BMC Nursing

RESEARCH

Open Access

Psychometric properties of the Turkish version of the neonatal eating assessment tool-breastfeeding (NeoEAT–Breastfeeding)

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Abstract

Background Literature reports indicate that breastfeeding is often ended earlier than planned, within the first 6 months. Assessment tools can help nursing professionals identify early breastfeeding problems to identify interventions to support families in meeting their breastfeeding goals. Here we present our analyses of the validity/reliability of the Neonatal Eating Assessment Tool (NeoEAT)–Breastfeeding adapted to the Turkish language for use in post-discharge infants in Türkiye.

Methods A Turkish version of the NeoEAT-Breastfeeding was created and applied to 310 mothers of term and preterm infants (corrected age < 7 months) between June 2023 and April 2024. Validity and reliability were assessed using Cronbach's α coefficients, exploratory/confirmatory factor analysis, and item-total correlation, test-retest, and known-groups analysis.

Results The Turkish NeoEAT–Breastfeeding includes 59 items in 6 factors with 48.047% total explained variance. Exploratory factor analysis indicated that item factor loadings ranged from 0.314 to 0.788. Known-group analysis confirmed that infants with diagnosed feeding problems had higher total and subscale scores than those without ($P < 0.05$). The Cronbach's α coefficient was 0.87. Item-total correlations were sufficient (0.302–0.753; $P < 0.01$). There was excellent agreement between test values and retest values obtained after a two-week interval (intraclass correlation coefficients = 0.904-1.000).

Conclusion The Turkish NeoEAT–Breastfeeding was shown to be a reliable and valid parent-reported measure of feeding problems in breastfed infants younger than 7 months of corrected age after discharge.

Keywords Breastfeeding, Feeding behavior, Infant, Patient-reported outcome measure, Psychometrics

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Background

Considering the myriad nutritional, immunological, developmental, social, and economic benefits of breastfeeding for infants, mothers, and society [1–5], exclusive breastfeeding is recommended for the first 6 months of life [6]. Receiving only human milk reduces an infant's risk of gastrointestinal infection [7, 8], protects from necrotizing enterocolitis, diarrhea [9], and upper respiratory tract infections [10], contributes to improved neurological function [11], and lowers the risk of childhood obesity [12]. Globally, infants 0–5 months of age who were not breastfed were reported to have 14.4 times higher odds of all-cause death when compared with infants who were exclusively breastfed [13].

The Breastfeeding Report (2022) reported that 62.6% of mothers exclusively breastfed their newborns, but only 24.9% continued to breastfeed their infants for 6 months [14]. In Türkiye, the frequency of exclusive breastfeeding is 59% among neonates (age 0–1 months) but decreases to 45% in infants 2–3 months old and 14% in infants 4–5 months old [15]. Although most mothers plan to exclusively breastfeed/feed with breast milk until their infant is 6 months of age, the literature indicates that breastfeeding is often discontinued earlier than planned [16–18]. Infants who have feeding disorders, experience feeding intolerance, or have problems with sucking and latching for various reasons have difficulty thriving in the first few months of their lives with breastfeeding only [19, 20]. Additional factors that can potentially lead to discontinuation of breastfeeding include infant sleepiness, prolonged time between breastfeeding sessions, and inadequate breast milk supply [18, 21, 22]. The persistence of these difficulties leads to more complex maladaptive behavioral responses to feeding and greater risk of long-term feeding problems [23–25]. Early recognition of breastfeeding difficulties and referral to feeding specialists are critical for successful continuation of breastfeeding and timely detection of possible feeding disorders [26–28]. Assessment tools can facilitate early identification of feeding problems, but it is essential that any assessment tool used in clinical practice have evidence of validity and reliability [23, 27].

In the literature, there are various tools for evaluating breastfed infants' feeding skills, behaviors, and problems [29, 30]. In their systematic review, Pados et al. (2016) determined there are nine assessment tools that can be used to evaluate the feeding behaviors and skills of breastfed preterm/term infants younger than 6 months of age [30]. Among these tools, the Early Feeding Skills Assessment Tool and Neonatal Oral Motor Assessment Scale require training or clinical knowledge and thus are used exclusively by clinicians. Although these scales are important for clinical evaluation, this limits their use [31, 32]. Another three assessment tools that are evaluated by clinicians but do not require training for scoring (Mother-Baby Assessment, Potential Early Breastfeeding Problem Tool, and Mother-Infant Breastfeeding Progress Tool) were reported to have insufficient validity and reliability analyses [30, 33–35].

Considering that the rate of exclusive breastfeeding decreases in the first 6 months and some discharged infants may experience feeding problems at home, parent-administered assessment tools are important for diagnosing feeding problems early [27, 30]. While clinical feeding evaluations take into account a single point in time, parents regularly observe their infants' feeding behaviors. Therefore, their use of assessment tools can increase their awareness of feeding problems and enable early interventions to correct these problems in cooperation with clinicians [26, 27, 30]. When the literature is examined, there are four assessment tools (Bristol Breastfeeding Assessment Tool, Infant Breastfeeding Assessment Tool, LATCH, and Preterm Infant Breastfeeding Behavior Scale) that can be administered by both parents and clinicians [36–39]. Drawbacks of these tools include inability to comprehensively evaluate infants' feeding skills and behaviors at the breast due to having a small number of items [37, 39], inadequate interobserver agreement, predominance of items that evaluate the mother's breastfeeding skills rather than the infant's [30, 37], or evaluating only preterm infants' feeding skills [30, 39]. As a result, Pados et al. (2018) developed the Neonatal Eating Assessment Tool-Breastfeeding (NeoEAT-Breastfeeding) to comprehensively assess the breastfeeding behaviors and skills of term and preterm infants and enable the early identification of feeding problems and prevention of long-term breastfeeding problems through cooperation between parents and clinicians [27]. In this methodological study, we investigated the psychometric properties of the Turkish version of the NeoEAT-Breastfeeding to provide a valid and reliable tool for the assessment of parent-reported feeding status and difficulties in exclusively breastfed preterm/term infants in Türkiye.

