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The Validity and Reliability of Early Feeding Skills Assessment and Cue-Based Feeding Scales for Preterm Infants

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Abstract

Background: One of the fundamental factors in infants' readiness to discharge from the Neonatal Intensive Care Unit (NICU) is attaining full oral feeding. Determining the infants' development requires instruments to comprehensively assess the infants' oral skills and the process of feeding.

Objectives: This study aimed to measure the validity and reliability of Early Feeding Skill assessment (EFS) and the subscales of the cue-based feeding (Oral Feeding Readiness scale (OFRS) and Oral Feeding Quality scale (OFQS)).

Methods: Participants consisted of 30 preterm infants born at gestational age (GA) $\leq$ 34 weeks in Dr. Shariati Hospital, Tehran University of Medical Sciences, Tehran, Iran. Infants were enrolled by convenience sampling. Intraclass correlation coefficients (ICC) and Weighted Kappa were used to measure reliability, and Spearman and Pearson's correlation coefficient were used to test convergent and discriminant validity.

Results: The inter- and intra-rater reliability of all dimensions of EFS were good (ICC ranged from 0.77 to 0.95) except intra-rater reliabiltiy for the ability to maintain physiologic stability and ability to coordinate swallowing was moderate. The inter-rater reliability of the cue-based feeding scales was excellent (Weighted Kappa of $>$ 0.74). The intra-rater reliablity indicated good agreement for OFRS (Weighted Kappa = 0.73) and excellent agreement for OFQS (Weighted Kappa = 0.75). There was an inverse correlation between most subscales of EFS and cue-based feeding scales ($P < 0.05$), except the ability to maintain physiologic stability and ability to coordinate swallowing dimensions ($P > 0.05$). There was a significant correlation between the ability to maintain physiologic stability dimension and post menstrual age (PMA) ($r = 38$, ($P < 0.05$) and between the oral feeding recovery assessment and GA ($r = 0.37$, ($P < 0.05$). OFQS was inversely correlated with GA and PMA ($P < 0.05$).

Conclusions: EFS and cue-based feeding scales are valid and reliable scales to assess the oral feeding skills of preterm infants; however, using only one of these scales solely to evaluate infants' feeding process is not enough.

Keywords: Feeding Behavior, Infant, Premature, Psychometrics

1. Background

One of the most important concerns for preterm infants' discharge is the achievement of oral feeding skills (1, 2). The immaturity of neurological, cardio-respiratory, and gastrointestinal functions in preterm infants leads to delay in oral feeding (3-5). Approximately, 40% to 70% of infants with comorbidities and 3% to 10% of other infants require tube feeding after discharge (6). One of the most difficult tasks for preterm infants is making a decision for starting oral feeding (7, 8). The evaluation should be performed based on the maturity of infants' neurodevelopment, respiratory status, weight, activity level, and coordination of sucking, swallowing, and breathing (4). Facilitation of transition to independent oral feeding is one of the most important aims of the speech-language pathologist in the neonatal field (9).

Assessment instruments are required to objectively evaluate infants' oral feeding skills before and during feeding (10, 11). If tools do not provide enough detail to guide therapists for decision-making about the starting time of oral feeding, they are not able to identify deficient areas of infants' oral skills to select the best method for interven-

tion, and more importantly, tools do not determine the effects of feeding interventions precisely. In this situation, it is possible to start infants' oral feeding before readiness for feeding, which has negative effects on infants and families, such as prolonged hospitalization, increase in health costs, and low interaction between infant and parents (6, 12).

There are some available scales to assess the infants' oral feeding skills (10). LATCH is one of the scales developed to assess oral feeding skills during breastfeeding (L, latches; A, audible swallowing; T, nipple type; C, level of comfort; H, holding infant) (13). Another scale is Preterm Oral Feeding Readiness scale (POFRS) that is only for assessing preterm infants' oral feeding readiness. The subscales of this scale include corrected age, behavioral organization, oral posture, oral reflexes, and nonnutritive sucking (14, 15). Moreover, Neonatal Oral Motor Assessment scale (NOMAS) is one of the primary tools to assess infants' oral motor function and sucking. NOMAS is a 28-item scale that evaluates the infants' jaw and tongue movements to classify their sucking patterns as normal, disorganized, or dysfunctional. It solely assesses the movements of tongue and jaw (6, 16, 17).

