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REVIEW ARTICLE

Systematic Review: Non-Instrumental Swallowing and Feeding Assessments in Pediatrics

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Abstract There is a high incidence of parental reporting of abnormal swallowing and feeding function and the negative impacts thereof on children. As such there is a need for well validated assessments in the area of pediatric swallowing and feeding. While instrumental assessments are well validated, there is limited information available to guide the selection and use of non-instrumental assessments for swallowing and feeding function. The aim of this study was to identify and report on non-instrumental assessments available to clinicians for pediatric swallowing and/or feeding function in order to support clinical decision making. A systematic literature search was performed by two independent reviewers using Medline and Embase databases, to find non-instrumental assessments for pediatric swallowing and feeding function. Published assessments were also included in the study by searching well-known publishers and relevant feeding and swallowing textbooks. Assessments were summarized and evaluated according to respondent type, target populations, assessment design, domains of assessment and scoring. Thirty assessments were included in the final review. All assessments had either caregiver or clinician respondents. There was high variability in target populations, assessment designs and areas of assessment. Twenty-four of the 30 assessments did not provide instruction for scoring or interpreting scores. There is high variability among the many assessments available to clinicians in the area of feeding and swallowing function in pediatrics. There appears to be limited information available on the validity and reliability of these assessments. Thus, most assessments need to be used with caution. Further research is needed to evaluate the psychometric properties of the assessments.

Abbreviations

AEPS	Assessment, Evaluation, and Programming System for Infants and Children—Second Edition
ASD	Autism spectrum disorder
AYCE	About Your Child's Eating
BAMBI	Brief Autism Mealtime Behavior Inventory
BAMF-OMD	Brief Assessment of Motor Function (Oral Motor Deglutition scale)
BASOFF	Behavioral assessment scale of oral functions in feeding
BED	Bedside Evaluation of Dysphagia—Revised Edition
CCITSN	Carolina Curriculum for Infants and Toddlers with Special Needs
CCTI	Colorado Childhood Temperament Inventory
CEBI	Children's Eating Behavior Inventory
CEBQ	Children's Eating Behavior Questionnaire
CFQ	Child Feeding Questionnaire
CMFBQ	Child Mealtime Feeding Behavior Questionnaire
CTCAE	Common Terminology Criteria for Adverse Events
DASH-3	Developmental Assessment for Individuals with Severe Disabilities—Third Edition
DAYC-2	Developmental Assessment of Young Children—Second Edition

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DEP	Dysphagia Evaluation Protocol
DDS	Dysphagia Disorder Survey or Dysphagia Disorders Survey
DINE	Dyadic Interaction Nomenclature for Eating
DSFS	Drooling Severity and Frequency Scale
EFS	Early Feeding Skills Assessment
FES	Family Environment Scale
FDA-2	Frenchay Dysarthria Assessment—Second Edition
FSQ	Feeding and Swallowing Questionnaire
FSQ	Feeding Strategies Questionnaire
GVA	Gisel Video Assessment
IFSQ	Infant Feeding Style Questionnaire
IFTI	Infant-Toddler and Family Instrument
MFP	Multidisciplinary Feeding Profile
NOMAS	Neonatal Oral-Motor Assessment Scale
NR	Not Reported
OAG	Oral Assessment Guide for children and young people
OD	Oropharyngeal Dysphagia
OMAS	Oral Motor Assessment Scale
PASSFP	Pediatric Assessment Scale for Severe Feeding Problems
PIBBS	Preterm Infant Breastfeeding Behavior Scale (revised)
PMAS	Parent Mealtime Action Scale
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)
PSAS	Pre-Speech Assessment Scale
QoL	Quality of Life
SAFE	Swallowing Ability and Function Evaluation
SAIB	Systematic Assessment of the Infant at Breast
SOMA	Schedule for Oral Motor Assessment
STEP-Child	Screening Tool of Feeding Problems, modified for children
SWAL-QoL	Swallowing Quality of Life Questionnaire (adapted for use with pediatric patients)

Introduction

Oropharyngeal dysphagia can refer to problems with chewing and preparing food, transporting a bolus from the oral cavity to the back of the tongue, moving food into the esophagus, or unsafe and inefficient swallowing [1]. The term oropharyngeal dysphagia is not commonly used in pediatric populations as oropharyngeal and esophageal dysfunction are intrinsically linked in this population [2]. Swallowing dysfunction in the general population has been linked to poorer patient outcomes including higher rates of malnutrition [3], higher mortality rates [4, 5], increased medical complications [6, 7], longer hospitalisations [4, 7, 8], poorer immune responses [6], higher support required post hospital discharge [6, 7], and overall poorer quality of life (QoL) [4, 6]. In addition to the poor health outcomes that are associated with swallowing difficulties, pediatric populations, face physical, and developmental challenges if their nutritional and caloric intake is not sufficient [9–13].

