 HD055931), and the National Center for Advancing Translational Sciences (UL1 TR000448, sub award KL2 TR000450).

We express our appreciation to the following individuals from Washington University who assisted with this project: Ryan Colvin, Michael Wallendorf, Karen Lukas, Anthony Barton, Jessica Connors, Rachel Paul, Claudine Vavasseur, and Han Tjoeng, who conducted data collection and analysis, obtained informed consents, and conducted patient oriented responsibilities to support the success of this project; Jim Alexopoulos, Reginald Lee, Tara Smyser, and Joe Ackermann Jr. who worked on imaging data synthesis; and Meredith Gronski, Sarah Oberle, Lisa Tiltges, Lauren Reynolds, Cori Zarem, and Laura Lewis, who provided editorial assistance and guidance. We also thank the families and infants who were participants and made this research possible.

ABBREVIATIONS

BDI-II	Beck Depression Inventory 2 nd edition
Bayley-III	Bayley Scale of Infant and Toddler Development-3 rd edition

HADS	Hospital Anxiety Depression Scale
ITSEA	Infant- Toddler Social Emotional Assessment
LMS	lambda-mu-sigma
NICU	neonatal intensive care unit
PSI-SF	Parenting Stress Index, short form

References

1. Silberstein D, Geva R, Feldman R, Gardner JM, Karmel BZ, Rozen H, et al. The transition to oral feeding in low-risk premature infants: relation to infant neurobehavioral functioning and mother-infant feeding interaction. *Early Hum Dev.* 2009; 85(3):157–62. [PubMed: 18809266]
2. Medoff-Cooper B, Ratcliffe SJ. Development of preterm infants: feeding behaviors and brazelton neonatal behavioral assessment scale at 40 and 44 weeks' postconceptional age. *ANS Adv Nurs Sci.* 2005; 28(4):356–63. [PubMed: 16292021]
3. Palmer MM, Crawley K, Blanco IA. Neonatal oral-motor assessment scale: a reliability study. *J Perinatol.* 1993; 13(1):28–35. [PubMed: 8445444]
4. Crapnell TL, Rogers CE, Neil JJ, Inder TE, Woodward LJ, Pineda RG. Factors associated with feeding difficulties in the very preterm infant. *Acta Paediatr.* 2013; 102(12):e539–45. [PubMed: 23952198]
5. Bazyk S. Factors associated with the transition to oral feeding in infants fed by nasogastric tubes. *Am J Occup Ther.* 1990; 44(12):1070–8. [PubMed: 2126165]
6. Bier JA, Ferguson A, Cho C, Oh W, Vohr BR. The oral motor development of low-birth- weight infants who underwent orotracheal intubation during the neonatal period. *Am J Dis Child.* 1993; 147(8):858–62. [PubMed: 7688931]
7. Howe TH, Sheu CF, Hinojosa J, Lin J, Holzman IR. Multiple factors related to bottle-feeding performance in preterm infants. *Nurs Res.* 2007; 56(5):307–11. [PubMed: 17846551]
8. Mathisen B, Reilly S, Skuse D. Oral-motor dysfunction and feeding disorders of infants with turner syndrome. *Dev Med Child Neurol.* 1992; 34(2):141–9. [PubMed: 1733819]
9. Cassidy SB, Schwartz S, Miller JL, Driscoll DJ. Prader-willi syndrome. *Genet Med.* 2012; 14(1):10–26. [PubMed: 22237428]
10. Sangermano M, D'Aniello R, Massa G, Albano R, Pisano P, Budetta M, et al. Nutritional problems in children with neuromotor disabilities: an Italian case series. *Italian journal of pediatrics.* 2014; 40:61. [PubMed: 25000975]
11. Feldman R, Keren M, Gross-Rozval O, Tyano S. Mother-Child touch patterns in infant feeding disorders: relation to maternal, child, and environmental factors. *J Am Acad Child Adolesc Psychiatry.* 2004; 43(9):1089–97. [PubMed: 15322412]
12. Chatoor I, Ganiban J, Colin V, Plummer N, Harmon RJ. Attachment and feeding problems: a reexamination of nonorganic failure to thrive and attachment insecurity. *J Am Acad Child Adolesc Psychiatry.* 1998; 37(11):1217–24. [PubMed: 9808934]
13. Chatoor I, Ganiban J, Hirsch R, Borman-Spurrell E, Mrazek DA. Maternal characteristics and toddler temperament in infantile anorexia. *J Am Acad Child Adolesc Psychiatry.* 2000; 39(6):743–51. [PubMed: 10846309]
14. Aviram I, Atzaba-Poria N, Pike A, Meiri G, Yerushalmi B. Mealtime dynamics in child feeding disorder: The role of child temperament, parental sense of competence, and paternal involvement. *J Pediatr Psychol.* 2014; jsu095.
15. Fishbein M, Benton K, Struthers W. Mealtime Disruption and Caregiver Stress in Referrals to an Outpatient Feeding Clinic. *Journal of Parenteral and Enteral Nutrition.* 2014:0148607114543832. [PubMed: 25052548]

