Erol *et al.*
Egyptian Pediatric Association Gazette (2023) 71:65
https://doi.org/10.1186/s43054-023-00213-7

Egyptian Pediatric Association Gazette

RESEARCH **Open Access**

Investigation of the relationship between oral motor feeding development and gross motor development between preterm and term infants at 10- to 12-month postnatal age

Erkan Erol[1*], Umut Apaydın[2], Numan Demir[3] and Bülent Elbasan[4]

Abstract

Background Immature central nervous system, extended stay in the neonatal intensive care unit, and sensory experience deficiency may contribute to oral and gross motor delay in preterm infants. Current study aimed to investigate oral and motor development in preterm infants.

Methods Twenty-nine preterm infants and 28 term infants were evaluated within the scope of the study. Oral motor feeding development was assessed with the Schedule for Oral Motor Assessment, and motor development was evaluated with the Alberta Infant Motor Scale. All analyses were performed using SPSS 22. The study was approved by the Gazi University Clinical Researches Ethics Committee (no: 25901600–23).

Results There was a correlation between the Schedule for Oral Motor Assessment categories (solid, semisolid, cracker, puree, bottle, and cup) and the Alberta Infant Motor Scale score ($p < 0.05$). There was a significant difference between groups in the Schedule for Oral Motor Assessment's solid, semisolid, cracker, and puree categories and total score ($p < 0.05$). There was a significant difference between groups regarding the Alberta Infant Motor Scale score ($p < 0.05$).

Conclusion Preterm infants come behind their term peers in motor and oral motor feeding performance. These two areas of development can influence each other. For this reason, oral motor feeding problems should be emphasized as well as motor problems in physiotherapy rehabilitation evaluations.

Keywords Infant, Premature, Growth and development, Feeding

*Correspondence:
Erkan Erol
erkanerol@gmail.com
Full list of author information is available at the end of the article

Background

Recent evidence suggests that preterm birth and low birth weight are the strongest indicators of feeding problems [1, 2]. In the neonatal intensive care unit (NICU), preterm infants often experience issues such as poor arousal to engage in the feeding process, inadequate oral motor reflexes, and suck-swallow-breathe discoordination [3]. Difficulties in developing eating skills, food rejection, starting solid foods, and symptoms of dysphagia are some of the problems that arise after hospital discharge [4]. These challenges result from immaturity, parenteral or tube feeding instead of oral motor feeding experience, or health conditions such as neurological or cognitive disorders [5].

Preterm infants may experience oral motor feeding dysfunction during the sucking stage and when transitioning to solid foods. In healthy-term infants, oral skills gradually develop in the first 2 years after birth [2]. Chewing skills typically emerge between 6 months and 2 years of age, with the fastest development occurring between months 6 and 10 [6]. Feeding problems that arise during the neonatal stage can persist throughout the child's early years [7]. Delays in feeding skills in preterm infants become more noticeable in the second half of the first year when they are introduced to new foods and textures [8].

Understanding the development of oral motor feeding skills in preterm children is crucial for promoting interventions that support feeding [9]. There are numerous studies in the literature on the eating problems experienced by preterm infants in the NICU [10–13]. Pineda et al. reported that preterm infants have more feeding problems compared to their term peers [14]. Rinat et al. reported that feeding difficulties in preterm infants at 4 months were associated with motor development at 4–5 years of age [15]. But the number of studies investigating the significant impact of eating skills on the development and growth of preterm infants in late infancy is insufficient.

Several studies have reported a relationship between feeding skills and motor development during the newborn period [15, 16]. However, there is a research gap in the literature regarding the relationship between feeding skills and motor development around 10–12 months, a critical period when chewing skills mature.