In addition to swallowing difficulties, children may also be at risk of reduced nutrition and caloric intake due to feeding difficulties. Feeding difficulties in pediatrics may be broadly defined as difficulties eating adequately which may result in reduced absorption or consumption of food, impacting on physical and/or psychosocial function [14]. Feeding difficulties in children or infants have been associated with negative parent–child interactions, anxiety, stress, social avoidance, and specific fears (phobias) [15–18].

Studies have previously estimated that around 20–45 % of parents within the general population report that their children have some form of feeding or swallowing difficulty [19–22], and that between 3 and 10 % of children have significant swallowing or feeding difficulties resulting in significant health or developmental consequences [23]. Swallowing and feeding difficulties are also projected to increase due to improved survival rates of infants born prematurely or with complex medical conditions [19]. Given the high rates of swallowing and feeding difficulties and the negative consequences of these conditions, it is important to use assessments with sound psychometric properties in order to support early identification and optimize treatment outcomes [19, 24–28]. Current evidence for swallowing and feeding difficulties in pediatric populations recommends the use of a multidisciplinary team approach for both conducting comprehensive assessments and delivery of interventions [19, 25, 29]. The use of videofluoroscopy and fiberoptic endoscopic evaluation of swallowing to assess swallow function (or dysfunction) is well supported in the literature [6, 27–31]. However, there is a lack of discussion and support for the use of standardized, psychometrically sound measures of swallowing or feeding function, such as non-instrumental assessments, which can augment or serve as alternatives to instrumental assessment in order to reduce unnecessary cost and the use of invasive procedures [32–36].

This systematic review is a first step in addressing the need to identify and report on the characteristics of non-instrumental assessments in the areas of both pediatric swallowing and feeding functions that are available to clinicians. The terms swallowing and feeding function (i.e., normal swallowing and feeding) and swallowing and feeding dysfunction (i.e., swallowing and feeding

Table 1 Search strategy: pediatric swallowing or feeding assessment

Search type	Database	Search terms	Limitations	Abstracts identified
Mesh/Thesaurus terms	Medline	("Deglutition Disorders" OR "Deglutition" OR "Feeding and Eating Disorders of Childhood" OR "Eating Disorders" OR "Feeding Behavior") AND ("Questionnaires" OR "Health Surveys") AND ("Child" OR "Infant")	None applied	923
	Embase	dysphagia/OR eating disorder/OR feeding disorder/) AND questionnaire/OR health survey/) AND (child/OR infant/)	None applied	759
Free text	Medline	(questionnaire* or survey*) AND (swallow* or dysphag* or deglut* or feed*) AND (child* or toddler* or infant* or schoolchild* or youth* or baby or babies or pediatr* or paediatr* or neonat* or newborn* or postneonat* or postnat* or suckling* or juvenile*)	Year: 2012-Current	712
	Embase	(swallowing disorder* OR deglut* OR feed* OR eating disorder*) AND (questionnaire* OR survey*) AND (child* OR toddler* OR infant* OR schoolchild* OR yout* OR baby OR babies OR pediatr* OR paediatr* OR neonat* OR newborn* OR postneonat* OR postnat* OR suckling* OR juvenile*)	Year: 2012-Current	498
Total abstracts	2892			
Total abstracts (duplicates removed)	2201			

Table 2 Inclusion and exclusion criteria for abstract and original article selection

Inclusion criteria	Exclusion criteria
Describes the use of a non-instrumental assessment	Does not refer to an assessment in the methodology
Refers to swallowing/feeding function/dysfunction	Refers only to instrumental assessments
Includes assessment of the pediatric or neonatal population	Refers only to the assessment of conditions not related to swallowing or feeding
	Refers only to conditions of a psychological origin (e.g., anorexia nervosa)
	Assessment is used on non-human populations
	Only includes adult participants

difficulties or disorders) are used throughout this manuscript and include behavioral aspects of feeding.