Methods

Sample size estimation

This methodological descriptive study was conducted between June 2023 and April 2024 with mothers and infants followed in three family health centers in Istanbul affiliated with the Turkish Ministry of Health. These three family health centers were selected because they provide health services to the largest population on the Asian side of Istanbul. A sample size of 100–500 has been described as good for validity/reliability studies [40, 41]. Therefore, we included 310 infants and mothers who met the selection criteria. We recruited parents for the study using random sampling.

Infants meeting the following criteria at recruitment were included in the study: (1) having a corrected/chronological age of less than 7 months, (2) being exclusively breastfed for the last 7 days, and (3) being discharged from the hospital at least 7 days earlier. Infants fed by any method other than breastfeeding within the last week were excluded from the study. The NeoEAT–Breastfeeding is a parent-report assessment of breastfeeding in infants from birth to 7 months old. For this reason, babies who were exclusively breastfed for the last 7 days according to mother report were included in the sample [27]. The upper age limit of 7 months was determined for the NeoEAT-Breastfeeding because the American Academy of Pediatrics recommends that infants be exclusively breastfed for the first 6 months and that solid foods be introduced starting at 6 months of age [6]. Within the first month, infants consume relatively small amounts of solid foods. Therefore, the evaluation of breastfeeding is most appropriate up to the age of 7 months [27, 42, 43, 44]. Inclusion criteria for mothers were: (1) being 18 years of age or older, (2) being the primary caretaker of the infant, (3) being literate in Turkish, and (4) signing the parental informed consent form. Mothers with any hearing, speech, or cognitive impairment were excluded.

Ethical considerations

Permission for the study was obtained by email from the developer of the NeoEAT-Breastfeeding [27]. This study has been approved by the Ethics Committee of Health Sciences University in Istanbul, Türkiye (Ethical Review Number: 26.05.2023/111). The study is conducted in accordance with the Declaration of Helsinki. All participants provided written informed consent. Clinical trial number: Not applicable.

Instruments

Participant information form

Created for this study in accordance with literature data [26, 27, 42], this form consists of a total of 8 questions concerning the infant's sex, gestational age at birth, corrected/chronological age at the time of the study, any diagnosed feeding impairment, the mother's age, education level, economic level, and number of children.

NeoEAT-Breastfeeding

This assessment tool was developed through cooperation between parents and health professionals with the aim of evaluating the feeding skills and problems of preterm and term infants at a corrected age of less than 7 months [43]. The NeoEAT-Breastfeeding was determined to be suitable for use with infants younger than 7 months [43] based on the American Academy of Pediatrics' recommendation to start solid food no earlier than 6 months of age and the assumption that solid foods represent a small proportion of the diet in the first month of this transition [44]. It initially included 72 items [43] but was later reduced to 62 items as a result of factor analysis studies [27]. The English version of the NeoEAT-Breastfeeding consists of 62 items in 7 subscales: *Infant Regulation*, *Energy & Physiologic Stability*, *Oral-pharyngo-esophageal Function*, *Gastroesophageal Function*, *Gastrointestinal Function*, *Feeding Efficiency & Sensory Responsiveness*, and *Compelling Symptoms of Problematic Feeding* [27]. The parent rates each item on a 6-option Likert-type scale of frequency for the stated behavior (never, almost never, sometimes, often, almost always, and always) based on their observations [27]. The total NeoEAT-Breastfeeding score ranges from 0 to 310, with a higher score indicating more problematic feeding [27]. The English version of the tool was reported to have good internal consistency reliability (Cronbach's α coefficient = 0.92) and strong test-retest correlation ($r = 0.91$; $P < 0.001$). Moreover, in comparison of known groups, NeoEAT-Breastfeeding total scores were higher in infants with feeding problems when compared with healthy, typically feeding infants [27].

Procedure

Before data collection from the study sample, cross-cultural consistency and content validity were ensured through translation/back-translation, expert panel opinion, and pilot testing as recommended in the literature [45, 46].

Translation and back-translation

The scale was translated from English to Turkish independently by two native Turkish, English-fluent translators. We compared and synthesized the translations and sent this draft for review by a Turkish linguist. Back translation was then performed independently by two native English-speaking medical translators, and the back-translated versions were compared to the original for semantic consistency.

Expert opinion

To assess content validity, an 8-specialist panel that included 6 members of the nursing faculty, 1 neonatologist, and 1 neonatal healthcare professional reviewed the English and both Turkish versions of the scale [47]. The experts scored each item from 1 (suitable as is) to 4 (requires major revision) [48]. Using Davis' technique, content validity index (CVI) values were calculated for the scale and items [48, 49]. The items were revised based on the expert panel feedback and a single draft Turkish version was created [40].

Pilot testing

Twenty eligible mothers not included in the sample completed the draft scale [50]. As the pilot group provided no negative feedback about the time required to complete the scale or the items' readability or comprehensibility, we made no further changes and used this as the final version during data collection from the entire sample.

Data collection

In Türkiye, all infants are seen in the local family health center at least once a month until the age of 6 months to track their growth and development, provide vaccinations, perform neonatal screenings, and monitor the feeding process. Thus, we interviewed mothers bringing their infants to the family health center for these visits. Those who met the sample criteria were informed about the study. Verbal and written consent was obtained from those willing to participate. The sections of the participant information form pertaining to the infant were filled in based on the health records in the family health center and information from the mother. Body weight of the infant was measured using a scale sensitive to 10 g after removing the infant's clothing and diaper. The mothers completed the part of the participant information form related to them. They were then asked to respond to the Turkish NeoEAT-Breastfeeding according to their observations while breastfeeding their infant. Data collection lasted approximately 15–20 min per participant. Two weeks after the initial completion of the NeoEAT-Breastfeeding scale, a subsample of 35 mothers completed the scale again for test-retest analysis to examine its time invariance [40].

Based on the recommendations of family health center physicians and nurses, mothers whose infants showed insufficient growth (weight and/or height) according to their chronological/corrected age, were observed to have problems during the feeding observation, or who reported having breastfeeding problems and requested assistance were referred to another clinic for more detailed evaluation by an independent neonatologist or pediatric gastroenterologist not involved in the study. Feeding impairments were diagnosed based on their clinical evaluation. Families who were referred to a neonatologist or pediatric gastroenterologist were asked to report any feeding disorder diagnoses received to the family health center and the researcher.

Data analysis

SPSS Statistics version 22.0 and Amos software (IBM Corp, Armonk, NY) were used for data analyses. Descriptive and clinical information of the mothers and infants is presented as number, percentage, mean, standard deviation, median, and range.