Method

The study was carried out at Gazi University, Department of Physiotherapy and Rehabilitation. Twenty-nine preterm (mean gestational age: 32, 15 girls-14 boys) and 28 term (mean gestational age: 38.75, 14 girls-14 boys) infants between 10 and 12 months were included in this cross-sectional study. Written informed consents were obtained from their parents. The study was approved by the Gazi University Clinical Researches Ethics Committee (no: 25901600–23). Infants could not sit with support, diagnosed with swallowing dysfunction, congenital malformation, and systemic diseases were excluded from the study.

The infants were fed by their caregivers and were not allowed to intake food around the time before the assessment. They were assessed in the sitting position on a standard feeding chair. The proper position of the body and head was obtained. They were video-recorded during feeding for oral motor feeding assessment. A physiotherapist with a 4-year clinical pediatric rehabilitation experience carried out assessments. The room was quiet enough for the infants to cooperate.

Oral motor feeding assessment

The Schedule for Oral Motor Assessment (SOMA) was used for oral motor feeding assessment. The SOMA was developed in 1995 by Reilly et al. and is used to objectively assess oral motor functions in 8–24-month-old infants [17]. Its validity and reliability have been established previously [17, 18].

Motor assessment

The Alberta Infant Motor Scale (AIMS) assesses motor development. The AIMS evaluates motor performance during the period beginning from birth to the walking phase [19]. The baby was encouraged to carry out a skill spontaneously during the assessment. The AIMS has 58 items in four positions: supine, prone, sitting, and standing. The AIMS is a valid and reliable scale [20].

Statistical analysis

All analyses were performed using SPSS 22. Mann–Whitney *U*-test was used to compare two independent groups. Correlation coefficients and statistical significance of normally distributed data were calculated by the Pearson test, while correlation coefficients and statistical significance of non-normally distributed data were calculated by the Spearman test. In addition, the association between the two variables was analyzed by linear regression. A univariate linear regression analysis model was used to assess the independent association of SOMA data with the AIMS score as the dependent variable.

Results

Table 1 shows the characteristics of the groups. While there was a significant difference between groups regarding puree, solids, semisolids, cracker, and total SOMA scores, there was no difference in bottle and cup categories (Table 2).

Table 1 Characteristics of the infants

	Study group ($n=29$)	Control group ($n=28$)
Corrected age (month)	11 (10.5–11.5)	10.13 (10–12)
Height (cm)	73.62 ± 1.93	74.29 ± 2.60
Weight (kg)	8.87 ± 0.97	9.49 ± 1.12
Maternal age	31.24 ± 4.74	31.07 ± 4.94
Paternal age	34.34 ± 4.62	33.86 ± 5.80
Gestational age (week)	32 (30.4–33.4)	38.75 (38–40)
Birth weight (g)	1738.97 ± 542.70	3196.79 ± 426.27
Oxygen support duration (day)	4 (0–18)	0 (0–0)
NICU stay duration (day)	30 (15–54)	0 (0–0)

NICU Neonatal intensive care unit

$p<0.05$

Table 2 Scores according to the Schedule for Oral Motor Assessment categories

	Study group ($n=29$) Median (IQR)	Control group ($n=28$) Median (IQR)	Mann–Whitney *U*-test *p*
SOMA (puree)	0 (0–1)	0 (0–0)	**0.005**
SOMA (solids)	0 (0–0)	0 (0–0)	**0.01**
SOMA (semisolids)	0 (0–0.75)	0 (0–0)	**0.005**
SOMA (cracker)	0 (0–0)	0 (0–0)	**0.035**
SOMA (bottle)	0 (0–0)	0 (0–0)	0.083
SOMA (cup)	1 (0–2)	0 (0–1)	0.126
SOMA (total)	2 (0–3.5)	0 (0–1)	**0.009**

IQR Interquartile range

$p<0.05$

Eight infants in the study group were under the five percentile according to the AIMS score and presented atypical motor development. On the other hand, none of the infants in the control group presented atypical motor development according to the AIMS (Table 3).

