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Original article

# Psychometric properties of the behavioral pediatrics feeding assessment scale for children with cerebral palsy

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**Abstract.** *Background and aim:* This study aimed to investigate the Behavioral Pediatrics Feeding Assessment Scale (BPFAS) as a tool for measuring the feeding difficulty of children with cerebral palsy (CP). It was adapted using the standard adaptation process. *Methods:* A survey was conducted with 87 mothers of 2–8-year-old children with CP. Rasch analysis was used to identify the BPFAS's psychometric characteristics. The degree of item fit, item difficulty, rating scale analysis, and reliability were investigated. *Results:* The analysis showed that the fitness index of one of the 25 items did not meet the criteria. The most difficult item was "Has required supplemental tube feeds to maintain proper nutritional status," and the least difficult was "Takes longer than 20 min to finish a meal." The rating scale analysis indicated that the fitness index was appropriate for the five-point scale, and the participants' average ability estimate increased as the score rose. The reliability analysis showed that the person separation index was 3.45 and the item separation index was 3.06, indicating a reliable level. *Conclusions:* The BPFAS's psychometric properties suggest that it is useful for measuring the feeding difficulty of children with CP. Future research should determine the reliability and validity of various aspects of the scale.

**Key words:** Children with cerebral palsy, behavioral pediatrics feeding assessment scale, feeding difficulties, parent report

## Introduction

Feeding disorders in children can be associated with neurological vulnerability and they have increasingly become a topic of research and clinical attention (1,2). It has long been understood that various conditions, such as cerebral palsy (CP), and neurodevelopmental factors and medical needs affect feeding function and these are recognized as a risk for chronic feeding difficulties more and more (2,3). CP is a developmental disorder that can affect sensation, perception, cognition, communication, and behavior. It is a result of a non-progressive brain injury that can occur in the womb or during infancy, and it is a developmental disorder that restricts movement and posture maintenance (4). In order to promote the delayed motor function of children with CP, various adaptations are established as the goal of rehabilitation, such as with the performance of general communication, independent daily living activities (eating, drinking, dressing, washing, using the toilet, etc.), and recreational activities, and using a wheelchair (5). Among the daily activities of children with CP, the provision of meals is important for their nutritional intake for their growth and development, and it is an essential activity for maintaining life (6). In children with CP, feeding has a strong correlation with their nutritional status and health status, and multiple diagnosed health problems can also cause difficulty with their diet (7,8).

Feeding disorders that occur in children during their development, regardless of the time period, can have a significant impact on their growth and

development, overall health, and family relationships (3,9,10). The prevalence of neurological disorders in children is estimated to be 29 per 1,000, with about 68% to 80% experiencing one type of feeding difficulty (11,12), and these feeding difficulties contribute significantly to poor nutrition (13-15). Growth deviation and impaired nutritional conditions are common in children with CP (16), and it has been proposed that maintaining proper nutrition is one of the most important factors for their healthy growth and well-being (17,18). However, despite the importance of the nutritional factors that influence the growth of children with CP, nutritional care has not been a priority in the medical treatment process for these children (19). Especially, among the types of feeding difficulty, dysphagia is most frequently found in children with neurological disorders (20) and feeding difficulties related to non-clinical problems, such as behavioral problems, have not been sufficiently addressed in the published literature (21). Therefore, the evaluation of dietary disorders in children with neurological disorders should include the assessment of the clinical and behavioral factors, including child and parental anxiety.

Given that the parents have observed their child's dietary behavior over time and in different situations, a parental reporting tool can obtain meaningful information about a child's feeding difficulties (22). Moreover, the use of parental reporting tools provides a more holistic approach than simply relying on a clinician's observation in a sterile clinic setting (20). Parental reporting tools can be very useful for assessing children with neurological disorders because these children are often highly dependent on their parents for feeding. A wide range of measures has been used to quantify the clinical significance of children's dietary problems (23). However, there are few valid and reliable psychometric questionnaires available for evaluating children who have clinically important dietary problems.

Currently, the measure with the best psychometric profile is the Behavioral Pediatrics Feeding Assessment Scale (BPFAS) (24). The BPFAS can reliably and consistently differentiate between population samples and it can be used assess psychological interventions (25). It is a comprehensive and widely used measurement tool for behavioral and skill-based diet problems. It has been reported to be reliable and effective for successfully distinguishing between children with clinically important dietary problems in both the normative and clinical populations (24). The BPFAS was originally designed to compare mealtime behaviors in healthy children and children with cystic fibrosis aged between 1 and 8 years (26). Since the original validation, it has been associated with additional pediatric populations, such as children with dietary problems (24), children with Type 1 diabetes (27), and children with autism spectrum disorder (28). However, although the BPFAS has been used to evaluate feeding behavior in children with CP (29,30), its usefulness for assessing feeding difficulties in children with CP has not yet been investigated. Therefore, this study aimed to verify the psychometric characteristics of this report-based evaluation tool for children with CP. Specifically, the study examined (a) item fit of the BPFAS, (b) item difficulty, (c) suitability of the rating scale, and (d) person and item separation indices of the BPFAS.