The above-mentioned scales assess oral motor skills before feeding and only the LATCH scale assesses during feeding, which is not used for evaluation during bottle feeding and before starting oral feeding. Oral feeding progress in preterm infants is evaluated based on neurodevelopmental evolution, the avoidance of stresses during feeding, and positive experience (18). Early Feeding Skill Assessment (EFS) and cue-based feeding are the only scales which evaluate infants' oral feeding readiness before feeding, feeding tolerance, and feeding quality during their feeding.

Evidence demonstrates that the cue-based feeding approach is based on the recognition of ready cues and stress cues to help preterm infants to attain an independent oral feeding that is safe and efficient. In the cue-based feeding protocol, infants' feeding behaviors are assessed based on the Oral Feeding Readiness scale (OFRS) which investigates infants' oral feeding cues such as infant's state, rooting behavior, muscle tone, physiological instability before feeding, and Oral Feeding Quality scale (OFQS) that considers oral feeding behavior during feeding such as sucking, coordination between sucking, swallowing, and breathing, and duration of feeding (19-21).

Early Feeding Skill assessment (EFS) is another scale that evaluates oral feeding skills before, during, and after feeding. EFS measures infants' feeding skills from first oral feeding until 52 weeks of post-conceptional age. The subscales of EFS indicate areas of strength, areas of some clinical concerns, and areas of major clinical concerns (22-24).

Early identification of infants with feeding disorders is necessary to receive appropriate treatment, optimize their feeding, and improve oral feeding skill. However, since infants are not able to communicate during feeding, confusing feeding behaviors might appear inconsistently. It is difficult to distinguish between confusing feeding behaviors and usual feeding behaviors. Under this condition, some instruments are required to objectively and comprehensively assess the infants' oral skills and process of feeding (10, 11). EFS and cue-based feeding scales are the only scales which not only assess infants' feeding readiness before starting oral feeding but also their oral feeding quality during feeding. Using these scales, speech and language pathologists are able to identify and resolve infants' oral feeding problems early and recognize the best time for infants to attain independent oral feeding, which positively affect infants' growth (6, 25). In addition, one of the most important feeding methods over the world is cue-based feeding, and since this method has been recently used in Iran, the validated scale of this method is required.

2. Objectives

There is no study in Iran on concurrent investigation of EFS and cue-based feeding scales and inter- and intra-rater reliability of these scales; the present study aimed to measure the validity and reliability of the EFS and cue-based feeding scales.

3. Methods

A cross-sectional study was carried out. The study protocol was approved by the Institutional Review Board, School of Rehabilitation, and the Ethics Committee of Tehran University of Medical Sciences (code: IR.TUMS.VCR.REC.1398.042). The consent form was completed by the infants' parents.

3.1. Participants

Participants consisted of preterm infants with gestational age (GA) $\leq$ 34 weeks born in the Neonatal Intensive Care Unit of Shariati Hospital, Tehran University of Medical Sciences, Tehran, Iran, from December 2017 to February 2018. The infants were enrolled based on convenience sampling, and the restriction of enrollment method was used for minimizing confounding variables (26). Term infants and preterm infants over the gestational age of 34 weeks were the confounding variables. To control these confounders, the study population was limited to preterm infants aged $\leq$ 34 weeks. Infants who received a score more than 30 in Preterm Oral Feeding Readiness scale in a primary assessment performed by the speech-language pathologist, infants who did not have neurological disorders and congenital anomalies, and infants with Apgar

score of 3 or more in the first minute and Apgar score of 5 or more in the first 5 minutes were included in the study. Dead infants, infants with reluctant families to participate, and a sudden change in infants' nutritional status, such as cerebral hemorrhage or intestinal problems were excluded from the study.

According to Bonet's study, with $\alpha = 0.05$, power = 95%, and minimum ICC = 0.65, the minimum sample size was calculated for two raters and 23 preterm infants (27, 28). To prevent attrition, 30 preterm infants were enrolled in the research to determine psychometrical properties.