As described above, content validity was assessed by expert panel opinion and CVI values [48]. After data collection, the suitability of the sample size and data set were evaluated using the Kaiser-Meyer-Olkin (KMO) test (desired value greater than 0.50) and Bartlett's test of sphericity (desired significance of $P < 0.05$) [40]. We then performed exploratory factor analysis (EFA) using principal components with varimax rotation, confirmatory factor analysis (CFA) to ensure construct validity, and chi-square/degrees of freedom (χ^2/df) ratio, root mean square error of approximation (RMSEA), and the goodness-of-fit (GFI), comparative fit (CFI), normal fit (NFI), incremental fit (IFI), and relative fit (RFI) indexes to evaluate the model's fit to the data [50, 51]. In known-groups analysis, we used Mann-Whitney U test to compare the NeoEAT-Breastfeeding total and subscale scores of preterm/term infants with and without a diagnosed feeding impairment. Our hypothesis was that infants with a feeding impairment would have higher scores on the NeoEAT-Breastfeeding [27]. In addition, specificity and sensitivity in receiver operating characteristic (ROC) curve analysis were used to identify the best cut-off point for the Turkish NeoEAT-Breastfeeding total score as a diagnostic screening test [41].

Reliability was assessed using Cronbach's α, item-total correlation (Pearson correlation coefficient), test-retest analysis (interclass coefficient correlation [ICC]), and item discriminant validity analysis (t-test). A *P*-value less than 0.05 was considered statistically significant [40, 50].

Results

Sample characteristics

The sociodemographic and clinical characteristics of the infants in the sample are presented in Table 1. The infants were evenly distributed in terms of sex (50.3% males), with a mean gestational age at birth of 38.39 ± 1.57 weeks. Their mean corrected/chronological age at the time of study inclusion was 4.84 ± 1.74 months and 4.2% ($n = 13$) had a diagnosed feeding impairment.

Of the 310 mothers included in the sample (mean age 30.24 ± 4.73 years, range: 19–48 years), 40.9% ($n = 127$) were secondary school graduates, 60.6% ($n = 188$) had income equal to their expenses, and 44.5% ($n = 138$) had one child.

Validity analysis

Content validity

Analysis of the feedback from the 8-expert panel yielded item CVI values of 0.75-1.00 and a scale CVI of 0.90.

Construct validity

Before factor analysis, we determined the KMO coefficient was 0.866 and Bartlett's test result was significant ($\chi^2 = 9346.576$, $P < 0.001$). During EFA of the Turkish

Table 1 Descriptive and clinical characteristics of infants and parents ($n = 310$)

Variable		*n* (%)
Infant sex	Female	154 (49.7)
	Male	156 (50.3)
Gestational age at birth (weeks)	*Mean ± SD*	38.39 ± 1.57
	Median (range)	38 (28–42)
Corrected/chronological age (months)	*Mean ± SD*	4.84 ± 1.74
	Median (range)	5.40 (0.50–6.83)
	0–2 months	39 (12.5)
	2.1-4 months	53 (17.1)
	4.1-6 months	144 (46.5)
	6.1–6.83 months	74 (23.9)
Feeding impairment	Yes	13 (4.2)
	No	297 (95.8)
Maternal age (years)	*Mean ± SD*	30.24 ± 4.73
	Median (range)	30 (19–48)
Maternal education	Primary school	53 (17.1)
	Secondary school	127 (40.9)
	University	112 (36.1)
	Postgraduate degree	18 (5.9)
Financial status	Income equal to expenses	188 (60.6)
	Income more than expenses	43 (13.9)
	Income less than expenses	79 (25.5)
Number of children	1	138 (44.5)
	2	108 (34.8)
	≥ 3	64 (20.7)

version of the NeoEAT-Breastfeeding, three items (28, 47, 55) in the English scale loaded similarly on multiple factors and had factor loadings below 0.30. Therefore, these items were removed.

According to EFA conducted with the remaining 59 items, the Turkish NeoEAT-Breastfeeding showed a 6-factor structure: factor 1, *Infant Regulation* (14 items: 1–14); factor 2, *Energy & Physiologic Stability* (10 items: 15–17,19–25); factor 3, *Oropharyngeal & Gastroesophageal Function* (13 items: 26,27,29–38,50); factor 4, *Gastrointestinal Function* (10 items: 18,39–46,48); factor 5, *Feeding Efficiency & Sensory Responsiveness* (6 items: 49,51–54,61); and factor 6, *Compelling Symptoms of Problematic Feeding* (6 items: 56–60,62). These 6 factors explained 48.047% of the total variance of the scale, with 12.066% explained by I*nfant Regulation*, 9.112% by the *Energy & Physiologic Stability*, 8.294% by the *Oropharyngeal & Gastroesophageal Function*, 6.815% by the *Gastrointestinal Function*, 6.504% by the *Feeding Efficiency & Sensory Responsiveness*, and 5.256% by the Com*pelling Symptoms of Problematic Feeding* factor. Item factor loadings varied between 0.314 and 0.788 (Table 2).

During EFA, some changes were made in the distribution of the items. In the English NeoEAT-Breastfeeding, item 18 (takes more than 30 min to eat, including rest/burping periods) in the energy & physiologic stability subscale was included in the gastrointestinal function subscale. In the English NeoEAT-Breastfeeding, the two separate oral-pharyngo-esophageal function and gastroesophageal function subscales were combined in the Turkish version and named the oropharyngeal & gastroesophageal function subscale. This subscale also included item 50 (gags in between feedings when there is nothing in his/her mouth), which was in the feeding efficiency & sensory responsiveness subscale in the English version. In the English NeoEAT-Breastfeeding, items 39 (is uncomfortable if laid flat after eating) and 40 (needs to be burped more than once before the end of feeding) in the gastroesophageal function subscale were added to the gastrointestinal function subscale in the Turkish version. Item 61 (sweats/gets clammy when eating), which was in the compelling symptoms of problematic feeding in the English NeoEAT-Breastfeeding, was included in the feeding efficiency & sensory responsiveness subscale.