There was a correlation between puree, solid, cracker, bottle, and cup categories of SOMA, SOMA total score, and AIMS score ($p<0.05$). According to the Spearman test, there was no correlation between the semisolids category of SOMA and the AIMS score ($p>0.05$). According to univariate regression analysis, there was a significant correlation between all categories of SOMA, SOMA total score, and AIMS score ($p<0.05$). According to the univariate linear regression analysis results, oral motor feeding skills were determined to represent a factor affecting motor development (Table 4).

Table 3 Percentage scores of the Alberta Infant Motor Scale

	Study group ($n=29$)		Control group ($n=28$)		Mann–Whitney *U*-test
	n	%	*n*	%	*p*
AIMS (0–5%)	8	27.6	0	0	**0.037**
AIMS (5–10%)	0	0	2	71	
AIMS (10–25%)	0	0	1	3.6	
AIMS (25–50%)	3	10.3	6	21.4	
AIMS (50–75%)	13	44.8	8	28.6	
AIMS (75–90%)	5	17.2	7	25.0	
AIMS (90–100%)	0	0	4	14.3	

AIMS Alberta Infant Motor Scale

$p<0.05$

Table 4 Linear regression analysis and correlation between Alberta Infant Motor Scale and Schedule for Oral Motor Assessment

	AIMS			
	p^1	r	p^2	R^2
SOMA (puree)	**< 0.001**	**− 0.626**	**0.001**	**0.355**
SOMA (solids)	**< 0.001**	**− 0.623**	**0.001**	**0.364**
SOMA (semisolids)	0.066	− 0.352	**0.022**	**0.187**
SOMA (cracker)	**< 0.001**	**− 0.670**	**0.002**	**0.332**
SOMA (bottle)	**0.014**	**− 0.453**	**0.009**	**0.225**
SOMA (cup)	**0.036**	**− 0.391**	**0.008**	**0.235**
SOMA (total)	**< 0.001**	**− 0.618**	**< 0.001**	**0.434**

SOMA Schedule for Oral Motor Assessment, *AIMS* Alberta Infant Motor Scale, p^1 Spearman test, p^2 regression analysis, $p<0.05$

Discussion

This study shows that oral motor feeding development and motor performance are related, and preterm infants with a developmental delay may also have problems in oral motor feeding. Preterm infants were found to be behind term infants regarding oral and motor development.

It is estimated that the feeding problem's prevalence is between 25 and 45% in preterm infants [21]. Sanchez et al. reported that 38% of preterm infants born before 30-week gestation have oral motor feeding impairment [22]. Buswell stated that 20% of preterm infants have oral motor feeding dysfunction [2]. In the present study, five preterm infants (17.2%) had dysfunction in at least one category of SOMA. The rate of oral motor dysfunction in our study is similar to Buswell's study. It was less than the rate reported by Sanchez et al. because all preterm infants born before 37 weeks were included in our study. None of the infants in the control group had oral motor feeding dysfunction. It is widely accepted that oral motor feeding problems occur when preterm infants do not complete their maturation, stay in the NICU, cannot get sufficient environmental stimulation, or are exposed to non-oral feeding methods.

Preterm infants are at risk in terms of motor development [23]. Castro investigated sensory oral and global motor development of preterm infants and stated that 26% of preterm infants showed abnormal motor development according to AIMS [24]. Infants with lower gestational ages received lower AIMS scores. The present study found eight preterm infants (27.6%) below the fifth percentile who showed abnormal motor development. However, none of the infants in the control group presented abnormal motor development. Preterm infants may have motor development delays due to an immature central nervous system, brain lesion, or adverse effects of NICU. So tracking them to support early development may be a reasonable course of action.

Due to the potential hypotonia and delayed neck, body, jaw, and cheek control, preterm infants may have feeding problems such as weak suction, weak lip closure, and poor coordination [25]. All these factors affect liquid intake through a bottle or cup. The present study found a correlation between SOMA (bottle and cup categories) and AIMS scores. These results indicate that decreased motor skills and posture affect oral motor feeding skills for these categories, which is in line with the literature. Previous studies have shown that using a cup is one of the most challenging oral motor feeding skills for infants.

