

# Parent-report instruments for assessing feeding difficulties in children with neurological impairments: a systematic review

NURUL HAZIRAH JAAFAR<sup>1</sup>  | AZIZAH OTHMAN<sup>1</sup> | NOORIZAN A MAJID<sup>1</sup> | SAKINAH HARITH<sup>2</sup> | ZAMH ZABIDI-HUSSIN<sup>3</sup>

**1** Paediatrics Department, School of Medical Sciences, Universiti Sains Malaysia, Kelantan; **2** Faculty of Health Sciences, Universiti Sultan Zainal Abidin, Terengganu; **3** Department of Paediatrics and Chancellery, Perdana University, Selangor, Malaysia.

Correspondence to Zamh Zabidi-Hussin, Block D, Level 1, MAEPS Building MARDI Complex, Jalan MAEPS Perdana, 43400 Serdang, Selangor Darul Ehsan, Malaysia.  
E-mail: zabidihussin@perdanauniversity.edu.my

## PUBLICATION DATA

Accepted for publication 13th June 2018.  
Published online

## ABBREVIATIONS

BPFAS	Behavioural Paediatric Feeding Assessment Scale
CEBI	Children's Eating Behaviour Inventory
MCHFS	Montreal Children's Hospital Feeding Scale
PASSFP	Paediatric Assessment Scale for Severe Feeding Problems
PEDI-EAT	Paediatric Eating Assessment
STEP-CHILD	Screening Tool of Feeding Problems applied to children

**AIM** This study aimed to review the psychometric properties and clinical application of parent-report instruments that assess feeding difficulties in children with neurological impairments.

**METHOD** Papers were identified through five electronic databases based on 15 keywords and were included if they met the following criteria: published in English, described the implementation of parent-report instruments, and included children with neurological impairments (either in the report or a related study population).

**RESULTS** In total, 1220 relevant abstracts were screened and 22 full-text articles were evaluated. The following six parent-report instruments met the inclusion criteria: (1) Screening Tool of Feeding Problems applied to children, (2) Paediatric Eating Assessment Tool, (3) Paediatric Assessment Scale for Severe Feeding Problems, (4) Montreal Children's Hospital Feeding Scale, (5) Children's Eating Behaviour Inventory, and (6) Behavioural Paediatric Feeding Assessment Scale (BPFAS). Based on comprehensive psychometric testing and consistently good results, the BPFAS was considered the most valid and reliable instrument. The BPFAS also showed good clinical applicability because it was readily available, required a short administration time, and used a simple scoring system.

**INTERPRETATION** We reviewed the available parent-report instruments for assessing feeding difficulties in children with neurological impairments. The BPFAS had the best psychometric properties and clinical applicability.

Children with neurological impairments can be defined as those with injuries affecting their nervous system, causing functional and intellectual impairments. They comprise those with brain impairment acquired either early in life (cerebral palsy or spina bifida)<sup>1,2</sup> or later in life (traumatic brain injury, encephalitis, brain tumour) as well as those with genetic, metabolic, and neurological degenerative disorders. The prevalence of neurological impairment in children is estimated to be 29 per 1000, and approximately 68% to 80% of them have experienced some kind of feeding difficulties,<sup>3,4</sup> significantly contributing to poor nutritional status,<sup>5-7</sup> repeated lung infections, and failure to thrive.

The most common type of feeding difficulties seen among children with neurological impairments is dysphagia. Feeding difficulties associated with non-clinical issues such as behaviour problems are not addressed well in published literatures. As an example, a recent review conducted by Benfer et al.<sup>8</sup> only evaluated instruments that assessed oropharyngeal dysphagia in children with cerebral palsy and neurodevelopmental disabilities; very little attention is

paid to behaviour and psychological problems that contribute to feeding difficulties. Hence, any assessment of feeding difficulties in children with neurological impairment should incorporate evaluations of clinical and behavioural elements including child and parental anxiety.

Given that parents have observed their child's feeding behaviour over time and in different situations, parent-report instruments can provide meaningful information about feeding difficulties in children.<sup>9</sup> Moreover, their use provides a more holistic approach than simply relying on a clinician's observation in a sterile clinic environment. In children with neurological impairments, parent-report instruments can be very valuable because these children are often highly dependent on their parents for feeding. To date, however, reviews conducted on preschool children have not looked at this topic in sufficient detail. In their review on psychometric properties of parent-report instruments, Sanchez et al.<sup>10</sup> did not specifically address children with neurological impairments.

Therefore, in this review, we aim to identify the psychometric details and clinical applicability of the available

parent-report instruments for assessing feeding difficulties in children with neurological impairments.

## METHOD

### Search strategy

Papers related to the implementation of parent-report instruments for assessing feeding difficulties in children with neurological impairments were gathered from five electronic databases: MEDLINE, Web of Science, Scopus, ScienceDirect, and PsychINFO. The databases were then searched using the following search terms: (“children with neurological impairment” OR “disabled children” OR “children with neurodisability” OR “children with physical impairment”) AND (“feeding problem” OR “dysphagia” OR “feeding difficulties” OR “deglutition disorder” OR “swallowing disorder”) AND (“assess” OR “scale” OR “evaluate” OR “psychometric” OR “validation” OR “reliability”). In this review, we did not limit the search period because doing so may have excluded potentially useful instruments.

### Eligibility

Studies were included if they met the following criteria: (1) they were based on the implementation of parent-report instruments for assessing feeding difficulties; (2) they included children with neurological impairments in either their current or a previous study population; and (3) they were published in English. Studies were excluded if they were review articles or described the implementation of an instrument to assess oropharyngeal dysphagia.