With the 59 items retained in EFA, CFA of the 6-factor model yielded factor loadings of 0.34–0.80 for the *Infant Regulation* subscale, 0.42–0.74 for the *Energy & Physiologic Stability* subscale, 0.45–0.74 for the *Oropharyngeal & Gastroesophageal Function* subscale, 0.32–0.68 for the *Gastrointestinal Function* subscale, 0.31–0.63 for the *Feeding Efficiency & Sensory Responsiveness* subscale, and 0.53–0.75 for the *Compelling Symptoms of Problematic Feeding* subscale (Fig. 1). In terms of model fit indexes, χ^2/df was 3.39, RMSEA was 0.071, CFI was 0.94, NFI was 0.93, IFI was 0.95, GFI was 0.94, and RFI was 0.92 (Table 3).

Known-groups validity and diagnostic value

NeoEAT-Breastfeeding subscale and total scores were significantly higher in infants with a diagnosed feeding impairment than those without ($P < 0.05$; Table 4). Based on this significance, we calculated a cut-off value for the Turkish NeoEAT-Breastfeeding total score using ROC curve analysis. The optimum cut-off score to differentiate infants according to diagnosed feeding impairment was found to be 211. At this cut-off value, the NeoEAT-Breastfeeding total score had 91.67% sensitivity, 73.06% specificity, positive predictive value of 12.09%, negative predictive value of 99.54%, and accuracy of 73.79% (Table 5; Fig. 2). The area under the ROC curve (AUC) was 92.5% with 3.1% standard error.

Reliability analysis

Cronbach's α was 0.91 for the *Infant Regulation* subscale, 0.84 for the *Energy & Physiologic Stability* subscale, 0.82 for the *Oropharyngeal & Gastroesophageal Function* subscale, 0.74 for the *Gastrointestinal Function* subscale, 0.71 for the *Feeding Efficiency & Sensory Responsiveness* subscale, and 0.78 for the *Compelling Symptoms of*

Table 2 Exploratory factor analysis results of the Turkish version of NeoEAT–Breastfeeding ($n = 310$)

Items*	Item factor loadings					
	Infant Regulation	Energy & Physiologic Stability	Oropharyngeal & Gastroesophageal Function	Gastrointestinal Function	Feeding Efficiency & Sensory Responsiveness	Compelling Symptoms of Problematic Feeding
Item 1	0.691					
Item 2	0.788					
Item 3	0.749					
Item 4	0.757					
Item 5	0.781					
Item 6	0.779					
Item 7	0.739					
Item 8	0.725					
Item 9	0.679					
Item 10	0.694					
Item 11	0.659					
Item 12	0.506					
Item 13	0.467					
Item 14	0.378					
Item 15		0.653				
Item 16		0.727				
Item 17		0.610				
Item 19		0.347				
Item 20		0.540				
Item 21		0.510				
Item 22		0.592				
Item 23		0.639				
Item 24		0.474				
Item 25		0.598				
Item 26			0.361			
Item 27			0.438			
Item 29			0.426			
Item 30			0.347			
Item 31			0.518			
Item 32			0.375			
Item 33			0.548			
Item 34			0.555			
Item 35			0.643			
Item 36			0.616			
Item 37			0.672			
Item 38			0.544			
Item 50			0.588			
Item 18				0.431		
Item 39				0.567		
Item 40				0.578		
Item 41				0.400		
Item 42				0.665		
Item 43				0.573		
Item 44				0.751		
Item 45				0.362		
Item 46				0.532		
Item 48				0.508		
Item 49					0.314	
Item 51					0.486	
Item 52					0.563	

Table 2 (continued)

Items*	Item factor loadings					
	Infant Regulation	Energy & Physiologic Stability	Oropharyngeal & Gastroesophageal Function	Gastrointestinal Function	Feeding Efficiency & Sensory Responsiveness	Compelling Symptoms of Problematic Feeding
Item 53					0.322	
Item 54					0.601	
Item 61					0.472	
Item 56						0.527
Item 57						0.715
Item 58						0.787
Item 59						0.620
Item 60						0.681
Item 62						0.528
Explained variance (%)	12.066	9.112	8.294	6.815	6.504	5.256
Total explained variance (%)	**48.047**					

*Three items in the original scale were removed. The original scale consists of 62 items and the Turkish version consists of 59 items. Items are numbered as in the original scale

Problematic Feeding subscale. The Cronbach's alpha value for the entire scale was 0.87.

During EFA and CFA, item-total score correlations lower than 0.30 were found for item 28 (0.27), item 47 (0.21), and item 55 (0.28), and they were removed from the scale. After their removal, the item-total score correlation coefficients of the remaining 59 items were between 0.302 and 0.753 ($P<0.01$; Table 6). In the comparison made to determine the discriminatory power of the items, we detected a statistically significant difference in mean item scores between the top-scoring 27% and bottom-scoring 27% groups. The mean item scores of the infants in the top 27% group were significantly higher than those in the bottom 27% group ($P<0.05$; Table 6).

Test-retest analysis at an interval of 2 weeks was conducted with 35 parents, which represented 11.3% of the total sample. ICC values were between 0.904 and 1.000 for all items ($P=0.001$), indicating excellent reliability between the two measurements.

Discussion

In this study, we have described the rigorous process followed to translate and culturally adapt the NeoEAT-Breastfeeding from English to Turkish and evaluate the validity and reliability of the new version. The Turkish NeoEAT-Breastfeeding has evidence of adequate psychometric properties in infants under 7 months of corrected age.

The item-level and scale-level CVIs in our study indicate that the items in the Turkish NeoEAT-Breastfeeding adequately represented the construct being measured and were appropriate for Turkish culture [48, 52]. However, CVI values for the English NeoEAT-Breastfeeding scale were not provided in the study by Pados et al. (2018), making a direct comparison difficult [27]. EFA can be performed if the KMO coefficient is greater than 0.50 and Bartlett's test of sphericity gives a significant result [48, 52, 53]. Our results in these tests confirmed the adequacy and suitability of the sample size and data set for factor analysis [51, 52]. Pados et al. reported comparable values for the English version ($P<0.001$ for Bartlett's χ^2; KMO coefficient = 0.888) [27].