Methods

This review was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement [37]. A systematic literature search was conducted using Medline and Embase online databases (Table 1). From this search, all appropriate journal abstracts up to June 2013 were included. Both databases were searched using medical subject headings (MeSH) or Thesaurus terms and free text. Two independent abstract reviewers selected abstracts and original publications of non-instrumental assessments according to the inclusion and exclusion criteria as described in Table 2. Reference lists of included articles were also searched for further publications and assessments. Eligibility of publications was appraised independently by both reviewers; consensus was reached through discussion where there was disagreement on eligibility.

The non-instrumental assessments were then identified by searching for the original, first publication that described the selected assessment, and when this failed, by contacting the authors directly. To ensure that the search was comprehensive, well-known publishers for assessment tools and textbooks around the topic of pediatric swallowing or feeding were also searched so as to capture relevant assessments that have been published in sources other than research databases. The assessments were then considered for eligibility according to inclusion and exclusion criteria as listed in Table 3. For assessments to be included, they were required to (a) have at least 50 % of the items related to swallowing or feeding; (b) be designed for use

Table 3 Inclusion and exclusion criteria for assessments

Inclusion criteria	Exclusion criteria
50 % or more of the assessment items (or items of a subtest) are swallowing/feeding related	The study population is not human
Populations include those aged 0–18 years	The assessment is used for instrumental assessment (e.g. observation tool for videofluoroscopy or video recording)
Any aspect of swallowing/feeding is investigated (excluding psychogenic conditions, but including behavioural and oral intake)	The assessment is a survey[a]
Assesses observations or reported history	The assessment is used for guiding case history taking only
May be completed by a clinician or parent/caregiver	The assessment is not published in English
	Less than 50 % of the assessment items relate to swallowing/feeding
	The assessment investigates oesophageal dysphagia, pain or mucositis
	The assessment investigates adult populations only
	The assessment investigates psychogenic swallowing/feeding difficulties only
	The assessment investigates obesity only

[a] Survey is defined as an assessment designed to collect data of a target population group, rather than for a specific individual [38]

with pediatric populations; and (c) needed to be of a non-instrumental assessment design (i.e., the assessment was not used in instrumental assessment processes or for retrospective video assessment). Guidelines for clinicians for case history taking and surveys were excluded. Eligibility of these assessments and analysis of the characteristics and assessment domains were independently appraised by two reviewers, who again reached consensus through discussion. Figure 1 provides an overview of the process of inclusion according to the PRISMA flow diagram [39].

Results

Systematic Literature Search

The systematic searches in Medline and Embase yielded 2201 records. A total of 76 original non-instrumental assessments were retrieved from the database, publisher, and textbook searches and the reference lists of the included articles. The assessments were evaluated using the inclusion criteria for assessments (Table 3).

Of the 76 assessments, 46 were excluded as they did not meet the inclusion criteria (see Table 4). The 46 assessments were excluded for the following reasons: 27 were excluded as less than 50 % of the assessment items were not related to feeding and/or swallowing; 6 assessments did not assess the target population of children or infants; and 13 assessments were excluded as they did not meet the requirements for non-instrumental assessments. A total of 30 non-instrumental assessments were identified as meeting all inclusion criteria as they investigated feeding or swallowing function in children of various aetiologies in various domains of feeding or swallowing functioning (see Table 5).

Respondents and Assessment Style

The assessments were designed to be completed by two types of respondents: caregivers (Table 6) or clinicians (Table 7). Of the 30 included assessments, 11 were identified as caregiver assessments; 9 of which took a case history style approach to asking questions and two focused on observation instead (Table 6). Eighteen assessments were designed to be completed by clinicians; these assessments all used clinical observations of swallowing or feeding function or set clinical tasks (Table 7). One assessment could be completed by either caregivers or clinicians and utilised a case history style of assessment (Table 8).