### Data extraction

Preliminary searches were conducted in February 2016 and were repeated in October 2017. One author (NHJ) conducted the searches and screened for relevant titles and abstracts from the databases. Duplicate studies were excluded. Then, full-text articles were retrieved, and their abstracts, methodologies, and results were reviewed by five all authors to identify relevant instruments. Once the instruments had been identified, the reference lists of the selected articles were searched to ensure that all data on their psychometric properties and clinical applicability were collected. In the event of missing or unpublished data, authors were contacted to obtain all relevant information.

### Data analysis

The characteristics of each instrument such as population studied, item generation, domains, total items, scoring system, and interpretation of total scores were extracted. Next, their psychometric properties were reviewed (i.e. validity and reliability).

Validity data included information collected about the following five aspects. (1) Content validity was assessed on whether the author adequately judged the relevance and comprehensiveness of items, either by experts or the opinion of the target population. (2) Structural validity was

### What this paper adds

- Six parent-report instruments were suitable for assessing feeding in children with neurological impairments.
- The Behavioural Paediatric Feeding Assessment Scale (BPFAS) has the strongest psychometric properties.
- The BPFAS also has good clinical applicability.

assessed on the need for adequate information on the methods involved in factor analysis. (3) Construct validity was assessed on whether the instrument had been tested to obtain a relationship between different groups, or different instruments. (4) Criterion validity was assessed by determining whether tests of the receiver operating characteristic curve, sensitivity, specificity, positive predictive value, and negative predictive value had been conducted. (5) Cross-cultural validity was assessed by determining whether there had been translation or adaptation studies, and, if appropriate, whether there had been validation studies after translation.

Reliability was assessed by reviewing the measures of the internal consistency, test-retest reliability, and measurement error. Test-retest reliability is essential for ensuring that scores are consistent when measures are repeated on a stable person and is assessed by Pearson's rank correlation coefficient or the intraclass correlation coefficient values. However, we considered the intraclass correlation coefficient to be favourable because it indicated the interindividual and intraindividual variation. Measurement error was calculated from the intraclass correlation coefficient value, with a small measurement error required to distinguish clinically important changes from the error. The formulae by Terwee et al.<sup>11</sup> were used to calculate the standard error of measurement and smallest detectable change. Reliability values were considered excellent if greater than 0.9, good if greater than 0.8, acceptable if greater than 0.7, questionable if greater than 0.6, poor if greater than 0.5 and unacceptable if 0.5 or less.<sup>12</sup>

Psychometric information was obtained according to the criteria listed by the Consensus-based Standard for the selection of Measurement Instrument (COSMIN) checklist.<sup>13</sup> Additional information, such as the primary purpose, administration time, equipment availability, readability, and language, were extracted to help understand clinical applicability.

## RESULTS

The article selection process is summarized in Figure S1 (online supporting information). The systematic searches identified 1220 relevant abstracts. Although 51 full-text articles fulfilled the inclusion criteria, 29 were excluded either for not assessing feeding difficulties ( $n=27$ ), for being a systematic review ( $n=1$ ), or for evaluating oropharyngeal dysphagia ( $n=1$ ). Therefore, we finally included 22 articles that described the psychometric properties and clinical application of six parent-report instruments of feeding difficulties in children with neurological impairments. The six instruments were the (1) Screening Tool of Feeding

Problems applied to children (STEP-CHILD),<sup>14</sup> (2) Paediatric Eating Assessment Tool (PEDI-EAT),<sup>15–17</sup> (3) Paediatric Assessment Scale for Severe Feeding Problems (PASSFP),<sup>18</sup> (4) Montreal Children's Hospital Feeding Scale (MCHFS),<sup>19–23</sup> (5) Children's Eating Behaviour Inventory (CEBI),<sup>24</sup> and (6) Behavioural Paediatric Feeding Assessment Scale (BPFAS).<sup>25–32</sup>

### Description of instruments

Detailed descriptions of the reviewed instruments are summarized in Table I. All reviewed instruments had included children with neurological impairments in their study populations. However, most were also used to assess feeding difficulties across a range of paediatric populations, including healthy children as well as those with the so-called CHARGE syndrome (coloboma, choanal atresia, ear abnormalities, and cranial nerve dysfunction), oesophageal atresia, autism spectrum disorder, diabetes mellitus type I, eosinophilic gastrointestinal disorder, or cystic fibrosis, and those who were overweight/obese. The age range in the study populations was 6 months to 18 years, with the BPFAS implemented across the widest age range (9mo–18y).

Most items of the reviewed instruments were generated using expert discussion, theoretical frameworks, previous instruments, and literature searches. Only the development of the PEDI-EAT considered parent perspectives when generating its items. All reviewed instruments incorporated the evaluation of the feeding behaviour (i.e. rapid eating, food refusal, food selectivity, stealing food, picky eaters, and stallers) and feeding capacity (i.e. oral motor skills, oral sensory, and appetite) of children when assessing feeding difficulties. However, the MCHFS, CEBI, and BPFAS also incorporated questions of parental perception, strategies and interaction at mealtime in their assessments, while the PASSFP also included an assessment of quality of life issues.

Three reviewed instruments had 14 to 15 items (STEP-CHILD, PASSFP, and MCHFS), and the PEDI-EAT had the highest number of items (78). The BPFAS and CEBI have 30 items and 25 items respectively. All reviewed instruments required responses to be given based on Likert-type scales, with most (PEDI-EAT, PASSFP, CEBI, and BPFAS) rated using the 5-point Likert scale, but the STEP-CHILD and MCHFS were rated using the 3-point and 7-point Likert-type scales respectively. In terms of the scoring systems, most instruments (PEDI-EAT, PASSFP, MCHFS, CEBI, and BPFAS) were typically evaluated based on their total or subscale scores, with higher scores indicating problematic or difficult feeding. However, we were unable to define the scoring system for the STEP-CHILD as the author did not provide the scoring methods in the article.<sup>14</sup>

### Validity of the instruments

The overall results of the validity of the reviewed instruments are summarized in Table II. Notably, we could find no information for the validity testing of the PASSFP.