Factor loadings indicate how strongly items are related to the scale factors and should be greater than 0.30 to include an item [40, 50, 54]. The English NeoEAT-Breastfeeding consisted of 62 items and 7 subscales [27]. During the EFA of the Turkish NeoEAT-Breastfeeding, three of the original items were removed (items 28, 47, and 55) because their factor loadings were below 0.30 [52, 55]. As these three removed items had factor loadings of 0.30 or greater in the study of the English version of the tool [27], the difference between the two studies could be a result of cultural interpretation of the infant behaviors described in these items. For example, there may be cultural differences in how parents determine whether their baby "arches back during or after eating", "gets the hiccups", or "holds breath when eating". The other 59 items had factor loadings of 0.314–0.788 and were retained [54, 55]. Factor loadings for the English scale were 0.30–0.86 [27].

The structure of an assessment tool often changes when it is translated and adapted to another language and culture [52, 53]. Similarly, while the English NeoEAT-Breastfeeding includes 62 items in 7 subscales, the Turkish version has 6 subscales and 59 items, and several items (18, 39, 40, 50, 61) were included in different subscales than in the English version. The 6-factor structure of the Turkish NeoEAT-Breastfeeding explained 48.047% of total variance (Table 2), which is above the desired threshold of 40% for multi-factor scales [53, 54] and

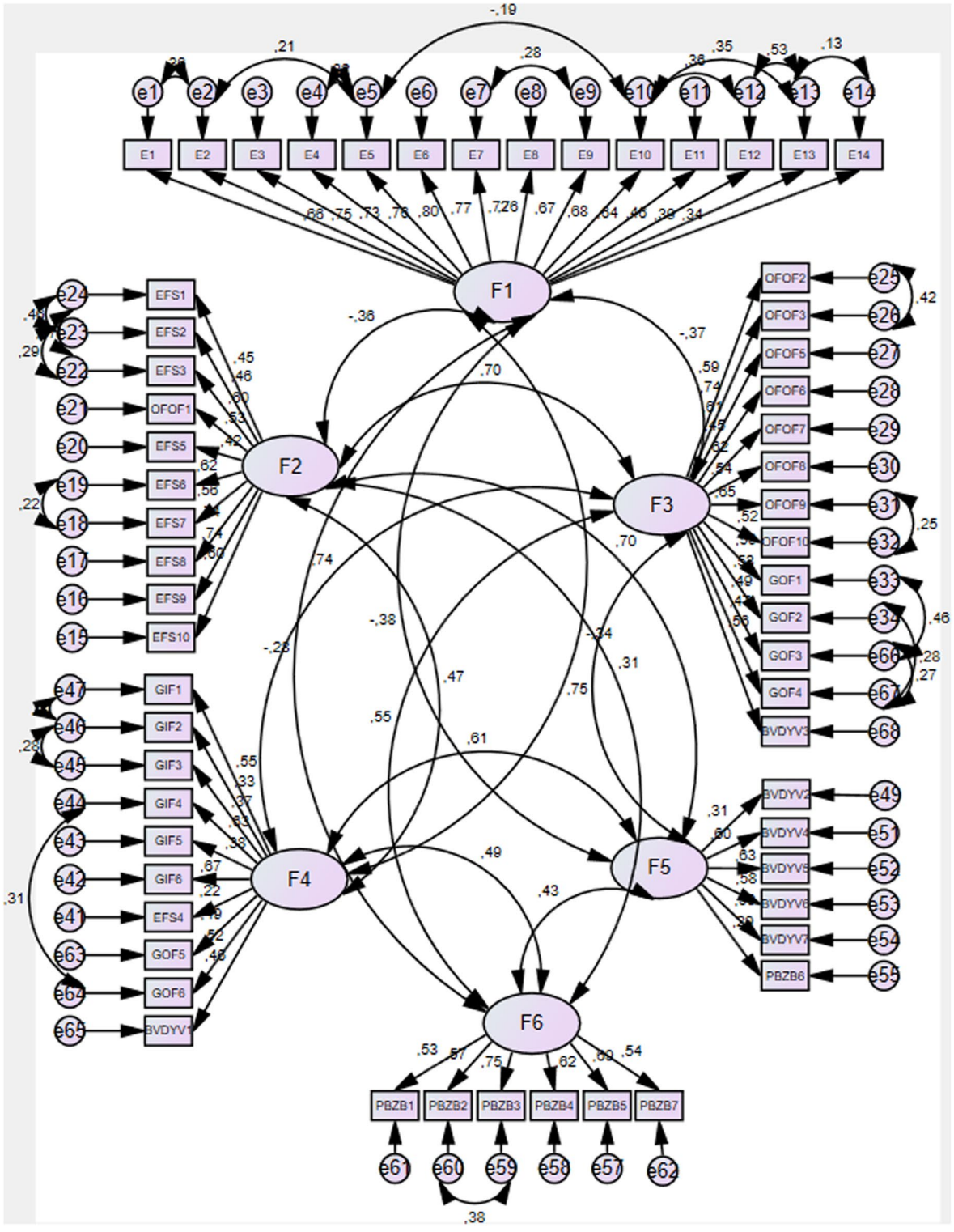

Fig. 1 Factor structure of the Turkish version of the NeoEAT–Breastfeeding. Note: P value for all factor loadings < 0.001. Factor 1: Infant Regulation; Factor 2: Energy & Physiologic Stability; Factor 3: Oral-pharyngo & Gastroesophageal Function; Factor 4: Gastrointestinal Function; Factor 5: Feeding Efficiency & Sensory Responsiveness; Factor 6: Compelling Symptoms of Problematic Feeding

Table 3 Model fit indices for confirmatory factor analysis ($n = 310$)

Model	χ^2	df[a]	χ^2/df	RMSEA[b]	GFI[c]	CFI[d]	NFI[e]	IFI[f]	RFI[g]
Six-factor model	4211.737	1785	3.39	0.071	0.94	0.94	0.93	0.95	0.92

[a] Degrees of freedom; [b]Root mean square error of approximation; [c]Goodness of fit index; [c]Goodness of fit index; [c]Goodness of fit index; [e] Normed fit index; [e] Normed fit index; [e] Normed fit index; [g] Relative fit index

Table 4 Comparison of NeoEAT-Breastfeeding scores of infants based on the presence of a diagnosed feeding impairment ($n = 310$)