3.2. Instruments

Early feeding skill Assessment is a 28-item scale that evaluates feeding skills in infants in three parts, including before starting oral feeding to demonstrate readiness for oral feeding by four items, during feeding consisting of four dimensions: the ability of engagement maintenance in feeding (four items), the ability of oral-motor skills organization (four items), the ability of swallow coordination (six items), and the ability of physiological stabilization (nine items), and after feeding assessment (two items). The score range of items was 1 - 3; score 1 indicates the presence of a problem and score 3 represents the absence of a problem. The content validity of EFS was affirmed by neonatal nurses and feeding experts. The inter-rater reliability and intra-rater reliability of EFS were reported 0.85 and 0.81, respectively (6, 22, 23).

Oral Feeding Readiness scale (OFRS) has five options related to preterm infants' oral feeding cues including infant state, rooting behavior, muscle tone, and physiological instability. Feeding readiness ranged from 1 to 5. Score 1 indicates drowsy or alert state, rooting behavior, and good tone. Score 5 means that an infant's physiological condition is not stable, and the infant is not ready for feeding (19, 21).

Oral Feeding Quality scale (OFQS) evaluates the quality of preterm infants' oral feeding. This scale considers an infant's sucking, coordination between sucking, swallowing, and breathing, and feeding duration. The scale consists of five items ranging from 1 to 5. Scores 1 and 2 demonstrate that oral feeding quality is satisfactory and the infant is able to feed all milk volume by bottle or breast (19, 21).

3.3. Translation and Face Validity

Initially, the researcher had permitted the scales' designer to use the EFS and the cue-based feeding. The forward and backward translation method was utilized to translate the English version of the scales into Persian (29). According to this method, two Iranian translators, who were expert in English, translated the original version of scales into Persian. Then, the translators and two SLPs participated on a panel to synthesize two translated versions. The synthesized Persian version of scales was back translated into English by two translators and was sent to the scales' developers. In the next step, the expert panel (an expert methodologist in the validation of instruments, two SLPs, a neonatologist, and a translator) investigated the original version and the Persian version in terms of conceptual, semantic, and clinical equivalence. Then, the prefinal version of the scales was approved. The Persian version of the scales was investigated by 10 speech and language pathologists to determine face validity. Finally, the Persian version of EFS and the cue-based feeding scales was constructed.

3.4. Construct Validity

Convergent validity and discriminant validity were used to examine construct validity. To assess the convergent validity, the subscales of EFS were correlated with the subscales of cue-based feeding. To test the discriminant validity, known-group validity was used, testing the correlation between EFS and the cue-based feeding scales in terms of GA and post-menstrual age (PMA).

3.5. Reliability

To measure the inter-rater reliability of the scales, two speech-language pathologists with 3 years experience in infants' feeding in NICU assessed each infant before and during feeding. Therapists accomplished the assessment for each infant without consulting each other. Both therapists observed the infants' behaviors concurrently.

To test the intra-rater reliability, while the infants' behaviors were video recorded, each infant was assessed once by one of the therapists. After 1 week, the infants' oral feeding skills on the recorded videos were re-evaluated by the therapist.

3.6. Statistical Analysis

Intraclass Correlation Coefficients were used to test the inter-rater and intra-rater reliability of EFS. Coefficients less than 0.5 indicate poor reliability, between 0.51 and 0.75 moderate reliability, and more than 0.75 good reliability (29). Weighted Kappa was used to measure the inter-rater and intra-rater agreement of the cue-based feeding scales. Evaluation criteria for kappa, using guidelines described in Cicchetti and Sparrow (30) and Fleiss et al. (31), are as follows: Fair = k of .40 - 0.59; Good = k of .60 - 0.74; and Excellent = k > 0.74. Spearman's correlation coefficient was used to test the convergent validity of EFS and the subscales of the cue-based feeding. The correlation between EFS and the cue-based feeding scales regarding GA and PMA were measured by Pearson's correlation coefficient. All data were analyzed with SPSS version 23.