Content validity has been established for the PEDI-EAT, MCHFS, and BPFAS. The PEDI-EAT showed

good content validity, with good relevance and clarity values; a clear process of content validation was reported by one excellent study.<sup>16</sup> Its items were generated from multidisciplinary information sources and were validated by multidisciplinary experts and the parents of children with feeding difficulties. The content validity of the MCHFS and BPFAS has also been validated among experts (i.e. psychologists), but there were no details on the process followed.

In terms of structural validity, the STEP-CHILD, PEDI-EAT, MCHFS, and BPFAS have implemented factor analysis. Only the BPFAS has been confirmed to have a good model fit by confirmatory factor analysis. Meanwhile, items in the STEP-CHILD, PEDI-EAT, and MCHFS were constructed by exploratory factor analysis, showing moderate variance between items and constructs. We could find no information on the structural validity of the PASSFP and CEBI.

The BPFAS has undergone extensive assessment of construct validity and has been shown to correlate well with multiple instruments that assess behaviour and development. The BPFAS has also been shown to reflect total energy intake and food consumption variation in children. Similarly, the STEP-CHILD corresponded well with observational feeding assessments, reflecting child behaviour and the parental situation at mealtime. Likewise, the PEDI-EAT has been shown to correlate well with mealtime behaviour and the penetration scale score, particularly for liquid and pudding consumption. In addition, the PEDI-EAT, MCHFS, CEBI, and BPFAS have undergone discriminative analysis and showed significant differences when comparing between control and clinical groups. After therapeutic intervention, the CEBI and BPFAS have also been found to be useful evaluative instruments for demonstrating changes in the expected direction.

Criterion validity has only been evaluated for the PEDI-EAT, MCHFS, and BPFAS, which have shown acceptable-to-good receiver operating characteristic, sensitivity, and specificity values. Moreover, predictive value has only been established for the BPFAS, which can accurately distinguish 87% of children into those with feeding problems and those without feeding problems.

To date, only the MCHFS has been culturally adapted and translated into French, Portuguese, Thai, and Dutch, with good acceptability and relevance. Although the BPFAS has also been culturally adapted, this is only among English-speaking countries, with the results of translation into Greek yet to be published.

### Reliability of the instruments

The overall results for the reliability of the reviewed instruments are summarized in Table II. Internal consistency has been established for all reviewed instruments, ranging from good to excellent for the PEDI-EAT and PASSFP, acceptable to excellent for the BPFAS, poor to questionable for the STEP-CHILD, and unacceptable to good for the MCHFS. Test-retest reliability has also been established for the instruments, except for the STEP-

**Table 1:** Parent-report instruments of feeding difficulties for children with neurological impairments: description of instruments

Authors	Instruments	Studied population (age range)	Item generation	Domain	Total items	Scoring (scale)	Interpretation of scores
Crist and Napier-Phillips <sup>32</sup>	BPFAS	Healthy children and children with feeding problems; CF, ASD, EGID, overweight, CHARGE, diabetes mellitus type 1 (9mo–18y)	Developed from experts' discussion and literature review	<ul style="list-style-type: none"> <li>Picky eaters</li> <li>Toddler refusal – general</li> <li>Toddler refusal – textured foods</li> <li>Older children refusal – general</li> <li>Stallers</li> <li>Parents perception and strategies</li> </ul>	35	Frequency score: 1=Always, 2=(in between), 3=Sometimes, 4=(in between), 5=Never. Problem score: 1=Yes, 2=No	Total frequency scores above 84, higher than normal Total problem score above 9, higher than normal
Archer et al. <sup>24</sup>	CEBI	Healthy children and children with eating problems; ASD, developmental disability, history of GERD (2–12y)	Developed from experts' discussion and literature review	<ul style="list-style-type: none"> <li>Food preferences</li> <li>Motor skills</li> <li>Behavioural compliance</li> <li>Parental child behaviour control</li> <li>Cognition and feeling about feeding</li> <li>Interaction between family</li> </ul>	40	1=Never, 2=Seldom, 3=Sometimes, 4=Often, 5=Always	Total eating problem scores: Higher scores indicate eating problem
Ramsay et al. <sup>23</sup>	MCHFS	Healthy children and children with feeding problems; failure to thrive, developmental disabilities, oesophageal atresia (6mo–6y)	Developed based on the biopsychological model of feeding problem and experts' discussion	<ul style="list-style-type: none"> <li>Oral sensory</li> <li>Appetite</li> <li>Mealtime behaviours</li> <li>Oral motor</li> <li>Maternal concerns about feeding</li> <li>Maternal strategies</li> <li>Family reactions to feeding</li> </ul>	14	1–7 (from negative to positive)	Total scores: 61–65: Mild difficulties, 66–70: Moderate difficulties, Above 70: Severe difficulties
Crist et al. <sup>18</sup>	PASSFP	Children with feeding difficulties; CHARGE syndrome, neurologic, gastrointestinal issues, preterm birth, renal, CF, cancer	Developed from experts' discussion and literature review	<ul style="list-style-type: none"> <li>Quality of life issues</li> <li>Nutritional</li> <li>Behavioural feeding</li> <li>Oral sensory</li> <li>Oral motor</li> </ul>	15	0=Always, 1=(in between), 2=Sometimes, 3=(in between), 4=Never	Total scores=66 Lower scores indicate significant feeding problems
Thoyre et al. <sup>16</sup>	PEDI-EAT	Healthy children and children with problematic eating behaviours; Down syndrome (9mo–13y)	Developed based on parents' interview, six existing instruments, and literature review	<ul style="list-style-type: none"> <li>Physiologic symptoms</li> <li>Problematic mealtime behaviours</li> <li>Selective/restrictive eating</li> <li>Oral processing</li> </ul>	78	0=Never, 1=Almost never, 2=Sometimes, 3=Often, 4=Almost always, 5=Always	Not yet to determine the cut-off points score
Seiverling et al. <sup>14</sup>	STEP-CHILD	Children with feeding problems; ASD, special needs (2–18y)	Developed based on two existing instruments and author's clinical judgements	<ul style="list-style-type: none"> <li>Rapid eating</li> <li>Food refusal</li> <li>Food selectivity</li> <li>Stealing food</li> <li>Vomiting</li> <li>Chewing problems</li> </ul>	15	0=not at all, 1=1–10 times, 2=more than 10 times per month	Not recorded in the article