## Materials and methods

### *Participants*

The participants of this study were 87 children with CP aged from 2 to 8 years who were enrolled in an elementary school for children with physical disabilities or were receiving rehabilitation treatment in a hospital. Table 1 shows their general characteristics. The average age of the children with CP was 5.3 years (standard deviation [*SD*] = 1.9), and 50 (57.5%) of them were boys and 37 (42.5%) were girls. The type of CP was spastic in 74 (85.1%) of the children, dystonic in seven (8.1%), hypotonic in three (3.4%), and ataxic in three (3.4%). There were 29 (33.3%) children who were at the Gross Motor Function Classification System's (GMFCS) level 1, 10 (11.5%) children who were at GMFCS level 2, 13 (14.9%) who were at GMFCS level 3, 16 (18.4%) who were at GMFCS level 4, and 19 (21.8%) who were at GMFCS level 5. The correlation coefficient between the Body Mass Index Z score and total score of BPFAS was .028 ($p > .05$). All participants gave their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration

**Table 1.** Participants' characteristics.

| Characteristics | Frequency | % |
|---|---|---|
| Gender | | |
| Male | 50 | 57.5 |
| Female | 37 | 42.5 |
| Type of CP | | |
| Spastic | 74 | 85.1 |
| Dystonic | 7 | 8.1 |
| Hypotonic | 3 | 3.4 |
| Ataxic | 3 | 3.4 |
| GMFCS level | | |
| Level 1 | 29 | 33.3 |
| Level 2 | 10 | 11.5 |
| Level 3 | 13 | 14.9 |
| Level 4 | 16 | 18.4 |
| Level 5 | 19 | 21.8 |

Note. GMFCS = Gross Motor Function Classification System.

of Helsinki. The study was approved by the Research Ethics Board of Jeonju University (ethical approval code number: IRB–1041042–2013–1).

*Measure*

The BPFAS was used to obtain parental reports of the parent's and child's mealtime behaviors (24). In order to examine the psychometric characteristics of the BPFAS as a tool for measuring the feeding difficulty of children with CP, an adaptation of the BPFAS was conducted. This adaptation followed the standard process of adaptation, review, reversal, and review (31). The measure asks parents to report the frequency of mealtime behaviors using a Likert scale (1 = never to 5 = always), and to state if they experience a mealtime behavior using a dichotomous scale (0 = no and 1 = yes). It includes 35 items. This study used 25 items to assess the children's feeding behavior. Since the metrics include items for positive (e.g., eating vegetables) and negative (e.g., tantrums at mealtime) behaviors, positive behavioral items are scored in reverse (e.g., Items 1, 3, 5, 6, 8, 9, 16, and 18). A higher score indicates that more mealtime problems exist and that there are fewer positive eating behaviors. Each item is associated with a specific mealtime behavior (e.g., the child is having problems chewing food or the child will try new foods). The scale generates scores for the frequency of the child's behavior, number of problematic child behaviors, frequency of the parent's behavior, and number of problematic parent behaviors. Previous studies have shown adequate confidence in the measurements (Cronbach's $\alpha = 0.76$) (24). The Cronbach's $\alpha$ of this study was 0.831.

*Statistical analysis*

The collected data were analyzed using Winstep (Chicago, IL, USA) 3.60.2 Version to analyze item fit, item difficulty, rating scale appropriateness, and separation reliability. Items that were misfit were excluded through the model's fitness statistics. If the mean square of infit value of item is less than 0.5 or greater than 1.7 and the Z value was less than -2.0 or greater than 2.0 at the same time, item was judged as inappropriate [3]. In order to confirm the difficulty of the item, the participant attribute score for the item and the distribution of the difficulty level were compared. At this time, it can be considered that the distribution is appropriate when the range of the distribution is similar so that the question difficulty can measure all ranges of participant attributes [5]. And the suitability of the rating scale was analyzed using the rating scale model. In determining the suitability of the rating scale, when the average residual of the outfit index is 2.0 or less, or the average measured value shows a vertical ordering, and the step correction interval is 1.0 logit or more and 5.0 logit or less, the appropriate scale category was determined [6]. Finally, separation reliability analysis was conducted for the items and subjects.