16. Wright CM, Parkinson KN, Drewett RF. How does maternal and child feeding behavior relate to weight gain and failure to thrive? Data from a prospective birth cohort. *Pediatrics*. 2006; 117(4): 1262–9. [PubMed: 16585323]
17. Carter AS, Briggs-Gowan MJ, Jones SM, Little TD. The infant-toddler social and emotional assessment (ITSEA): factor structure, reliability, and validity. *J Abnorm Child Psychol*. 2003; 31(5):495–514. [PubMed: 14561058]
18. Carter AS, Briggs-Gowan MJ, Jones SM, Little TD. The infant–toddler social and emotional assessment (ITSEA): Factor structure, reliability, and validity. *J Abnorm Child Psychol*. 2003; 31(5):495–514. [PubMed: 14561058]
19. Cole TJ, Green PJ. Smoothing reference centile curves: the LMS method and penalized likelihood. *Statistics in medicine*. 1992; 11(10):1305–19. [PubMed: 1518992]
20. Cole TJ, Freeman JV, Preece MA. British 1990 growth reference centiles for weight, height, body mass index and head circumference fitted by maximum penalized likelihood. *Statistics in medicine*. 1998; 17(4):407–29. [PubMed: 9496720]
21. Bayley, N. Bayley scales of infant and toddler development. 3. San Antonio, TX: Harcourt Assessment; 2006.
22. Beck, AT.; Steer, RA.; Brown, GK. Manual for the beck depression inventory-II. San Antonio, TX: Psychological Corporation; 1996.
23. Snaith, RP.; Zigmond, AS. The hospital anxiety and depression scale manual. Windsor, Ontario: NFER-Nelson; 1994.
24. Zigmond AS, Snaith RP. The hospital anxiety and depression scale. *Acta Psychiatr Scand*. 1983; 67(6):361–70. [PubMed: 6880820]
25. Abidin, RR. Parenting stress index professional manual. 3. Odessa, FL: Psychological Assessment Resources, Inc; 1995.
26. Budd KS, McGraw TE, Farbisz R, Murphy TB, Hawkins D, Heilman N, et al. Psychosocial concomitants of children's feeding disorders. *J Pediatr Psychol*. 1992; 17(1):81–94. [PubMed: 1545323]
27. Aldridge VK, Dovey TM, Martin CI, Meyer C. Identifying clinically relevant feeding problems and disorders. *J Child Health Care*. 2010; 14(3):261–70. [PubMed: 20534637]
28. Carruth BR, Skinner JD. Feeding behaviors and other motor development in healthy children (2–24 months). *J Am Coll Nutr*. 2002; 21(2):88–96. [PubMed: 11999548]
29. Black MM, Aboud FE. Responsive feeding is embedded in a theoretical framework of responsive parenting. *J Nutr*. 2011; 141(3):490–4. [PubMed: 21270366]
30. Crapnell T, Rogers C, Neil J, Inder T, Woodward L, Pineda R. Factors associated with feeding difficulties in the very preterm infant. *Acta Paediatr*. 2013
31. Eckerman CO, Hsu HC, Molitor A, Leung EH, Goldstein RF. Infant arousal in an en-face exchange with a new partner: effects of prematurity and perinatal biological risk. *Dev Psychol*. 1999; 35(1):282–93. [PubMed: 9923482]
32. Silberstein D, Feldman R, Gardner JM, Karmel BZ, Kuint J, Geva R. The Mother–Infant Feeding Relationship Across the First Year and the Development of Feeding Difficulties in Low-Risk Premature Infants. *Infancy*. 2009; 14(5):501–25.
33. Baker BL, McIntyre L, Blacher J, Crnic K, Edelbrock C, Low C. Pre-school children with and without developmental delay: behaviour problems and parenting stress over time. *Journal of Intellectual Disability Research*. 2003; 47(4–5):217–30. [PubMed: 12787154]
34. Blissett J, Meyer C, Haycraft E. The role of parenting in the relationship between childhood eating problems and broader behaviour problems. *Child Care Health Dev*. 2011; 37(5):642–8. [PubMed: 21434970]
35. Anthony LG, Anthony BJ, Glanville DN, Naiman DQ, Waanders C, Shaffer S. The relationships between parenting stress, parenting behaviour and preschoolers' social competence and behaviour problems in the classroom. *Infant and Child Development*. 2005; 14(2):133–54.
36. Rispoli KM, McGoey KE, Koziol NA, Schreiber JB. The relation of parenting, child temperament, and attachment security in early childhood to social competence at school entry. *Journal of school psychology*. 2013; 51(5):643–58. [PubMed: 24060065]