Target Populations

While all assessments were developed to investigate swallowing or feeding function in pediatric populations, various target groups (including diagnostic and age groups) were identified (Tables 6, 7 and 8). Nine assessments were developed to assess the swallowing and feeding difficulty of infants and children from birth to 2 years with no specific illness: Clinical Evaluation of Pediatric Dysphagia [40], Clinical Feeding Evaluation of Infants [82], Clinic/Bedside Oral-Sensorimotor Feeding Assessment Worksheet [81], Developmental Pre-Feeding Checklists [65], Early Feeding Skills Assessment (EFS) [84], Oral Motor

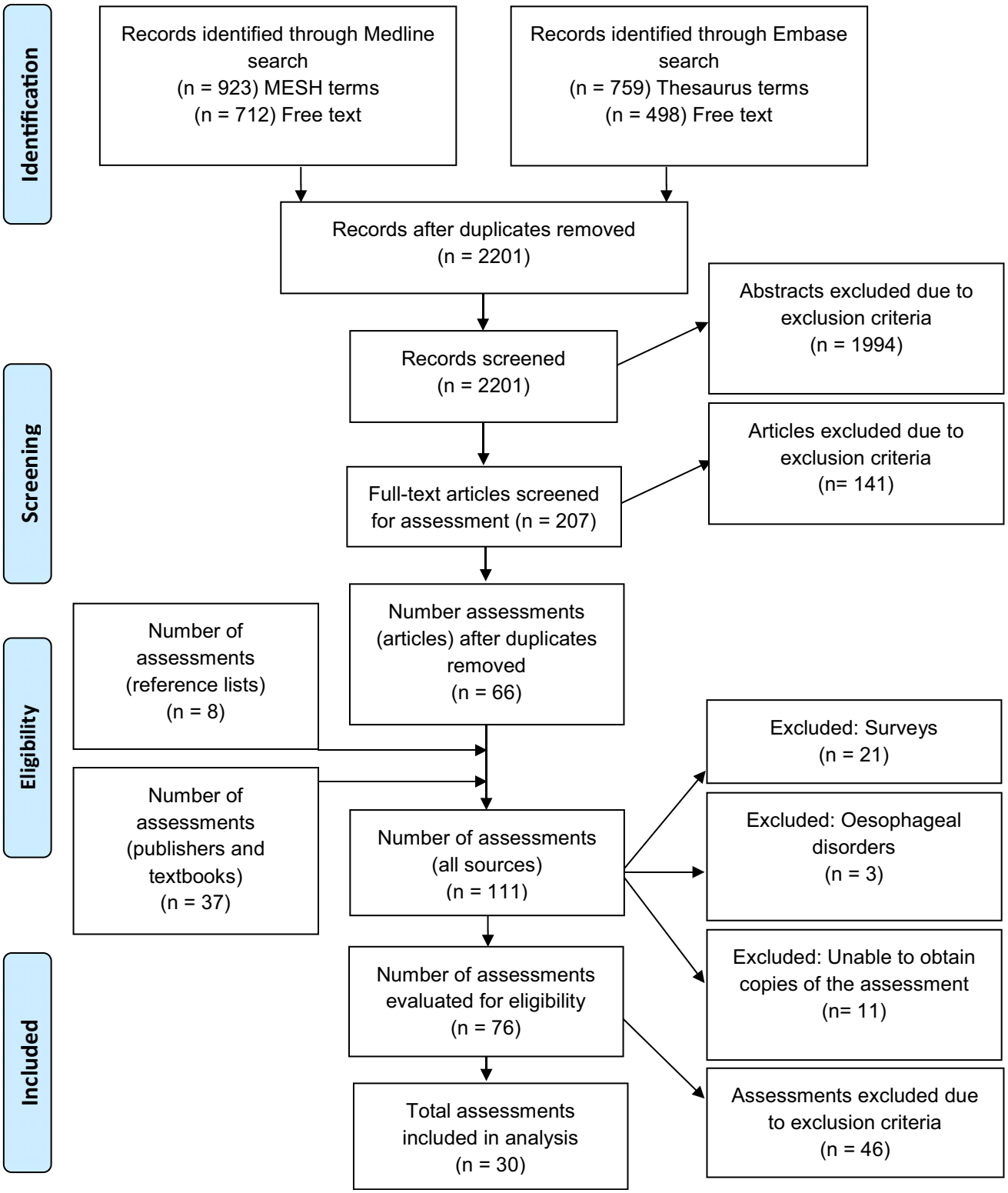

Fig. 1 Flow diagram of the reviewing process according to PRISMA. Study flow diagram showing the process of inclusion for assessments. The flow diagram follows the structure as recommended by PRISMA [39]

Table 4 Overview of excluded non-instrumental assessment tools for swallowing and feeding function in children ($n = 46$)