	Diagnosed Feeding Impairment				[a]*p*
	Yes ($n = 13$)		No ($n = 297$)		
	Mean ± SD	Median (Range)	Mean ± SD	Median (Range)	
Infant Regulation	23.76 ± 11.79	22 (6–45)	17.18 ± 11.28	15 (1–60)	0.048*
Energy & Physiologic Stability	42.38 ± 6.87	44 (28–50)	34.16 ± 7.14	35 (5–50)	0.001**
Oropharyngeal & Gastroesophageal Function	44.69 ± 4.29	45 (39–50)	38.28 ± 5.61	39 (18–50)	0.001**
Gastrointestinal Function	42.15 ± 6.58	45 (32–50)	33.02 ± 6.20	33 (12–49)	0.001**
Feeding Efficiency & Sensory Responsiveness	27.07 ± 3.98	28 (18–30)	21.09 ± 4.17	21 (8–30)	0.001**
Compelling Symptoms of Problematic Feeding	30.00 ± 1.10	30 (28–30)	27.97 ± 2.76	29 (15–30)	0.001**
Total	233.38 ± 15.99	240 (207–256)	196.01 ± 20.88	196 (132–241)	0.001**

[a]Mann-Whitney U Test *$p < 0.05$ **$p < 0.01$

Table 5 Diagnostic parameters and receiver operating characteristic (ROC) curve analysis results for the Turkish version of NeoEAT–Breastfeeding total score ($n = 310$)

	Diagnostic Parameter					ROC Curve		*p*
	Cut-off point	Sensitivity	Specificity	PPV	NPV	AUC	95% CI	
NeoEAT–Breast-feeding total score	≥ 211	91.67	73.06	12.09	99.54	0.925	0.865–0.986	0.001

PPV: Positive predictive value, NPV: Negative predictive value, AUC: Area under curve, CI: Confidence interval

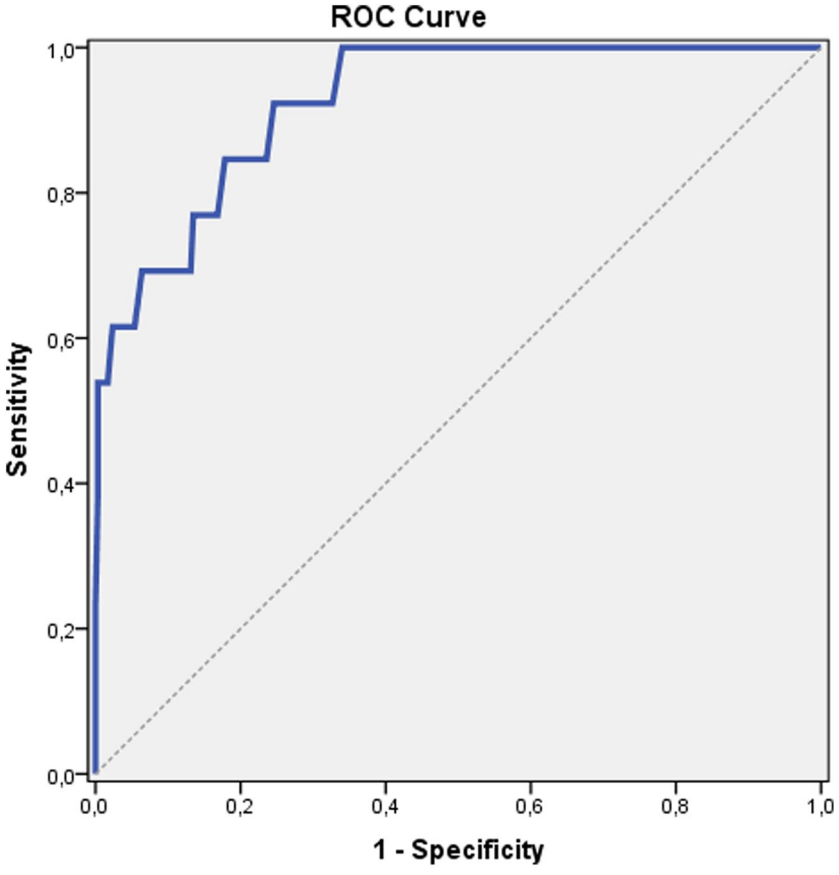

Fig. 2 Determination of the cut-off point according to the ROC analysis

Table 6 NeoEAT-Breastfeeding item statistics ($n = 310$)