## Results

*Unidimensionality*

After verifying the unidimensionality of the BPFAS in 87 children with CP, the fit index of Item 24, which is "Tries to negotiate what he/she will eat and what he/she will not eat," was not appropriate (Table 2). The results of the analysis after deleting Item

**Table 2.** Item fit statistics.

| Item no. | Content | MEASURE | SE | Infit | | Outfit | |
|---|---|---|---|---|---|---|---|
| | | | | MNSQ | Z-value | MNSQ | Z-value |
| 1 | Eats fruits | 50.38 | 1.13 | 0.90 | -0.7 | 0.85 | -0.9 |
| 2 | Has problems chewing food | 49.63 | 1.11 | 1.38 | 2.4 | 1.39 | 2.3 |
| 3 | Enjoys eating | 46.81 | 1.05 | 0.80 | -1.5 | 0.75 | -1.9 |
| 4 | Chokes or gags at mealtime | 50.38 | 1.13 | 0.97 | -0.2 | 0.94 | -0.3 |
| 5 | Will try new food | 40.82 | .99 | 0.98 | -0.1 | 0.99 | 0.0 |
| 6 | Eats meat and/or fish | 51.04 | 1.15 | 0.84 | -1.0 | 0.81 | -1.2 |
| 7 | Takes longer than 20 min to finish a meal | 37.69 | 1.02 | 1.09 | 0.7 | 1.08 | 0.6 |
| 8 | Drinks milk | 46.55 | 1.03 | 1.61 | 3.9 | 1.61 | 3.7 |
| 9 | Comes readily to mealtime | 44.17 | 1.00 | 0.54 | -4.2 | 0.55 | -4.0 |
| 10 | Eats junky snack foods but will not eat at mealtime | 42.88 | .99 | 1.45 | 3.1 | 1.56 | 3.7 |
| 11 | Vomits just before, at, or just after mealtime | 61.04 | 1.79 | 0.75 | -1.0 | 0.54 | -1.8 |
| 12 | Eats only ground, strained, or soft food | 54.78 | 1.34 | 1.16 | 0.9 | 1.14 | 0.7 |
| 13 | Gets up from table during meal | 50.51 | 1.14 | 1.20 | 1.3 | 1.12 | 0.8 |
| 14 | Let's food sit in his/her mouth and does not swallow it | 55.93 | 1.39 | 0.90 | -0.5 | 0.81 | -0.9 |
| 15 | Whines or cries at feeding time | 60.73 | 1.76 | 1.07 | 0.4 | 0.66 | -1.3 |
| 16 | Eats vegetables | 44.88 | 1.01 | 1.02 | 0.2 | 1.04 | 0.4 |
| 17 | Tantrums at mealtimes | 53.65 | 1.26 | 0.88 | -0.7 | 0.77 | -1.2 |
| 18 | Eats starches (for example, potato, noodles) | 38.34 | 1.01 | 1.27 | 1.9 | 1.25 | 1.8 |
| 19 | Has a poor appetite | 51.17 | 1.16 | 0.63 | -2.7 | 0.64 | -2.4 |
| 20 | Spits out food | 55.55 | 1.37 | 0.50 | -3.3 | 0.49 | -2.9 |
| 21 | Delays eating by talking | 49.39 | 1.10 | 0.95 | -0.3 | 0.91 | -0.6 |
| 22 | Would rather drink than eat | 52.29 | 1.20 | 1.05 | 0.4 | 1.20 | 1.1 |
| 23 | Refuses to eat meals but requests food immediately after the meal | 55.36 | 1.36 | 0.80 | -1.1 | 0.67 | -1.7 |
| 24 | Tries to negotiate what he/she will eat and what he/she will not eat | **41.99** | **.99** | **1.90** | **5.6** | **2.07** | **6.4** |
| 25 | Has required supplemental tube feeds to maintain proper nutritional status | 64.02 | 2.11 | 1.38 | 1.3 | 0.61 | -1.3 |

Note. SE = standard error, MNSQ = mean square, Bold means the misfit item.

24 showed that the infit mean square (MNSQ) ranged from 0.52 to 1.68. Item 8 had the highest infit MNSQ, which was "Drinks milk," and Item 20 had the lowest infit MNSQ value, which was "Spits out food."