A significant difference was found between groups regarding puree, solid, semisolid, and cracker categories. Preterm infants showed poorer performance in all four categories. Furthermore, the puree, solid, and cracker categories were correlated with the AIMS score. Coordinated and rhythmical movements of the lips, tongue, and chin play a leading role in manipulating puree, solid, semisolid, and cracker substances. A supportive layer provided by the cervical spine and shoulder girdle is needed for functional tongue and chin muscle development [26]. Preterm infants often experience underdeveloped control of these supporting layers due to insufficient gross motor development. Because of this inadequate development of proximal parts, their ability to eat solid foods will likely be insufficient.

Therefore, it is important to support motor skills in order to develop feeding skills. Increasing motor stability with environmental regulations (for example, using an assisted chair) may also improve feeding skills. Also, interventions for feeding skills may contribute to motor development.

Conclusion

Preterm infants come behind their term peers in motor and oral motor feeding performance. In previous studies, it has been shown that preterm infants experience feeding problems and motor developmental delay. However, in the present study, the oral motor feeding skills of 10–12-month-old infants were evaluated with foods of different consistencies, during the period when chewing skills were most rapidly developed, and it was shown that they performed worse than their term peers in this period. Therefore, including supportive treatments for motor and oral motor feeding development in the early intervention programs may affect development in preterm infants.

Acknowledgements
This study was produced from the first author's master's thesis.

Authors' contributions
EE contributed significantly to the design of the article, EE and UA to the collection of data, and ND to the analysis and interpretation of the data. All authors participated in the drafting of the article, and BE critically revised it. All authors have read and approved the final version of the article.

Funding
The authors report no involvement in the research by the sponsor that could have influenced the outcome of this work.

Availability of data and materials
Not applicable.

Declarations

Ethics approval and consent to participate
The study was approved by the Gazi University Clinical Researches Ethics Committee (No: 25901600–23).

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

Author details
[1]Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, Tokat Gaziosmanpaşa University, Tokat, Turkey. [2]Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, Karadeniz Technical University, Trabzon, Turkey. [3]Faculty of Physiotherapy and Rehabilitation, Hacettepe University, Ankara, Turkey. [4]Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, Gazi University, Ankara, Turkey.

Received: 17 July 2023 Accepted: 1 September 2023
Published online: 12 December 2023