Items***	Item-Total Score Correlation	Bottom 27%		Top 27%		t	*p*
	rp	Mean ± SD	Median (Range)	Mean ± SD	Median (Range)		
Item 1	0.304 0.000**	0.92 ± 1.06	1 (0–3)	1.59 ± 1.08	1.5 (0–5)	1.307	*0.015**
Item 2	0.311 0.000**	0.87 ± 0.99	0.5 (0–3)	1.26 ± 1.18	1 (0–5)	2.332	*0.021**
Item 3	0.315 0.009**	0.98 ± 1.07	1 (0–3)	1.26 ± 1.23	1.5 (0–5)	1.404	*0.017**
Item 4	0.331 0.000**	1.06 ± 1.11	1 (0–3)	1.58 ± 1.23	1.5 (0–5)	21.131	*0.046**
Item 5	0.314 0.003**	1.05 ± 1.16	1 (0–3)	1.77 ± 1.28	1.5 (0–5)	2.063	*0.045**
Item 6	0.321 0.000**	0.82 ± 1.04	0 (0–3)	1.64 ± 1.07	1.5 (0–5)	2.315	*0.040**
Item 7	0.302 0.007**	0.88 ± 1.08	0 (0–4)	1.75 ± 0.93	1.5 (0–3)	1.918	*0.038**
Item 8	0.327 0.005**	1.06 ± 1.23	1 (0–4)	1.73 ± 1.10	2 (0–5)	1.727	*0.048**
Item 9	0.303 0.009**	0.94 ± 1.21	0 (0–5)	1.47 ± 1.07	1 (0–4)	1.878	*0.031**
Item 10	0.320 0.000**	1.36 ± 1.32	1 (0–5)	2.07 ± 1.39	2 (0–5)	2.717	*0.011**
Item 11	0.361 0.008**	1.12 ± 1.08	1 (0–4)	2.24 ± 1.07	2 (0–4)	2.672	*0.014**
Item 12	0.472 0.001**	1.00 ± 1.40	1 (0–5)	2.68 ± 1.55	2 (0–5)	3.113	*0.026**
Item 13	0.315 0.001**	1.50 ± 1.38	1 (0–5)	2.18 ± 1.44	2 (0–5)	1.348	*0.002***
Item 14	0.377 0.001**	1.27 ± 1.32	1 (0–4)	2.55 ± 1.31	2(0–5)	5.639	*0.029**
Item 15	0.321 0.000**	2.99 ± 1.00	3 (0–5)	3.81 ± 0.88	4 (2–5)	6.614	*0.001***
Item 16	0.305 0.000**	2.81 ± 1.10	3 (0–5)	3.92 ± 1.07	4 (0–5)	7.408	*0.001***
Item 17	0.397 0.000**	2.54 ± 1.33	3 (0–5)	3.93 ± 1.10	4 (0–5)	4.002	*0.001***
Item 19	0.331 0.000**	2.45 ± 1.20	3 (0–5)	3.71 ± 1.06	4 (0–5)	7.619	*0.001***
Item 20	0.382 0.000**	2.98 ± 1.22	3 (0–5)	4.21 ± 0.85	4 (1–5)	6.841	*0.001***
Item 21	0.448 0.000 **	3.01 ± 1.30	3 (0–5)	4.23 ± 0.97	4 (0–5)	9.600	*0.001***
Item 22	0.406 0.000**	2.17 ± 1.30	3 (0–5)	3.87 ± 0.98	4 (1–5)	7.558	*0.001***
Item 23	0.504 0.000**	2.68 ± 1.19	3 (0–5)	3.99 ± 1.05	4 (0–5)	8.259	*0.001***
Item 24	0.456 0.000**	2.92 ± 1.14	3 (0–5)	4.29 ± 1	5 (0–5)	9.037	*0.001***
Item 25	0.506 0.000**	3.29 ± 0.91	3 (1–5)	4.44 ± 0.73	5 (3–5)	9.809	*0.001***
Item 26	0.753 0.000**	3.40 ± 0.91	3 (0–5)	4.58 ± 0.62	5 (3–5)	11.848	*0.001***
Item 27	0.486 0.000**	3.38 ± 0.76	3 (2–5)	4.64 ± 0.61	5 (3–5)	9.158	*0.001***
Item 29	0.592 0.000**	3.73 ± 1.06	4 (0–5)	4.76 ± 0.53	5 (2–5)	7.143	*0.001***
Item 30	0.514 0.000**	2.45 ± 1.07	3 (0–5)	3.67 ± 1.13	4 (0–5)	8.053	*0.001***
Item 31	0.508 0.000**	3.61 ± 0.94	4 (1–5)	4.64 ± 0.71	5 (1–5)	5.571	*0.001***
Item 32	0.413 0.000**	3.69 ± 1.08	4 (0–5)	4.49 ± 0.75	5 (3–5)	8.977	*0.001***
Item 33	0.502 0.000**	3.36 ± 0.96	3 (1–5)	4.54 ± 0.72	5 (3–5)	7.679	*0.001***
Item 34	0.311 0.000**	3.52 ± 0.86	3 (2–5)	4.49 ± 0.77	5 (2–5)	8.429	*0.001***
Item 35	0.498 0.000**	3.44 ± 0.88	3 (1–5)	4.49 ± 0.72	5 (2–5)	9.126	*0.001***
Item 36	0.453 0.000**	3.46 ± 0.80	3 (1–5)	4.51 ± 0.69	5 (3–5)	6.516	*0.001***
Item 37	0.734 0.000**	3.44 ± 0.94	3 (1–5)	4.36 ± 0.89	5 (1–5)	7.927	*0.001***
Item 38	0.486 0.000**	3.43 ± 0.81	3 (1–5)	4.37 ± 0.72	4.5(2–5)	5.178	*0.001***
Item 50	0.321 0.000**	3.96 ± 0.88	4 (1–5)	4.71 ± 0.55	5 (3–5)	6.717	*0.001***
Item 18	0.443 0.000**	2.33 ± 1.35	3 (0–5)	3.18 ± 1.39	3 (0–5)	7.237	*0.001***
Item 39	0.473 0.000 **	2.65 ± 1.34	3 (0–5)	3.69 ± 1.25	4 (0–5)	7.595	*0.001***
Item 40	0.421 0.000**	2.26 ± 1.27	2 (0–5)	3.68 ± 1.14	4 (0–5)	8.401	*0.001***
Item 41	0.325 0.000**	2.88 ± 1.41	3 (0–5)	4.35 ± 0.75	5 (3–5)	8.942	*0.001***
Item 42	0.434 0.000**	2.90 ± 0.98	3 (0–5)	4.15 ± 0.83	4 (3–5)	5.239	*0.001***
Item 43	0.594 0.000**	3.58 ± 0.95	4 (0–5)	4.27 ± 0.75	4 (3–5)	6.764	*0.001***
Item 44	0.468 0.000**	2.18 ± 1.45	2 (0–5)	3.58 ± 1.23	4 (0–5)	5.576	*0.001***
Item 45	0.460 0.000**	3.33 ± 1.01	3 (0–5)	4.14 ± 0.87	4 (2–5)	5.644	*0.001***
Item 46	0.321 0.000**	3.61 ± 0.89	4 (1–5)	4.31 ± 0.71	4 (3–5)	5.370	*0.001***
Item 48	0.342 0.000**	2.61 ± 1.09	3 (0–5)	3.65 ± 1.06	4 (0–5)	4.966	*0.001***
Item 49	0.338 0.000**	2.52 ± 1.35	3 (0–5)	3.58 ± 1.42	4 (0–5)	6.600	*0.001***
Item 51	0.631 0.000**	3.08 ± 1.36	3 (0–5)	4.31 ± 0.98	5 (1–5)	8.169	*0.001***
Item 52	0.385 0.000**	3.26 ± 1.19	3 (0–5)	4.51 ± 0.74	5 (2–5)	7.048	*0.001***
Item 53	0.329 0.000**	3.80 ± 1.12	4 (0–5)	4.75 ± 0.53	5 (3–5)	8.756	*0.001***
Item 54	0.410 0.000**	2.90 ± 1.03	3 (0–5)	4.18 ± 0.85	4 (3–5)	4.995	*0.001***

Table 6 (continued)