BPFAS, Behavioural Paediatric Feeding Assessment Scale; CF, cystic fibrosis; ASD, autism spectrum disorder; EGID, eosinophilic gastrointestinal disorder; CHARGE, coloboma of the eye, heart malformations, atresia of the nasal passages, retardation of growth or development, genital hypoplasia, ear malformations; CEBI, Children's Eating Behaviour Inventory; GERD, gastroesophageal reflux disorder; MCHFS, Montreal Children's Hospital Feeding Scale; PASSFP, Paediatric Assessment Scale for Severe Feeding Problems; PEDI-EAT, Paediatric Eating Assessment; STEP-CHILD, Screening Tool of Feeding Problems applied to children.

CHILD. Reliability values were excellent for the PEDI-EAT, PASSF, and BPFAS, good for the CEBI, and questionable to excellent for the MCHFS. Information about measurement error could only be calculated from data

published for the PASSFP and BPFAS and indicated that the standard error of measurement and smallest detectable change were much smaller in the PASSFP than in the BPFAS.

**Table II:** Parent-report instruments of feeding difficulties for children with neurological impairments: psychometric properties

Instruments	Content validity	Structural validity	Construct validity	Criterion validity	Cross-cultural validity	Internal consistency (n, Cronbach's $\alpha$ )	Test-retest reliability (time interval, ICC)	Measurement error
BPFAS	From direct communication with the original author, this instrument has been developed over 30 years by experts on feeding problems	Benjasuwantep et al. <sup>21</sup> (n=345) Introduces five factor model with 55% CV among healthy group and 54%-59% CV in clinical groups Allen et al. <sup>31</sup> (n=374) Improvised to three factor model with good model fit, evaluated among children with ASD Davis et al. <sup>30</sup> (n=160) Done EFA and CFA on overweight child. Introduce five factor model but it does not fit	Allen et al. <sup>31</sup> Correlate BPFAS with ADOS, CBCL, SRS, RBS-R, MPR, PLS, VABS, CSHQ, PSI with medium effect ( $r=0.02$ - $-0.48$ ) Wu et al. <sup>27</sup> Correlate BPFAS with PSI with medium effect ( $r=0.25$ - $0.31$ ) Compare between healthy children and children with EGID, significant difference on all scores of BPFAS subscales ( $p<0.001$ ) Dovey et al. <sup>29</sup> Martin et al. <sup>26</sup> Marshall et al. <sup>28</sup> Compare between healthy children and children with non-organic feeding difficulty, significant difference on all scores of BPFAS subscales ( $p<0.001$ ) Archer et al. <sup>24</sup> Compare non-clinic and clinic groups with feeding, significant difference on total eating problem scores ( $p<0.001$ )	Dovey et al. <sup>29</sup> Conducted discriminative test to set cut-off value in clinical and non-clinical groups. From ROC, Child frequency=61, (Sn=0.86, Sp=0.87, PPV=0.46) Child problem=6, (Sn=0.84, Sp=0.85, PPV=0.42) Parent frequency=20, (Sn=0.80, Sp=0.79, PPV=0.33) Parent problem=2 (Sn=0.81, Sp=0.85, PPV=0.32) Can accurately identify 87% children as clinical or non-clinical Marshall et al. <sup>28</sup> Applying Dovey et al. <sup>29</sup> cut-off point, Sn>75% in all domains, PPV>70%, Sp>85% and NPV>85% Not available	From direct communication with the original author, BPFAS has been used in multiple English-speaking countries. BPFAS has been adapted by Greek population, but is yet to published	Benjasuwantep et al. <sup>21</sup> 345, $\alpha=0.76$ - $0.78$ Allen et al. <sup>31</sup> 345, $\alpha=0.71$ - $0.81$ Wu et al. <sup>27</sup> 181, $\alpha=0.81$ - $0.92$ Davis et al. <sup>30</sup> 160 children, $\alpha=0.65$ - $0.80$	Marshall et al. <sup>28</sup> 2 weeks, ICC=0.91	Marshall et al. <sup>28</sup> Marshall et al. <sup>28</sup> ICC=0.91 SD=16.7 SEM=5.01 SDM=13.89
CEBI	Not available	Not available	Not available	Not available	Not available	Archer et al. <sup>24</sup> 316, $\alpha=0.58$ - $0.76$	Archer et al. <sup>24</sup> 4-6 weeks, ICC=0.87	Archer et al. <sup>24</sup> ICC=0.87 SD was not available, SEM could not be calculated