Assessment	Acronym[a]	Inclusion criteria	Exclusion criteria
Assessment, Evaluation, and Programming System for Infants and Children, Second Edition (Brookes Publishing)	AEPS	Suitable for children and infants	Less than 50 % swallowing/feeding related
Assessment of cranial nerves [40]	NR	Suitable for children	Less than 50 % swallowing/feeding related
			Assesses neurology only
Breastfeeding evaluation [41]	NR	Suitable for infants	Not an assessment: educational tool with information on normal feeding behaviours
Bedside examination/Cranial nerve examination [42]	NR	Assesses swallow safety	Not used with target population (children or infants)
Bedside Evaluation of Dysphagia—revised edition (Pro-ed) [43]	BED	Assesses swallowing function	Not used with target population (children or infants)
Carolina Curriculum for Infants and Toddlers with Special Needs (brookes publishing) [44]	CCITSN	Suitable for toddlers and infants	Less than 50 % swallowing/feeding related
Checklist of items for dysphagia screening [45]	NR	Assesses swallowing function	Not used with target population (children or infants)
Child Mealtime Feeding Behavior Questionnaire [46]	CMFBQ	Suitable for children aged 3;0–6;0	Less than 50 % swallowing/feeding related
			Assesses parental behaviours and problem solving primarily
Child Feeding Questionnaire [47]	CFQ	Questionnaire for children	Less than 50 % swallowing/feeding related
			Assesses factors related to obesity, rather than child's swallowing/feeding function
Children's Eating Behaviour Questionnaire [48]	CEBQ	Suitable for children aged 2;0–7;0	Less than 50 % swallowing/feeding related
			Assesses behaviours related to obesity, rather than swallowing/feeding function
Colorado Childhood Temperament Inventory [49]	CCTI	Suitable for children aged 0;5–9;0	Less than 50 % swallowing/feeding related
			Assesses the child's temperament
Common Terminology Criteria for Adverse Events (Previously: National Cancer Institute—Common Toxicity Criteria) [50]	CTCAE	Single item related to swallow function	Less than 50 % swallowing/feeding related
Cranial nerve examination [51]	NR	Suitable for children	Less than 50 % swallowing/feeding related
			Assesses neurology and physiology only
Developmental Assessment for Individuals with Severe Disabilities—Third Edition (Pro-ed) [52]	DASH-3	Suitable for children aged 0;6-adulthood	Less than 50 % swallowing/feeding related
Developmental Assessment of Young Children—Second Edition (Pro-ed) [53]	DAYC-2	Suitable for children aged birth-5;0	Less than 50 % swallowing/feeding related
Developmental checklist [54]	NR	Checklist for children with achondroplasia, beginning prior to 15 months, until last developmental milestone is met	Less than 50 % swallowing/feeding related
Drooling rating scale [55]	NR	Suitable for children	Less than 50 % swallowing/feeding related
			Assesses severity and frequency of drooling, rather than swallowing/feeding function

Table 4 continued

Assessment	Acronym[a]	Inclusion criteria	Exclusion criteria
Drooling Severity and Frequency Scale [56]	DSFS	Assessment for children	Less than 50 % swallowing/feeding related Assesses severity and frequency of drooling, rather than swallowing/feeding function
Dyadic Interaction Nomenclature for Eating [57]	DINE	Items behaviour related with some consideration for environment and feeding	Not a questionnaire-style assessment: assessment via video
Dysphagia Evaluation Protocol (Pearson) [58]	DEP	Assesses swallowing function	Not used with target population (children or infants)
Family Environment Scale [59]	FES	Assesses mealtime environment	Less than 50 % swallowing/feeding related Assesses family social environment with little related to moments of feeding
FEES Protocol, revised [60]	NR	Suitable for children	Not a questionnaire-style assessment: assessment via video
Frenchay Dysarthria Assessment—second edition (Pro-ed) [61]	FDA-2	Assesses swallowing function	Not used with target population (children or infants) Less than 50 % swallowing/feeding related
Gisel Video Assessment [62]	GVA	Assess children's feeding abilities and behaviours	Not a questionnaire-style assessment: assessment via video
History information [40]	NR	Suitable for children	Not a questionnaire-style assessment: open ended questions to guide case history taking
Infant Feeding Style Questionnaire [63]	IFSQ	Suitable for children aged 0;3–1;8	Less than 50 % swallowing/feeding related Assesses parental behaviours and beliefs around mealtimes
Infant-comprehensive dysphagia examination [42]	NR	Suitable for assessing feeding in infants	Not a questionnaire-style assessment: guide for clinicians for case history taking
Infant-Toddler and Family Instrument (Brookes Publishing) [64]	IFTI	Suitable for infants	Less than 50 % swallowing/feeding related
Mealtime assessment guide [65]	NR	Assesses children's mealtime environment	Not an assessment
Oral Assessment Guide for children and young people [66]	OAG	Designed for children	Less than 50 % swallowing/feeding related Assesses health of child's oral structures, and physiology rather than swallowing/feeding function
Oral motor and speech assessment [67]	NR	Suitable for people aged 2;6–21;5	Less than 50 % swallowing/feeding related Assesses oral motor skills related to communication not feeding
Oral secretion [55]	NR	Suitable for children	Less than 50 % swallowing/feeding related Assesses production and control of saliva, rather than swallowing/feeding function
Parent mealtime questionnaire: eating and drinking [65]	NR	Assesses children's mealtime environment	Not a questionnaire-style assessment: guide for clinicians for case history taking