References

1. Thabet AM, Sayed ZA (2021) Effectiveness of the premature infant oral motor intervention on feeding performance, duration of hospital stay, and weight of preterm neonates in neonatal intensive care unit: results from a randomized controlled trial. Dimens Crit Care Nurs 40(4):257–265
2. Buswell CA, Leslie P, Embleton ND, Drinnan MJ (2009) Oral-motor dysfunction at 10 months corrected gestational age in infants born less than 37 weeks preterm. Dysphagia 24(1):20–25
3. Kwon J, Kellner P, Wallendorf M, Smith J, Pineda R (2020) Neonatal feeding performance is related to feeding outcomes in childhood. Early Hum Dev 151(2):105202
4. Pados BF, Hill RR, Yamasaki JT, Litt JS, Lee CS (2021) Prevalence of problematic feeding in young children born prematurely: a meta-analysis. BMC Pediatr 21(1):110
5. Reilly S, Skuse D, Wolke D (2013) The nature and consequences of feeding problems in infancy. Childhood feeding problems and adolescent eating disorders. pp 7–40
6. Demonteil L, Tournier C, Marduel A, Dusoulier M, Weenen H, Nicklaus S (2019) Longitudinal study on acceptance of food textures between 6 and 18 months. Food Qual Prefer 71:54–65
7. Nieuwenhuis T, Verhagen EA, Bos AF, van Dijk MWG (2016) Children born preterm and full term have similar rates of feeding problems at three years of age. Acta Paediatr 105(10):452–457
8. Pridham K, Steward D, Thoyre S, Brown R, Brown L (2007) Feeding skill performance in premature infants during the first year. Early Hum Dev 83(5):293–305
9. Voniati L, Papaleontiou A, Georgiou R, Tafiadis D (2021) The effectiveness of oral sensorimotor intervention in children with feeding disorders. Curr Dev Disord Reports 8(4):201–211
10. Asadollahpour F, Yadegari F, Soleimani F, Khalesi N (2015) The effects of non-nutritive sucking and pre-feeding oral stimulation on time to achieve independent oral feeding for preterm infants. Iran J Pediatr 25(3):e809
11. Bache M, Pizon E, Jacobs J, Vaillant M, Lecomte A (2014) Effects of prefeeding oral stimulation on oral feeding in preterm infants: a randomized clinical trial. Early Hum Dev 90(3):125–129
12. Bala P, Kaur R, Mukhopadhyay K, Kaur S (2016) Oromotor stimulation for transition from gavage to full oral feeding in preterm neonates: a randomized controlled trial. Indian Pediatr 53(1):36–38
13. Barlow SM, Lee J, Wang J et al (2014) Effects of oral stimulus frequency spectra on the development of non-nutritive suck in preterm infants with respiratory distress syndrome or chronic lung disease, and preterm infants of diabetic mothers. J Neonatal Nurs 20(4):178–188
14. Pineda R, Prince D, Reynolds J, Grabill M, Smith J (2020) Preterm infant feeding performance at term equivalent age differs from that of full-term infants. J Perinatol 40(4):646–654
15. Rinat S, Mackay M, Synnes A, Holsti L, Zwicker JG (2022) Early feeding behaviours of extremely preterm infants predict neurodevelopmental outcomes. Early Hum Dev 173:105647
16. Tsai SW, Chen CH, Lin MC (2010) Prediction for developmental delay on Neonatal Oral Motor Assessment Scale in preterm infants without brain lesion. Pediatr Int 52(1):65–68
17. Reilly S, Skuse D, Mathisen B, Wolke D (1995) The objective rating of oral-motor functions during feeding. Dysphagia 10(3):177–191
18. Skuse D, Stevenson J, Reilly S, Mathisen B (1995) Schedule for Oral-Motor Assessment (SOMA): methods of validation. Dysphagia 10(3):192–202
19. Darrah J, Piper M, Watt MJ (1998) Assessment of gross motor skills of at-risk infants: predictive validity of the Alberta Infant Motor Scale. Dev Med Child Neurol 40(7):485–491
20. Fleuren KM, Smit LS, Stijnen T, Hartman A (2007) New reference values for the Alberta Infant Motor Scale need to be established. Acta Paediatr 96(3):424–427
21. Pagliaro CL, Bühler KEB, Ibidi SM, Limongi SCO (2016) Dietary transition difficulties in preterm infants: critical literature review. J Pediatr (Rio J) 92(1):7–14
22. Sanchez K, Spittle AJ, Slattery JM, Morgan AT (2016) Oromotor feeding in children born before 30 weeks' gestation and term-born peers at 12 months' corrected age. J Pediatr 178:113–118
23. Morag I, Bart O, Raz R et al (2013) Developmental characteristics of late preterm infants at six and twelve months: a prospective study. Infant Behav Dev 36(3):451–456
24. Costa PP, Ruedell AM, Weinmann ÂRM, Keske-Soares M (2010) Influência da estimulação sensório-motora-oral em recém-nascidos pré-termo. Rev CEFAC 13(4):599–606
25. Kamity R, Kapavarapu PK, Chandel A (2021) Feeding problems and long-term outcomes in preterm infants—a systematic approach to evaluation and management. Children (Basel) 8(12):1158
26. Nusser-Müller-Busch R, Gampp Lehmann K (eds) (2021) Facial-oral tract therapy (F.O.T.T.) for eating, swallowing, nonverbal communication and speech. Springer, Switzerland. https://doi.org/10.1007/978-3-030-51637-6.

Publisher's Note