4. Results

The demographic and clinical characteristics of infants are illustrated in Table 1. Thirty Infants aged 28 - 34 weeks of gestaion and weighted 1000 - 2290 gram were enrolled in the study. The majority of infants used breast feeding and bottle feeding (26.5%). 10.3% of infants used bottle feeding, and 7.2% of infants used breast feeding.

Table 1. Demographic and Clinical Characteristics of Infants[a]

Characteristics	Values (N = 30)
Female	17 (56.7)
Gestational age, wk	31.93 ± 1.71
< 28	2 (2.9)
28 - 32	10 (14.7)
32 - 34	18 (26.5)
Post menstrual age, wk	32.40 ± 1.45
Birth weight, g	1642.00 ± 320.54
1000 - 1500	10 (14.7)
1500 - 2000	17 (25)
2000 <	3 (4.4)
Apgar score 1 min	6.26 ± 1.98
Apgar score 5 min	8.33 ± 0.95

[a]Values are expressed as No. (%) or mean ± SD.

4.1. Inter- and Intra-Rater Reliability of EFS

According to Table 2, the inter-rater reliability of all dimensions of EFS was good (ICC ranged from 0.77 to 0.95). The ability to organize oral-motor function dimension showed the most agreement (ICC: 0.95; 95% CI: 0.89 - 0.97) and the ability to coordinate swallowing dimension had the least agreement (ICC: 0.80; 95% CI: 0.58 - 0.90). The intra-rater reliability (ICC ranged from 0.82 to 0.94) of all dimensions of EFS was good, except the ability to maintain engagement in feeding (ICC: 0.69; 95% CI: 0.38 - 0.85) and the ability to coordinate swallowing (ICC: 0.65; 95% CI: 0.28 - 0.83) dimensions were moderate.

4.2. Inter- and Intra-Rater Reliability of the Cue-Based Feeding Scales

Table 3 demonstrates the inter- and the intra-rater reliability of the cue-based feeding scales. Weighted Kappa for both scales revealed a high range of agreement between the two examiners (Weighted Kappa of OFRS = 0.88, Weighted Kappa of OFQS = 0.95). The intra-rater reliability indicated a good agreement for OFRS (Weighted Kappa = 0.73) and an excellent agreement for OFQS (Weighted Kappa = 0.75).

4.3. Convergent Validity of EFS and the Cue-Based Feeding Scales

Table 4 indicates Spearman's correlation between the subscales of EFS and the cue-based feeding. There was an inverse correlation between the subscales of EFS (readiness before feeding, the ability to maintain engagement in feeding, the ability to organize oral-motor functioning, and oral feeding recovery) and the subscales of the cue-based feeding (OFRS and OFQS) ($P < 0.05$). However, there was no correlation between the subscales of the ability to maintain physiologic stability ($P = 0.07$, $P = 0.13$) and the ability to coordinate swallowing ($P = 0.27$, $P = 0.07$) with OFRS and OFQS ($P > 0.05$).

4.4. Correlation Between EFS and the Cue-Based Feeding Scales Regarding GA and PMA

Table 5 shows the correlation between the subscales of EFS and the subscales of the cue-based feeding, considering infants' GA and PMA. There was a meaningful correlation between the ability to maintain physiologic stability dimension and PMA ($r = 0.38$, $P = 0.03$) and between the oral feeding recovery assessment subscale and GA ($r = 0.37$, $P = 0.04$). There was an inverse correlation between OFQS and GA ($r = -0.36$, $P = 0.04$); later GA and lower OFQS score (higher feeding quality) were correlated. In addition, more PMA was associated with lower OFQS score ($r = -0.39$, $P = 0.03$).

5. Discussion

This research investigated the reliability and validity of EFS and the cue-based feeding scales. There was no noticeable change in terms of translation and face validity. A professional group consisted of 10 speech-language pathologists who approved the clarification and relevance of the items. This was in agreement with the study that Ludwig and Waitzman (32) performed to investigate the content validity of the Cue-Based Feeding scales. Furthermore, it was consistent with the studies conducted by dos Santos Curado (11) in Brazil on the validation of EFS for the Portuguese population, including 698 infants with GA of 24 - 37 weeks. In addition, Abarzua et al. (24) and Thoyre et al. (6) confirmed the face and content validity of EFS.