Table 4 continued

Assessment	Acronym[a]	Inclusion criteria	Exclusion criteria
Parent mealtime questionnaire: tube feedings and beginning oral feeding [65]	NR	Assesses children's feeding needs	Not a questionnaire-style assessment: guide for clinicians for case history taking
Pediatric dysphagia case history form and caregiver questionnaire [68]	NR	Suitable for children	Not a questionnaire-style assessment: guide for clinicians for case history taking
Pediatric dysphagia case history form and caregiver questionnaire–Infant 0–6 months [68]	NR	Suitable for infants	Not a questionnaire-style assessment: guide for clinicians for case history taking
Parent Mealtime Action Scale [69]	PMAS	Assesses children's mealtime environment	Less than 50 % swallowing/feeding related
			Assessment designed to investigate factors related to obesity
			Assesses parental behaviours around mealtimes rather than child
Parental questionnaire (pre-surgery macroglossia) [70]	NR	Suitable for children aged 0;9–4;9	Less than 50 % swallowing/feeding related
			Investigates impact of macroglossia including but not focused on swallowing/feeding function
Post saliva surgery form [55]	NR	Suitable for children	Less than 50 % swallowing/feeding related
			Assesses ability to control saliva, rather than swallowing/feeding function
Reflux [65]	NR	Suitable for children	Less than 50 % swallowing/feeding related
			Assesses gastroesphageal reflux only
Saliva control assessment [55]	NR	Suitable for children	Less than 50 % swallowing/feeding related
			Assesses ability to control saliva, rather than swallowing/feeding function
Saliva control assessment Form [71]	NR	Suitable for children	Less than 50 % swallowing/feeding related
			Assesses ability to control saliva, rather than swallowing/feeding function
Swallowing Ability and Function Evaluation (Pro-ed) [72]	SAFE	Assesses swallowing function	Not used with target population (children or infants)
Swallowing disorders treatment complete kit—second edition (Pro-ed) [73]	NR	Assesses swallowing function	Not used with target population (children or infants)
Swallowing Quality of Life Questionnaire (adapted for use with pediatric patients) [74]	SWAL-QoL[b]	Questionnaire for children	Assesses parent's (QoL), rather than the child
Videofluorographic examination of swallowing [45]	NR	Suitable for children	Not a questionnaire-style assessment: assessment via video

[a] Acronyms have been used throughout the article where possible, for assessments without acronyms, full names have been used

[b] While the authors referred to this assessment using the same abbreviation (SWAL-QoL) as the adult version of this assessment, these two assessments are not identical. The listed assessment has been modified in order to assess the quality of life of the parents of children with feeding disorders

Table 5 Overview of included non-instrumental assessment tools for swallowing and feeding function in children ($n = 30$)