**Table II:** Continued

Instruments	Content validity	Structural validity	Construct validity	Criterion validity	Cross-cultural validity	Internal consistency (n, Cronbach's $\alpha$ )	Test-retest reliability (time interval, ICC)	Measurement error
MCHFS	Ramsay et al. <sup>23</sup> Items were generated by psychologist working with children with feeding difficulties	Ramsay et al. <sup>23</sup> EFA – one factor, 48% variance, 0.48 –0.87 correlation between items van Dijk et al. <sup>19</sup> EFA – two factors, 79% variance and 90% common variance Benjasuwantep et al. <sup>21</sup> EFA – three factors, 52.3% variances, low correlations between items	Ramsay et al. <sup>23</sup> Compare normative and clinical children using ANOVA, significant difference between normative and clinical groups Baird et al. <sup>22</sup> Compare healthy children and children with esophageal atresia using t-test, significant MCHFS scores ( $p<0.001$ ) Benjasuwantep et al. <sup>21</sup> Significant difference between healthy children and children with feeding problems	Ramsay et al. <sup>23</sup> When using 45 as discriminative score, ROC=0.85, Sn=0.87, Sp=0.82 Benjasuwantep et al. <sup>21</sup> When using 40 as discriminative score, ROC=0.86, Sn=0.72, Sp=0.81	Ramsay et al. <sup>23</sup> Translated into French van Dijk et al. <sup>19</sup> Translated into Dutch Benjasuwantep et al. <sup>21</sup> Translated into Thai	Ramsay et al. <sup>23</sup> 372, $\alpha=0.48-0.87$ Benjasuwantep et al. <sup>21</sup> 200, $\alpha=0.84$ van Dijk et al. <sup>19</sup> 1448, $\alpha=0.75-0.84$	Ramsay et al. <sup>23</sup> 7–10d Normative sample, ICC=0.76–0.98 Clinical sample, ICC=0.69–0.97	Ramsay et al. <sup>23</sup> ICC=0.97 SD was not available, SEM and SDM could not be calculated
PASSFP	Not available	Not available	Not available	Not available	Not available	Crist et al. <sup>18</sup> 54, $\alpha=0.89-0.92$	Crist et al. <sup>18</sup> 2–4 weeks, ICC=0.98	Crist et al. <sup>18</sup> ICC=0.98 SD=17.2 SEM=2.43 SDM=6.74 SD were not available, hence SEM and SDM could not be calculated
PEDI-EAT	Thoyre et al. <sup>16</sup> Validated by multidisciplinary experts and parents with feeding difficulty, I-CVI, relevance=0.67–0.70, clarity=0.50–1.0	Thoyre et al. <sup>17</sup> Principal factor analysis supported four factor model with 39.4% of total variance. Model was not checked for good fit (CFA)	Thoyre et al. <sup>17</sup> Correlate significantly with mealtime behaviour Serel Arslan et al. <sup>15</sup> Correlate significantly with penetration score for liquid and pudding ( $r=0.77, 0.83$ ): Significant difference between healthy children and children with cerebral palsy	Serel Arslan et al. <sup>15</sup> Score>4, Sn=91.3%, Sp=98.8%	Not available	Thoyre et al. <sup>17</sup> 347, $\alpha=0.83-0.92$ Serel Arslan et al. <sup>15</sup> 187, $\alpha=0.87$	Thoyre et al. <sup>17</sup> 2 weeks, ICC=0.95	Thoyre et al. <sup>17</sup> SD were not available, hence SEM and SDM could not be calculated

**Table II:** Continued

Instruments	Content validity	Structural validity	Construct validity	Criterion validity	Cross-cultural validity	Internal consistency (n, Cronbach's $\alpha$ )	Test-retest reliability (time interval, ICC)	Measurement error
STEP-CHILD	Not available	Seiverling et al. <sup>14</sup> Exploratory factor analysis 23 original items, six factor model. Model was not checked for good fit (CFA)	Seiverling et al. <sup>14</sup> Correlate STEP-CHILD subscales scores with CEBO, child demographic, dietary intake, weight, and parent mealtime actions	Not available	Not available	Seiverling et al. <sup>14</sup> 142, $\alpha=0.57-0.62$	Not available	ICC and SD were not available, hence SEM and SDM could not be calculated

ICC, intraclass correlation coefficient; BPFAS, Behavioural Paediatric Feeding Assessment Scale; CV, cumulative variance; ASD, autism spectrum disorder; EFA, exploratory factor analysis; CFA, confirmatory factor analysis; ADOS, Autism Diagnostic Observation Scale; CBCL, Child Behaviour Checklist; SRS, Social Responsiveness Scale; RBS-R, Repetitive Behaviour Scale-Revised; MPR, Merrill-Palmer-Revised; PLS, Preschool Language Scale; VABS, Vineland Adaptive Behaviour Scale; CSHQ, Children's Sleep Habits Questionnaire; PSI, Parenting Stress Index-EGID, eosinophilic gastrointestinal disorder; ROC, receiver operating characteristic; Sn, sensitivity; Sp, specificity; PPV, positive predictive value; NPV, negative predictive value; SD, standard deviation; SEM, standard error of measurement; SDM, smallest detectable measure; CEBI, Children's Eating Behaviour Inventory; MCHFS, Montreal Children's Hospital Feeding Scale; ANOVA, analysis of variance; PASSFP, Paediatric Assessment Scale for Severe Feeding Problems; PEDI-EAT, Paediatric Eating Assessment; I-CVI, item – content validity indices; STEP-CHILD, Screening Tool of Feeding Problems applied to Children; CEBO, Child Eating Behaviour Questionnaire.