37. Jansen PW, Roza SJ, Jaddoe VW, Mackenbach JD, Raat H, Hofman A, et al. Children's eating behavior, feeding practices of parents and weight problems in early childhood: results from the population-based Generation R Study. *Int J Behav Nutr Phys Act*. 2012; 9:130. [PubMed: 23110748]
38. Wright CM, Parkinson KN, Drewett RF. The influence of maternal socioeconomic and emotional factors on infant weight gain and weight faltering (failure to thrive): data from a prospective birth cohort. *Arch Dis Child*. 2006; 91(4):312–7. [PubMed: 16397011]
39. O'Brien LM, Heycock EG, Hanna M, Jones PW, Cox JL. Postnatal depression and faltering growth: a community study. *Pediatrics*. 2004; 113(5):1242–7. [PubMed: 15121936]
40. Crist W, Dobbelsteyn C, Brousseau AM, Napier-Phillips A. Pediatric assessment scale for severe feeding problems: validity and reliability of a new scale for tube-fed children. *Nutr Clin Pract*. 2004; 19(4):403–8. [PubMed: 16215132]
41. Seiverling L, Hendy HM, Williams K. The Screening Tool of Feeding Problems applied to children (STEP-CHILD): psychometric characteristics and associations with child and parent variables. *Res Dev Disabil*. 2011; 32(3):1122–9. [PubMed: 21316919]
42. Crist W, Napier-Phillips A. Mealtime behaviors of young children: a comparison of normative and clinical data. *J Dev Behav Pediatr*. 2001; 22(5):279–86. [PubMed: 11718230]
43. Lukens CT, Linscheid TR. Development and validation of an inventory to assess mealtime behavior problems in children with autism. *J Autism Dev Disord*. 2008; 38(2):342–52. [PubMed: 17578658]
44. Archer LA, Rosenbaum PL, Streiner DL. The children's eating behavior inventory: reliability and validity results. *J Pediatr Psychol*. 1991; 16(5):629–42. [PubMed: 1744810]
45. Sanchez K, Spittle AJ, Allinson L, Morgan A. Parent questionnaires measuring feeding disorder in preschool children: a systematic review. *Dev Med Child Neurol*. 2015

Table 1

Growth velocity among feeding groups.

Variables	No feeding difficulties > 50 th percentile (n=41)	At-risk for feeding difficulties 20 th to 50 th percentile (n=21)	Definite feeding difficulties < 20 th percentile (n=18)	F	p *
Weight Z-score at birth [†]	-0.49 (0.9)	-0.1 (0.7)	-0.9 (0.8)	1.3	0.25
Weight Z-score at term age [‡]	-1.6 (0.8)	-1.1 (1.1)	-1.6 (0.9)	0.01	0.92
Weight Z-score at age two years [‡]	0.4 (1.3)	-0.1 (1.2)	-0.2 (0.9)	2.9	0.10
Growth difference from birth to term [§]	-0.9 (0.8)	-0.9 (1.1)	-0.7 (0.9)	0.5	0.50
Growth difference from birth to age two years [§]	0.1 (1.2)	-0.1 (1.3)	0.3 (1.0)	2.1	0.15
Growth difference from term to age two years [§]	1.6 (1.3)	0.9 (1.5)	1.0 (1.1)	2.8	0.10

* ANOVA investigation of feeding difficulties and growth, using $\alpha < 0.05$.

[†] Birth time point ranges from 23 to 30 weeks gestation.