Assessment	Acronym[a]	Inclusion criteria
About Your Child's Eating [75]	AYCE	Majority of items related to behaviours around mealtimes
Behavior focused feeding assessment [76]	NR	Majority of items related to behaviours around mealtimes as well as feeding function and sensory aspects to feeding
Behavioral assessment scale of oral functions in feeding [77]	BASOFF	Majority of items related to oral motor and feeding function
Brief Assessment of Motor Function (Oral Motor Deglutition scale) [78]	BAMF-OMD	Oral motor scale for deglutition related to oral motor and feeding level of functioning
Brief Autism Mealtime Behavior Inventory [79]	BAMBI	Majority of items feeding behaviour and feeding sensation related
Children's Eating Behavior Inventory [80]	CEBI	Majority of items related to feeding and behaviour around mealtimes
Clinic/Bedside oral-sensorimotor feeding assessment worksheet [81]	NR	Majority of items related to oral motor skills, feeding function and some case history
Clinical evaluation of pediatric dysphagia [40]	NR	Majority of items related to physical structures involved in feeding, feeding and swallowing function and oral motor skills
Clinical feeding evaluation of infants [82]	NR	Majority of items related to early feeding skills and reflexes
Developmental pre-feeding checklists [65]	NR	Majority of items related to expected feeding skills for developmental stages
Dysphagia Disorder Survey [83]	DDS	Majority of Items oral motor and feeding related
Early Feeding Skills Assessment [84]	EFS	Majority of items related to early feeding skills
Eating profile [85]	NR	Majority of items related to behaviour and environmental factors of feeding
Feeding and Swallowing Questionnaire [86]	FSQ[b]	Majority of items related to feeding for children with complex feeding needs
Feeding assessment [87]	NR	Majority of Items related to feeding environment with consideration of some QoL factors
Feeding questionnaire [88]	NR	Majority of items related to feeding of infants
Feeding Strategies Questionnaire [89]	FSQ[b]	Majority of items related to behaviours around mealtimes
Mealtime behavior questionnaire [90]	NR	Majority of Items related to child feeding behaviours
Multidisciplinary Feeding Profile [91]	MFP	Majority of items feeding related over many different domains
Neonatal Oral-Motor Assessment Scale [92]	NOMAS	Majority of items related to motor functioning of jaw and tongue during feeding
Oral motor and feeding evaluation [77]	NR	Majority of items related to oral motor skills and feeding skills
Oral Motor Assessment Scale [93]	OMAS	Items related to oral-motor functioning and movements
Parental feeding questionnaire [94]	NR	Majority of items related to behaviour around mealtimes and oral intake
Pediatric Assessment Scale for Severe Feeding Problems [95]	PASSFP	Majority of items feeding related for children with severe feeding difficulties
Pediatric dysphagia clinical evaluation [68]	NR	Majority of items related to required physiology/neurology for feeding and feeding function with trials
Pre-Speech Assessment Scale [96]	PSAS	Majority of Items feeding and oral-motor related
Preterm Infant Breastfeeding Behavior Scale (revised) [97]	PIBBS	Majority of items related to early feeding skills and reflexes
Schedule for Oral Motor Assessment [98]	SOMA	Majority of items related to oral motor and feeding function
Screening Tool of Feeding Problems, modified for children [99]	STEP–Child	Majority of items sensation of feeding and feeding behaviour related
Systematic Assessment of the Infant at Breast [100]	SAIB	Majority of items related to early feeding skills and positioning.

[a] Acronyms have been used throughout the article where possible, for assessments without acronyms, full names have been used

[b] These two assessments have been referred to by their full title throughout this manuscript as they have been designated the same acronym by their respective authors

Table 6 Characteristics of non-instrumental assessment tools for swallowing and feeding function in children: Completed by parents/caregivers ($n = 11$)