## Clinical application

The clinical application of the reviewed instruments is summarized in Table III. All instruments were self-administered questionnaires requiring parental compliance to give opinions about their children's feeding abilities. The primary purposes of the reviewed instruments were predictive (i.e. STEP-CHILD), discriminative (i.e. PEDI-EAT and MCHFS), and evaluative (i.e. PASSFP, BPFAS, and CEBI). All instruments could be completed in 5 to 16 minutes, with the MCHFS and PASSFP requiring the least time. Although none of the reviewed instruments had technical manuals, their assessment and scoring forms were freely available either through the academic literature or through contact with the authors (the latter was required for the PEDI-EAT and BPFAS). The PEDI-EAT was the only instrument with a reported readability level (fifth-grade readability). All reviewed instruments were available in English, and the MCHFS was the only instrument available in other languages (i.e. French, Thai, and Dutch).

## DISCUSSION

Children with neurological impairments often have a wide range of feeding difficulties that go beyond oropharyngeal dysphagia. A clearer understanding of the problems can help determine the category and severity of feeding difficulty, including how much the problems affect their dietary intake. An appropriate diagnosis would allow sustainable nutritional interventions to be formulated that boost nutritional statuses through rigorous and long-term rehabilitation. We therefore wanted to identify parent-report instruments that could be used to assess feeding difficulties in children with neurological impairments.

In total, 22 articles were identified covering six parent-report instruments that could be used to measure feeding difficulties in children with neurological impairments. The assessments through parent-report instruments generally involved assessing mealtime behaviour and parental perceptions towards feeding. Such parental involvement was the unique feature of these instruments, serving to reveal the factors underlying feeding difficulties from the parent's perspective. These underlying factors included lack of nutritional knowledge (domain: maternal strategies), low motivation and confidence in feeding children (domains: maternal concerns about feeding; cognition and feeling about feeding), and lack of family support (domains: quality of life issues; family reactions to a child's feeding and interaction between family members). This information is invaluable when assessing the coping skills of parents and determining the support to be offered.

The comprehensiveness of an assessment instrument depends on the number of feeding domains and the items explaining each domain. Multiple domains are required when assessing feeding difficulties. However, the complex nature of feeding difficulties means that it can be difficult to determine what observable behaviours (i.e. which domains) should be included. We discovered that at least one domain of all reviewed instruments fits in with Field

**Table III:** Parent-report instruments of feeding difficulties for children with neurological impairments: clinical usage

Instruments	Primary purpose <sup>a</sup>	Administration time	Availability of equipment	Readability	Language
BPFAS	Evaluative	15min	Form available upon request	Not available	English
CEBI	Evaluative	15min	Form in journal	Not available	English
MCHFS	Discriminative	5min	Form in journal	Not available	Dutch, English, French, Thai
PASSFP	Discriminative	5min	Form in journal	Not available	English
PEDI-EAT	Discriminative	16min	Form available upon request	Fifth grader	English
STEP-CHILD	Predictive	Not available	Form in journal	Not available	English

<sup>a</sup>Discriminative, to distinguish which problems; evaluative, to measure changes; predictive, identify individual who has or will develop the problems. BPFAS, Behavioural Paediatric Feeding Assessment Scale; CEBI, Children's Eating Behaviour Inventory; MCHFS, Montreal Children's Hospital Feeding Scale; PASSFP, Paediatric Assessment Scale for Severe Feeding Problems; PEDI-EAT, Paediatric Eating Assessment; STEP-CHILD, Screening Tool of Feeding Problems applied to children.

**Table IV:** Summary of parent-report instruments for assessing feeding difficulties in children with neurological impairments

Instruments	Primary purpose	Validity	Reliability	Strength	Weakness
BPFAS	Distinguish children with problematic behaviour in feeding Measure behaviour changes after intervention	Excellent	Excellent	<ul style="list-style-type: none"> <li>Used across widest age range</li> <li>Has been implemented in seven studies (highest)</li> <li>Has cut-off scores</li> <li>Culturally-adapted</li> </ul>	
CEBI	Assess eating/mealtime problems in children Evaluate mealtime behaviours after an intervention	Reasonable	Moderate	<ul style="list-style-type: none"> <li>Address issue of interaction between family</li> </ul>	<ul style="list-style-type: none"> <li>No cut-off scores</li> <li>Has been implemented in one old study only<sup>24</sup></li> </ul>
MCHFS	Distinguish children with problematic behaviour in feeding	Excellent	Moderate	<ul style="list-style-type: none"> <li>Has cut-off scores</li> <li>Culturally-adapted</li> <li>Least number of items</li> <li>Least time to administer</li> <li>Addresses quality of life issues</li> </ul>	<ul style="list-style-type: none"> <li>Smallest age range</li> </ul>
PASSFP	Assess progress in the development of oral eating skills for children who need prolonged tube feeding	Undetermined	Excellent	<ul style="list-style-type: none"> <li>Least time to administer</li> </ul>	<ul style="list-style-type: none"> <li>Author did not specify age range</li> <li>No cut-off scores</li> <li>Has been implemented in one study only<sup>18</sup></li> </ul>
PEDI-EAT	Distinguish children with problematic behaviour in feeding	Moderate	Excellent	<ul style="list-style-type: none"> <li>Able to postulate level of oral motor dysfunction</li> </ul>	<ul style="list-style-type: none"> <li>Highest number of items</li> <li>Longest administration time</li> <li>Not freely available</li> <li>No cut-off scores</li> </ul>
STEP-CHILD	Screen for feeding difficulties	Moderate	Reasonable	<ul style="list-style-type: none"> <li>Scoring scales are more objective (times per mo)</li> </ul>	<ul style="list-style-type: none"> <li>The interpretation of total scores is not provided</li> <li>Has been implemented in one study only</li> </ul>

BPFAS, Behavioural Paediatric Feeding Assessment Scale; CEBI, Children's Eating Behaviour Inventory; MCHFS, Montreal Children's Hospital Feeding Scale; PASSFP, Paediatric Assessment Scale for Severe Feeding Problems; PEDI-EAT, Paediatric Eating Assessment; STEP-CHILD, Screening Tool of Feeding Problems applied to children.

et al.'s classification of feeding difficulties<sup>33</sup> and they were constructed based on factor analysis test. The oral-motor/dysphagia domain was included in all cases, consistent with the fact that this is essential when assessing children with neurological impairments. Other feeding difficulties related to selectivity and refusal arose from this domain. It was notable that the BPFAS and CEBI measured all feeding domains.