[‡] Term age ranges from 36 to 41 weeks postmenstrual age.

[§] Growth was obtained by subtracting z-scores for weight at birth from z-scores at term equivalent, by subtracting z-scores for weight from birth from z-scores at two years, and by subtracting z-scores for weight at term equivalent age from z-scores at two years. Positives indicate an increase in z-scores and negatives indicate a decrease in z-scores. Z-scores adjust weight based on the postmenstrual age (at birth and term equivalent age time points) and time of testing (at two year time point) compared to normative data.

Table II

Neurodevelopmental profile of children with feeding difficulties.

Variables	No feeding difficulties > 50 th percentile (n=41)	At-risk for feeding difficulties 20 th to 50 th percentile (n=21)	Definite feeding difficulties < 20 th percentile (n=18)	F	[*] p
Neurodevelopment (Bayley-III) [†]					
Cognitive composite score	88.7 (8.0)	83.8 (9.7)	83.1 (11.3)	5.6	0.02
Language composite score	91.4 (9.4)	84.8 (12.2)	85.7 (11.2)	4.4	0.04
Motor composite score	86.7 (8.2)	79.5 (12.7)	80.0 (13.7)	6.3	0.01
Social-emotional development (ITSEA) [‡]					
Externalizing domain [§]	52.0 (12.0)	55.0 (12.2)	58.0 (13.9)	3.0	0.09
Internalizing domain [§]	47.3 (10.8)	50.4 (6.7)	56.3 (13.9)	8.6	0.004
Competence domain ^{//}	45.5 (14.1)	37.3 (11.1)	36.1 (14.4)	7.7	0.007

^{*} ANOVA investigation associations between feeding difficulties and the Bayley Scales of Infant and Toddler Development, Third Edition (Bayley-III) and Infant-Toddler Social Emotional Assessment (ITSEA), using $\alpha < 0.05$.

[†] Scores from the Bayley-III.

[‡] Scores from the ITSEA.

[§] Higher scores indicate more abnormality (more externalizing and internalizing behaviors).

^{//} Lower scores indicate more abnormality (lower competence).

Table III

Family background and functioning factors associated with feeding difficulties.

Variables	No feeding difficulties > 50 th percentile (n=41)	At-risk for feeding difficulties 20 th to 50 th percentile (n=21)	Definite feeding difficulties < 20 th percentile (n=18)	F	p
Family background					
Mean (SD) Maternal age	29.5 (7.5)	27.1 (7.12)	27.9 (5.6)	1.1	0.31*
% Caucasian	52	42	44	1 [‡]	0.62 [‡]
% Single-parent or foster	21	29	17	1 [‡]	0.80 [‡]
% <11 years of schooling	5	10	6	1 [‡]	0.60 [‡]
% Unskilled occupation	33	19	27	1 [‡]	0.34 [‡]
% Full-time employment	33	20	22	1 [‡]	0.36 [‡]
Maternal mental health					
M (SD) depression [§]	7.9 (9.4)	11 (10.7)	8.58 (9.2)	0.2	0.64*
Mean (SD) anxiety ^{//}	10.2 (4.4)	9.33 (4.4)	10.75 (4.1)	0.03	0.86*
Parent-child relationship (PSI-SF) [¶]					
M (SD) Stress	63.6 (18.1)	78.81 (21.9)	74.73 (10.2)	6.2	0.02*
Mean (SD) Parental Distress	23.4 (9.3)	28.68 (12.4)	25.25 (6.0)	1.1	0.29*
Mean (SD) Difficult Child Characteristics	23.0 (7.8)	30 (8.9)	29.72 (8.4)	10.3	0.002*
Mean (SD) Parent-child Dysfunctional Interaction	16.5 (5.0)	20.47 (6.8)	20.88 (4.4)	9.9	0.002*

* ANOVA investigation associations between feeding difficulties and family background factors, social risk score, and Parenting Stress Index, Short Form (PSI-SF), using $\alpha < 0.05$ [‡] Chi-square analysis investigation with feeding difficulties and family background factors, using $p < 0.05$.[‡] df statistic from chi-square analysis investigating associations with feeding difficulties[§] Depression scores from the Beck Depression Inventory, Second Edition (BDI).^{//} Anxiety scores from the Hospital Anxiety and Depression Scale (HADS).[¶] Scores from the Parenting Stress Index, Short Form (PSI-SF).