The inter-rater reliability of all subscales of EFS was good. ICC greater than 0.75 represented good reliability for a tool. The results indicated that EFS had a high level of agreement. The ability to organize oral-motor function dimension showed the most agreement, and the ability to coordinate swallowing dimension had the least agreement.

In addition, the intra-rater reliability of all dimensions of EFS was good (ICC ranged from 0.82 to 0.94) except for maintenance and coordination dimensions that were

Table 2. Inter- and Intra-Rater Reliability of EFS

Dimensions	Inter-Rater Reliability				Intra-Rater Reliability			
	Mean (SD)	ICC	CI	SEM	Mean (SD)	ICC	CI	SEM
Oral feeding readiness assessment	2.50 (0.43)	0.94	0.87 - 0.97	0.16	2.33 (0.54)	0.82	0.63 - 0.91	0.22
Ability to maintain engagement in feeding	2.73 (0.31)	0.89	0.77 - 0.94	0.10	2.54 (0.36)	0.69	0.38 - 0.85	0.20
Ability to organize oral-motor functioning	2.47 (0.47)	0.95	0.89 - 0.97	0.10	2.38 (0.47)	0.94	0.87 - 0.97	0.11
Ability to coordinate swallowing	2.95 (0.08)	0.80	0.58 - 0.90	0.03	2.86 (0.24)	0.65	0.28 - 0.83	0.14
Ability to maintain physiologic stability	2.8 (0.37)	0.77	0.26 - 0.91	0.17	2.57 (0.41)	0.88	0.77 - 0.94	0.14
Oral feeding recovery assessment	2.66 (0.44)	0.86	0.70 - 0.93	0.16	2.61 (0.53)	0.83	0.64 - 0.92	0.21

Table 3. Inter- and Intra-Rater Reliability of Cue-Based Feeding Scales

Cue-Based Feeding Scales	Inter-Rater Reliability		Intra-Rater Reliability	
	Weighted Kappa	Standard Error	Weighted Kappa	Standard Error
Oral Feeding Readiness scale	0.88	0.09	0.73	0.10
Oral Feeding Quality scale	0.95	0.04	0.75	0.11

Table 4. Convergent Validity of EFS and Cue-Based Feeding Scales

Dimensions	Cue-Based Feeding Scales	P-Value
Oral feeding readiness assessment		
OFRS	0.000	-0.77
OFQS	0.000	-0.68
Ability to maintain engagement in feeding		
OFRS	0.002	-0.53
OFQS	0.052	-0.35
Ability to organize oral-motor functioning		
OFRS	0.000	-0.71
OFQS	0.000	-0.74
Ability to coordinate swallowing		
OFRS	0.271	-0.20
OFQS	0.078	-0.32
Ability to maintain physiologic stability		
OFRS	0.075	-0.33
OFQS	0.136	-0.27
Oral feeding recovery assessment		
OFRS	0.003	-0.51
OFQS	0.006	-0.49

Abbreviations: OFQS, Oral Feeding Quality scale; OFRS, Oral Feeding Readiness scale.

moderate. The findings demonstrated that EFS had a high intra-rater reliability.

Previous studies used the internal consistency method to determine reliability. In a study by Bahrami et al. (33), Cronbach's alpha coefficient was 0.88. Thoyre et al. (6) tested the psychometric properties of the EFS, which included 142 32-50-week PMA infants; the internal consistency of the total EFS was good (Cronbach α = 0.81). To examine the internal consistency of the subscales, they measured interiterm correlation mean, ranged from 0.28 to 0.47. The interiterm correlation mean ranged from 0.15 to 0.50 are acceptable (6). In the Portuguese version, the overall Cronbach's alpha of EFS was 0.85. In this version, the reliability of the ability to organize oral-motor functioning (α = 0.79) and the ability to coordinate swallowing (α = 0.65) dimensions were acceptable, and the ability to maintain physiologic stability dimension (α = 0.81) was reliable (11). The standard reliability for a tool is Cronbach's alpha coefficient of 0.7 and higher. Previous literature has confirmed the reliability of EFS (11, 33).