When assessing feeding difficulties, the validity of an instrument refers to how accurately its scores reflect the true state of those difficulties in patients. The process by which validity is assessed is often ongoing and requires a board range of evidence to support the outcomes of an

instrument being well-grounded, relevant, and meaningful.<sup>34</sup> In this review, criterion validity was difficult to establish in most instruments because of the lack of a criterion standard tool for comparison. We therefore assessed the sensitivity, specificity, and receiver operating characteristic for the criterion validity because these measures addressed agreement between the proposed index and the reference standard for identifying the target condition.<sup>34</sup> For an instrument assessing feeding difficulties, we considered it essential to establish these criteria to determine whether the cut-off scores for problematic feeding truly captured patients who had feeding difficulties. In addition, we found that most instruments were



not culturally adapted. Overall, only the MCHFS and BPFAS were comprehensively validated based on the five measures of validity we assessed.

A reliable instrument is one that can produce consistent scores over several assessment points. Test reliability is essential for parent-report instruments because these instruments are particularly prone to information bias when parents report their perception towards their child's behaviour. Parents may exaggerate problematic behaviour to gain a clinician's attention, or they may minimize the frequency of problematic behaviour to which they have become accustomed. In this review, however, measurement error was difficult to calculate in most instruments, probably because the instruments were primarily designed for discriminative purposes. Hence, mean differences between groups after certain time intervals were not reported. Nonetheless, we discovered a small standard error of measurement and smallest detectable change in the PASSFP and BPFAS, indicating that 'real' changes have been observed. Overall, the PEDI-EAT, PASSFP, and BPFAS have excellent reliability, which is essential for an instrument aiming to have discriminative utility.

Concerning the clinical applicability, none of the reviewed instruments have a manual, though their scoring forms are available in journal articles. However, we found that no training was needed as the forms were simple to use and readily available. Furthermore, as parent-completed forms, they are relatively inexpensive measures that require zero compliance from children. Most forms are also no more than two pages in length and require a maximum of 16 minutes to be completed. These simple, yet reliable, instruments therefore allow for frequent measurements, making them suitable for monitoring a child's feeding development and for assessing the efficacy of any feeding intervention. The simple scoring systems will ensure that the instruments produce immediate results, further strengthening their usefulness. An executive summary of each instrument's primary purpose, validity, reliability, strength, and weakness is shown in Table IV.

## REFERENCES

1. Reddihough D. Cerebral palsy in childhood. *Aust Fam Physician* 2011; **40**: 192–6.
2. Schoenmakers MA, Uiterwaal CS, Gulmans VA, Gooskens RH, Hadders PJ. Determinants of functional independence and quality of life in children with spina bifida. *Clin Rehabil* 2005; **19**: 677–85.
3. Andrew MJ, Sullivan PB. Feeding difficulties in disabled children. *Paediatr Child Health (Oxford)* 2010; **20**: 321–6.
4. Sullivan PB, McIntyre E. Gastrointestinal problems in disabled children. *Curr Paediatr* 2005; **15**: 347–53.
5. Hakime Nogay N. Nutritional status in mentally disabled children and adolescents: a study from Western Turkey. *Pak J Med Sci* 2013; **29**: 614–8.
6. Vega-Sanchez R, de la Luz Gomez-Aguilar M, Haua K, Rozada G. Weight-based nutritional diagnosis of Mexican children and adolescents with neuromotor disabilities. *BMC Res Notes* 2012; **5**: 218.
7. Tüzün EH, Güven DK, Eker L, Elbasan B, Bülbül SF. Nutritional status of children with cerebral palsy in Turkey. *Disabil Rehabil* 2013; **35**: 413–7.
8. Benfer KA, Weir KA, Boyd RN. Clinimetrics of measures of oropharyngeal dysphagia for preschool children with cerebral palsy and neurodevelopmental disabilities: a systematic review. *Dev Med Child Neurol* 2012; **54**: 784–95.
9. Arvedson JC. Assessment of pediatric dysphagia and feeding disorders: clinical and instrumental approaches. *Dev Disabil Res Rev* 2008; **14**: 118–27.
10. Sanchez K, Spittle AJ, Allinson L, Morgan A. Parent questionnaires measuring feeding disorders in preschool children: a systematic review. *Dev Med Child Neurol* 2015; **57**: 798–807.
11. Terwee CB, Bot SD, de Boer MR, et al. Quality criteria were proposed for measurement properties of health status questionnaires. *J Clin Epidemiol* 2007; **60**: 34–42.
12. Perrin KKM. Principles of evaluation and research for health care programs. Burlington, MA: Jones & Bartlett Learning, LLC, 2014.
13. Mokkink LB, Terwee CB, Patrick DL, et al. The COSMIN checklist manual. The Netherlands: VU University Medical Center, 2012.
14. Seiverling L, Hendy HM, Williams K. The screening tool of feeding problems applied to children (STEP-CHILD): psychometric characteristics and associations with child and parent variables. *Res Dev Disabil* 2011; **32**: 1122–9.