*Item difficulty*

Figure 1 shows the difficulty level of the BPFAS. The right side of the figure presents the distribution of the difficulty level of each item, and the left side displays the distribution of the participants' ability. The logit value increases and the item becomes more difficult toward the top of the figure (measure = 64.02), and the logit value decreases and the item becomes easier (measure = 37.69) toward the bottom of the figure. The item with the lowest level of difficulty among the 24 items becomes the easiest item. Among the items, the easiest was Item 7, which is "Takes longer

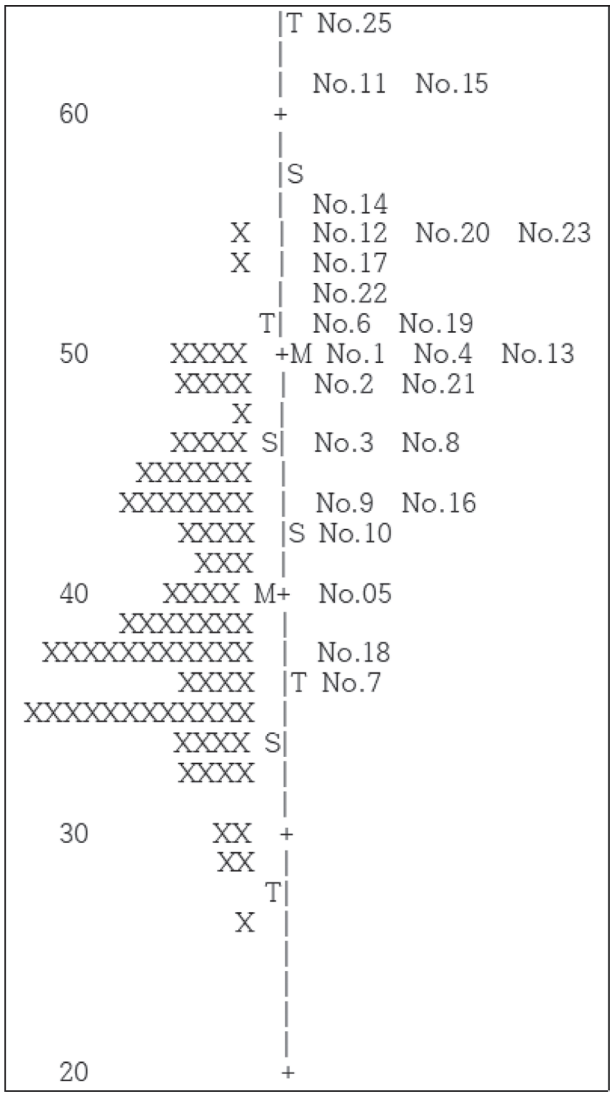


**Figure 1.** Map of the item difficulty and participants' ability.

The left side displays the participants' ability and the right side presents the items' difficulty. People with a higher ability and more difficult items are placed at the top of the diagram. X = one person, M = mean, S = one standard deviation from the mean, and T = two standard deviations from the mean.

than 20 min to finish a meal." The most difficult was Item 25, which was "Has required supplemental tube feeds to maintain proper nutritional status."

*Separation index*

The results of the separation reliability of the Rasch analysis are shown in Table 3. The person separation index was 3.45 and the separation reliability was .92. In addition, the separation index of the item was 3.06 and the separation reliability was .90. In terms of the numbers, it can be observed that both the person and item separation reliability were excellent.

**Table 3.** Person and item separation indexes.

| Category | Separation Index | Reliability |
|---|---|---|
| Person | 3.45 | 0.92 |
| Item | 3.06 | 0.90 |

*Rating scale analysis*

In the rating scale analysis (Table 4), the observed counts were all over 10, the average measure increased, and there was no value above 1.5 in the fitness index. Thus, all of the scale's appropriateness conditions were met.

## Discussion

Item response theory analyzes the items of a scale according to each item's unique characteristic curve and it estimates the items' characteristics and the ability of the participant. The limitations of classical test theory, which analyzes the items and estimates the participant's ability, can be overcome by using the total score (32). Item response theory has the advantage of invariability in the item characteristics as the characteristics of the items do not change according to the characteristics of the participant group (33). The Rasch model, which is based on item response theory, estimates the participant's response to an item using a mathematical formula (34). The participant's ability or the difficulty of the item can be identified through the converted logit score (35). Due to these advantages, Rasch analysis is widely used to verify existing evaluation tools and to develop new measurement tools in the fields of psychology and rehabilitation (36,37). Therefore, this study conducted a Rasch analysis to investigate whether the BPFAS is an appropriate tool for evaluating the feeding behavior of children with CP.