The inter- and intra-rater reliability of the cue-based feeding scales revealed a high agreement between the two examiners (Weighted Kappa of OFRS = 0.88, Weighted Kappa of OFQS = 0.95). The intra-rater reliability indicated a good agreement for OFRS (Weighted Kappa = 0.73) and an excellent agreement for OFQS (Weighted Kappa = 0.75). Good to moderate intra-rater reliability represented the acceptable stability of the cue-based feeding scales over time. Davidson et al. performed a study to adapt the cue-based feeding scales with the chronic conditions of preterm infants such as bronchopulmonary dysplasia; the Cronbach's alpha coefficient was 0.51 (21).

There was no correlation between the ability to main-

Table 5. Correlation Between the EFS and Cue-Based Feeding Scales Regarding GA and PMA

	GA		PMA	
	P-Value	R	P-Value	r
EFS				
Oral feeding readiness assessment	0.26	0.20	0.68	0.07
Ability to maintain engagement in feeding	0.06	0.73	0.38	0.16
Ability to organize oral-motor functioning	0.24	0.21	0.25	0.21
Ability to coordinate swallowing	0.90	0.02	0.72	0.06
Ability to maintain physiologic stability	0.66	0.08	0.03	0.38
Oral feeding recovery assessment	0.04	0.37	0.53	0.11
Cue-based feeding				
OFRS	0.41	-0.15	0.53	-0.11
OFQS	0.04	-0.36	0.03	-0.39

Abbreviations: GA, gestational age; OFQS, Oral Feeding Quality scale; OFRS, Oral Feeding Readiness scale; PMA, post menstrual age.

tain physiologic stability and the ability to coordinate swallowing dimensions regarding OFRS and OFQS ($P > 0.05$). Thoyre et al. (6) demonstrated a significant inverse correlation between all subscales of EFS and OFQS. The lower score of OFQS (high feeding quality) indicated the higher score of the EFS subscales (higher oral feeding skills). This difference can be due to the difference between infants' PMA in the present study and Thoyre' (6). Infants' PMA in this research was lower.

In the present study, only the higher ability to maintain physiologic stability score correlated with later PMA ($P < 0.05$), while in Thoyre's study (6), only the ability to maintain engagement dimension was associated with PMA. In this study, the infants with later PMA were a more healthy group, and the ability to maintain engagement in the study of Thoyre et al. (6) was consistent with brain maturation and wake and sleep developments. Moreover, the higher oral feeding recovery assessment score was associated with later GA ($P < 0.05$), and according to Thoyre et al. (6), the ability to maintain physiologic stability score was correlated with more GA. Difference in the skills of observers in two studies can be the reason for variations in the results. Later GA was correlated with lower OFQS score (higher feeding quality). In addition, more PMA was associated with lower OFQS score.

5.1. Conclusions

The EFS and cue-based feeding scales are valid and reliable scales to assess the oral feeding skills of preterm infants. Not only most EFS subscales were correlated with the cue-based feeding scales but also some subscales of EFS and OFQS were associated with GA and PMA; however, using one of these scales is not solely enough to evaluate infants' feeding process. One of the limitations of the study was infants' different behavioral patterns during feeding, causing observers' confusion. Another limitation was the small sample size of preterm infants. Assessing EFS and cue-based feeding scales with larger samples involving preterm and full-term infants are recommended.

Footnotes

Authors' Contribution: Study concept and design: Farideh Kamran and Seyyed Ahmadreza Khatoonabadi. Acquisition of data: Farideh Kamran and Setareh Sagheb. Analysis and interpretation of data: Abbas Ebadi. Drafting of the manuscript: Farideh Kamran, Setareh Sagheb, Seyyed Ahmadreza Khatoonabadi, and Mahshid Aghajanzadeh. Critical revision of the manuscript for important intellectual content: mahshid aghajanzade and Yaser Faryadras. Statistical analysis: Abbas Ebadi. Study supervision: Mahshid Aghajanzadeh.

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