It is noteworthy that this review provides a comprehensive psychometric evaluation of parent-report instruments for assessing feeding difficulties in children with neurological impairments. Through this review, we were able to identify new domains related to parental strategies which are the unique features of a parent-report instrument. However, this study has limitations. Firstly, we only included instruments in English, and may have missed instruments in other languages. Secondly, because this review focused on children with neurological impairments, many widely used and validated instruments were not included by design. Although this does not necessarily indicate a lack of robustness or usefulness of our findings, further studies will be needed to evaluate feeding difficulties, including the optimal methods of evaluation.

## CONCLUSION

In this review, we identified six parent-report instruments for assessing feeding difficulties in children with neurological impairments; among these, the BPFAS was the most validated and reliable instrument. However, it is clear that no single instrument provides a comprehensive evaluation of feeding difficulties among children with neurological impairments. In particular, our data indicate that further research with the BPFAS is warranted in other settings and that its translation and adaptation can greatly increase its value.

## ACKNOWLEDGEMENTS

This project was supported by the Universiti Sains Malaysia Grant (304/PPSP/652205/K13, RU Top Down 1001.CSKK.870020). The authors have stated that they had no interests that might be perceived as posing a conflict or bias.

## SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

**Figure S1:** Article selection process.

15. Serel Arslan S, Demir N, Karaduman AA, Belafsky PC. The pediatric version of the eating assessment tool: a caregiver administered dysphagia-specific outcome instrument for children. *Disabil Rehabil* 2018; **40**: 2088–92.
16. Thoyre SM, Pados BF, Park J, et al. Development and content validation of the Pediatric Eating Assessment Tool (Pedi-EAT). *Am J Speech Language Pathol* 2014; **23**: 46–59.
17. Thoyre SM, Pados BF, Park J, Estrem H, McComish C, Hodges EA. The Pediatric Eating Assessment Tool (PediEAT): factor structure and psychometric properties. *J Pediatr Gastroenterol Nutr* 2018; **66**: 299–305.
18. Crist W, Dobbelsteyn C, Brousseau AM, Napier-Phillips A. Pediatric assessment scale for severe feeding problems: validity and reliability of a new scale for tube-fed children. *Nutr Clin Pract* 2004; **19**: 403–8.
19. van Dijk M, Timmerman ME, Martel C, Ramsay M. Feeding problems in young children. *Netb J Psychol* 2011; **66**: 112–9.
20. Guimarães I. Montreal Children's Hospital Feeding Scale: translation and contribution for the validation into European Portuguese. *Revista Portuguesa de Terapia da Fala* 2015; **33**: 5–23.
21. Benjasuwantep B, Rattanamongkolgul S, Ramsay M. The Thai version of the Montreal Children's Hospital Feeding Scale (MCH-FS): psychometric properties. *J Med Assoc Thai* 2015; **98**: 163–9.
22. Baird R, Levesque D, Birnbaum R, Ramsay M. A pilot investigation of feeding problems in children with esophageal atresia. *Dis Esophagus* 2015; **28**: 224–8.
23. Ramsay M, Martel C, Porporino M, Zygmuntowicz C. The Montreal children's hospital feeding scale: a brief bilingual screening tool for identifying feeding problems. *Paediatr Child Health* 2011; **16**: 147–51.
24. Archer LA, Rosenbaum PL, Streiner DL. The children's eating behavior inventory: reliability and validity results. *J Pediatr Psychol* 1991; **16**: 629–42.
25. Patton SR, Dolan LM, Smith LB, Thomas IH, Powers SW. Pediatric parenting stress and its relation to depressive symptoms and fear of hypoglycemia in parents of young children with type 1 diabetes mellitus. *J Clin Psychol Med Settings* 2011; **18**: 345–52.
26. Martin CI, Dovey TM, Coulthard H, Southall AM. Maternal stress and problem-solving skills in a sample of children with nonorganic feeding disorders. *Infant Ment Health J* 2013; **34**: 202–10.
27. Wu YP, Franciosi JP, Rothenberg ME, Hommel KA. Behavioral feeding problems and parenting stress in eosinophilic gastrointestinal disorders in children. *Pediatr Allergy Immunol* 2012; **23**: 730–5.
28. Marshall J, Raatz M, Ward EC, Dodrill P. Use of parent report to screen for feeding difficulties in young children. *J Paediatr Child Health* 2015; **51**: 307–13.
29. Dovey TM, Jordan C, Aldridge VK, Martin CI. Screening for feeding disorders. Creating critical values using the behavioural pediatrics feeding assessment scale. *Appetite* 2013; **69**: 108–13.
30. Davis AM, Canter KS, Stough CO, Gillette MD, Patton S. Measurement of mealtime behaviors in rural overweight children: an exploratory factor analysis of the Behavioral Pediatrics Feeding Assessment Scale. *J Pediatr Psychol* 2014; **39**: 332–9.
31. Allen SL, Smith IM, Duku E, et al. Behavioral pediatrics feeding assessment scale in young children with autism spectrum disorder: psychometrics and associations with child and parent variables. *J Pediatr Psychol* 2014; **40**: 581–90.
32. Crist W, Napier-Phillips A. Mealtime behaviors of young children: a comparison of normative and clinical data. *J Dev Behav Pediatr* 2001; **22**: 279–86.
33. Field D, Garland M, Williams K. Correlates of specific childhood feeding problems. *J Paediatr Child Health* 2003; **39**: 299–304.
34. Cook DA, Beckman TJ. Current concepts in validity and reliability for psychometric instruments: theory and Application. *Am J Med* 2006; **119**: 166.e7–16.