**Table 4.** Rating scale analysis.

| Category Level | Observed Count | Average Measure | Infit MNSQ | Outfit MNSQ | Structure Measure |
|---|---|---|---|---|---|
| 1 | 931 | -16.55 | 0.88 | 0.94 | NONE |
| 2 | 451 | -8.85 | 1.00 | 0.70 | -5.80 |
| 3 | 403 | -3.82 | 0.86 | 0.72 | -6.81 |
| 4 | 204 | -2.43 | 1.25 | 1.36 | 3.66 |
| 5 | 95 | 0.19 | 1.46 | 1.46 | 8.95 |

Note: MNSQ = mean square.

The fitness of the item indicates the unidimensionality of a test question, and the questionnaire's fitness MNSQ value can be found using the rating scale model. The unidimensionality indicates how it is composed. If the MNSQ value is high, it means that the item is not homogeneous with the other items in the scale, and if the value is low, it means that the item overlaps the other items (38). There are two values for the MNSQ: infit and outfit. The standardized value of the infit and outfit is represented by the Z value. An MNSQ value of 1 is the ideal value in the Rasch model (39). In this study, in order to determine the fit of an item, it was judged to be a misfit item when the infit index was less than .5 or greater than 1.7, and when the Z value was less than -2 or greater than 2 (40). As a result, one misfit item was "Tries to negotiate what he/she will eat and what he/she will not eat."

CP is a permanent impairment of movement and posture development that results from non-progressive abnormalities during fetal or infant brain development and it limits activity (41). As indicated by the definition of children with CP, the main disorder is a problem with movement and posture development; that is, it is a movement disorder (42). By examining the content of Item 24, which is an inappropriate item, it can be seen that it requires the children's motor skills. Thus, their movement disorder is thought to be related to the inadequateness of the items that require motor function.

The difficulty level of the items was compared in a graph of the participant's ability score and the difficulty level of the item. This allows a direct comparison because the participants and items are placed in a single graph according to each ability score and difficulty level. In addition, since the participant's ability score and item difficulty are converted into the logit scale, a direct comparison is achievable, and it is possible to evaluate whether the item difficulty is appropriate for the group being analyzed. When the ranges of the two distributions coincide—that is, when the ranges are similar and the item difficulty can measure all ranges of the participants' abilities—it can be said that the distribution is appropriate (38). As a result of comparing the participant's ability score distribution and item difficulty distribution for the BPFAS, it was found that the difficulty was higher than the participant's ability. The left side of Figure 1 shows the ability of the participants, and it was found that the feeding difficulty of the children with CP was not concentrated on one level; instead, there was a difference according to the ability. The right side of Figure 1 presents the distribution of the item difficulty, and it can be observed that the difficulty of the item was also not concentrated on one level; there was a difference in the difficulty level. Accordingly, it can be concluded that the BPFAS is suitable for evaluating the feeding difficulty of children with CP.

When creating a test, the rating scale should have a clear response level, such as in terms of the latent variable to be measured (43). The fit index of each scale score also provides information about whether the rating scale is functioning properly. If the fitness index of an individual scale score has a value of 1.5 or more, based on the ideal value of 1.0, it implies that the scale is not functioning properly and it indicates whether the scale scores should be merged later (44). The five-point rating scale of the BPFAS was found to be appropriate. The estimate for the scale threshold should show a tendency to increase as each scale score increases, similar to the

estimate of the average ability of the participant. The difference between the scale threshold and the participant's average ability estimate is that the latter is calculated from the observation frequency of the sample, whereas the scale threshold is an estimate that is calculated by the Rasch model (32). The analysis results showed that the BPFAS is in proportion to the increase in the scale score.

In the Rasch analysis, the reliability of the BPFAS was evaluated using the person separation reliability. As the person separation index/stratum of the data was 3.45, which was higher than the standard value of 3, it can be judged as being at a good level. This means that the children with CP were separated into at least three levels (high, medium, and low). The reason for the low level of ability of a low-ranked person may be that more items are needed to distinguish between those with high and low ability, or that a wider sample of human ability needs to be used (45). Therefore, the person separation index value of the BPFAS in this study indicates that the number of items and number of participants were appropriate.

## Conclusions

To determine whether the BPFAS is an appropriate tool for evaluating the feeding difficulty of children with CP, the unidimensionality, item difficulty, and relevance and reliability of the rating scale were verified using Rasch analysis. It was found that two items that violate the unidimensionality should be deleted and not used. The item difficulty, rating scale, and reliability of the BPFAS that consisted of 23 items were shown to be at an appropriate level. This study is meaningful in that it confirms the psychometric characteristics of the BPFAS, which was used with children with CP. However, although the number of participants required for the Rasch analysis was sufficient, there is a limitation that the number of children investigated was small. In future, research studies should be conducted to verify the validity of this evaluation tool.

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