Items***	Item-Total Score Correlation	Bottom 27%		Top 27%		t	*p*
	rp	Mean ± SD	Median (Range)	Mean ± SD	Median (Range)		
Item 61	0.316 0.000**	2.95 ± 1.36	3 (0–5)	3.93 ± 1.28	4.5 (0–5)	5.578	*0.001***
Item 56	0.450 0.000**	4.63 ± 0.71	5 (2–5)	4.98 ± 0.22	5 (3–5)	4.704	*0.001***
Item 57	0.418 0.000**	4.54 ± 0.78	5 (2–5)	4.95 ± 0.21	5 (4–5)	4.573	*0.001***
Item 58	0.490 0.000**	4.57 ± 0.73	5 (3–5)	4.95 ± 0.21	5 (4–5)	4.573	*0.001***
Item 59	0.336 0.000**	4.57 ± 0.76	5 (3–5)	4.96 ± 0.19	5 (4–5)	4.247	*0.001***
Item 60	0.676 0.000**	4.32 ± 0.95	5 (1–5)	4.82 ± 0.52	5 (3–5)	4.792	*0.001***
Item 62	0.413 0.000**	3.80 ± 1.13	4 (0–5)	4.75 ± 0.56	5 (3–5)	6.940	*0.001***

*$p < 0.05$ **$p < 0.01$

*** Three items in the original scale were removed. The original scale consists of 62 items and the Turkish version consists of 59 items. Items are numbered as in the original scale

greater than that reported in the study of the psychometric properties of the English version (46.820%) [27]. The higher total explained variance in our study compared to the original study indicates that the concepts in the scale were effectively measured in this Turkish sample [54]. According to CFA of the 6-factor model, factor loadings for all items exceeded 0.30, the RMSEA value was lower than 0.08, χ^2/df was lower than 5, and model fit indexes exceeded 0.90. These results demonstrated an acceptable level of fit [40, 53, 55].

Infants diagnosed with feeding problems received higher NeoEAT-Breastfeeding subscale and total scores compared to those without any diagnosed feeding problem in our study, demonstrating known-group validity (Table 4). Consistent with our findings, Pados et al. (2018) found that the total NeoEAT-Breastfeeding score of typically feeding infants was lower than that of infants with feeding problems (90.82 ± 34.35 vs. 61.19 ± 23.94; $P < 0.001$). As a result of the ROC analysis, we determined the optimum cut-off value of the Turkish NeoEAT-Breastfeeding total score for the diagnosis of feeding problems was 211 (Table 5). Infants with a score of 211 or higher on the Turkish NeoEAT-Breastfeeding can be evaluated as having a high level of feeding problems or a feeding impairment. This cut-off point had the highest sensitivity and specificity values (91.67% and 73.06%, respectively). The sensitivity of a measure is the proportion of affected people who test positive, while its specificity is the proportion of unaffected people who test negative [56, 57]. In ROC curve analysis, an AUC of 0.70–0.80 is considered acceptable, 0.80–0.90 is very good, and over 0.90 is excellent [56, 57, 58]. The AUC in this study was 0.925, indicating that the Turkish NeoEAT-Breastfeeding also has significant ability to distinguish infants with and without feeding impairment ($P = 0.001$).

Cronbach's α coefficients between 0.70 and 1.00 are considered an indicator of acceptable reliability [40, 54]. The Cronbach's α coefficient of the NeoEAT-Breastfeeding (0.87) and its subscales (0.71–0.91) were all greater than 0.70. Pados et al. (2018) reported a Cronbach's α of 0.92 in the study of the psychometric properties of the English version [27]. When evaluating item-total score correlation, coefficients should be positive and higher than 0.30 [40, 53]. In this study, item-total correlations of the 59 retained items were greater than 0.30. These results all suggest that the items are sufficiently related to the scale, adequately measure the construct, and are reliable [53, 54]. There was also an excellent agreement between the two measurements in test-retest analysis performed with 35 mothers at a 2-week interval in our study, demonstrating temporal stability reliability [40]. These findings are consistent with those reported for the English version [27].

Limitations

This study has some limitations. Firstly, the Turkish NeoEAT–Breastfeeding was used with infants who span a wide range of ages and therefore a single cut-off score may not be ideal. Additional analyses with age as a potential variable could be very informative and useful for interpretation of the scores. Future studies should also evaluate differences in scores for infants that are born preterm or have intrauterine growth retardation. Secondly, the mother's previous breastfeeding experience and age of the infant may affect the mother's evaluation of the breastfeeding process and the observation of differences in scoring. This is another limitation of the study. In future research, it would be useful to monitor the changes in the scale score taking these factors into account.

Conclusion

The Turkish NeoEAT-Breastfeeding has 59 items in 6 subscales and shows validity and reliability as a parent-reported measure of symptoms of problematic feeding in breastfed infants younger than 7 months of age. Through cooperation between parents and neonatal follow-up clinic staff, using the NeoEAT-Breastfeeding scale will be beneficial in monitoring infants' feeding status associated with breastfeeding, preventing early cessation of

breastfeeding, referring preterm/term infants at risk of feeding problems and breastfeeding cessation for specialist support, and preventing long-term feeding problems. Neonatal nurses can use this assessment tool to identify problems and prevent early cessation of breastfeeding.

Acknowledgements
The authors thank the parents for their support.

Author contributions
Conceptualization: BAG, DG. Methodology: BAG, DG, BP. Software: BAG, DG, FÇ, YK, BP. Validation: BAG, DG, FÇ, YK, BP. Formal analysis: BAG, DG, FÇ, YK, BP. Investigation: BAG, DG, FÇ, YK, BP. Resources: BAG, DG, FÇ, YK, BP. Data Curation: BAG, DG, FÇ, YK, BP. Writing - Original Draft: BAG, DG, FÇ. Visualization: BAG, DG, BP, FÇ, YK. Supervision: BAG, DG, BP.

Funding
Not applicable.

Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
This study has been approved by the Ethics Committee of Health Sciences University in Istanbul, Türkiye (Ethical Review Number: 26.05.2023/111). The consent that was obtained from all of the participants was informed. This study was conducted in accordance with the principles outlined in the Declaration of Helsinki.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Received: 15 September 2024 / Accepted: 28 April 2025
Published online: 07 May 2025

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