Assessment (alphabetical order)	Assessment format	Target population (age)	Scale titles (number of items)	Number of scales (total number of items); Range of score	Response options	Cut off (Normal vs. Abnormal)	Time
About Your Child's Eating (AYCE) [75]	History	Children with chronic illnesses (8;0–18;11)	Negative interactions (6) Positive interactions (4) Neutral situations (5)	3 (15); Range:15–75	5-point ordinal scale	NR	NR
Brief Autism Mealtime Behavior Inventory (BAMBI) [79]	Observations	Children with ASD (3;0–11;11)	Feeding behaviours (18)	1 (18); Range: 18–90	5-point scale	NR	NR
Children's Eating Behavior Inventory (CEBI) [80]	History	Children with eating and mealtime disorders (2;0–12;11)	Child (28) Parent (8 or 12 dependent on presence of spouse in family)	2 (40; Range Total Eating Problem score: 40–200) Range perceived problems: 0–40	Mixed: 5-point ordinal scale (some negatively scored), Binary scoring	NR	Approximately 15 min
Eating profile [85]	History	Children with ASD (3;0–12;11) and their parents	Child identification (12) Dietary history of the child (16) Child health (8) Family dietary history (7) Child mealtime behaviours (23) Food preferences (19) Autonomy with eating (11) Behaviours outside mealtime (12) Impact on daily life (8) Strategies used to resolve difficulties encountered at mealtime (31) Communication abilities (8) Socio–economic factors (2)	12 (157); Range: NR	Mixed: 3/4/5-point ordinal scales, Binary scoring, Multiple options	NA	NR
Feeding and swallowing questionnaire [86]	History	Children with CP (0;11–4;10)	Feeding and swallowing skills (18)	1 (18); Range: NR	Mixed: Binary, Open ended, VAS	NR	NR
Feeding assessment [87]	History	Children with PKU (1;0–5;11)	Feeding environment (13)	1 (13); Range: NR	Mixed: 4/11-point ordinal scales, Multiple options, Open ended	NR	NR
Feeding Questionnaire [88]	History	Infants born prematurely: 25–36 weeks gestation (Measured at 0;3, 0;6 and 1;0)	Feeding behaviours (17)	1 (19); Range: NR	Mixed: 3/4/5-point ordinal scales, Binary scoring	NR	NR
Feeding strategies questionnaire [89]	History	Children (2;0–6;11)	Strategies used during mealtimes by parents (40)	1 (40); Range: 40–200	5-point ordinal scale	NR	NR
Mealtime behavior questionnaire [90]	Observations	Children (2;0–6;11)	Mealtime behaviours (33)	1 (33); Range: 33–165	5-point ordinal scale	Normal <100 Abnormal ≥100	NR

Table 6 continued

Assessment (alphabetical order)	Assessment format	Target population (age)	Scale titles (number of items)	Number of scales (total number of items); Range of score	Response options	Cut off (Normal vs. Abnormal)	Time
Parental feeding questionnaire [94]	History	Children with feeding disorders (0;6–3;0)	Parental feeding/perception of child's feeding (4) Mealtime behaviour (11) Food refusal and struggle for control (6) Neophobia (2)	4(23); Range: NR	Mixed: 4-point ordinal scale, Binary scoring	NR	NR
Screening Tool of Feeding Problems, modified for children (STEP-child) [99]	History	Children with ASD or other conditions (2;0–18;11)	Chewing problems (3) Rapid Eating (3) Food refusal (3) Food Selectivity (2) Vomiting (2) Stealing food (2)	6 (15 frequency, 15 severity); Range Chewing problems: 0–9 (each frequency and severity) Range Rapid eating: 0–9 (each frequency and severity) Range Food refusal: 0–9 (each frequency and severity) Range Food selectivity: 0–6 (each frequency and severity) Range Vomiting: 0–6 (each frequency and severity) Range Stealing food: 0–6 (each frequency and severity)	3-point ordinal scale	Rapid Eating: 0–1 Food Refusal: 0-1 Food Selectivity: 1–2 Vomiting: 0–1 Stealing food: 0–1 Scores for both frequency and severity of difficulties	NR

Table 7 Characteristics of non-instrumental assessment tools for swallowing and feeding function in children: Completed by clinicians ($n = 18$)

Assessment (alphabetical order)	Assessment format	Target population (age)	Scale titles (number of items)	Number of scales (total number of items); Range of score	Response options	Cut off (Normal vs. Abnormal)	Time
Behavior focused feeding assessment [76]	Observations and history	Unspecified (assumed ≈2;0–12;0)	General development and background (5) Feeding history (7) Feeding environment used most often for meals (11) Mealtime habits (5) Current feeding problems (47) Feeding techniques (29)	6 (104) Range: NR	Mixed: Binary, Multiple options, Open ended	NR	NR
Behavioral Assessment Scale of Oral Functions in Feeding (BASOFF) [77]	Observations	Children with severe to profound developmental delays (0;10–21;6)	Assessment of oral motor skills relating to feeding ability (14)	1 (14); Range: 14–84	6-point ordinal scale	NR	NR
Brief Assessment of Motor Function (Oral Motor Deglutition scale) (BAMF-OMD) [78]	Observations	Children (0;6–20;0)	Articulation (10) Oral motor deglutition (10)	2 (1); Range: 0–10 per scale	11-point ordinal scale according to description of maximum motor performance during deglutition	NR	<5 min if parent is present, 10–15 min if parents are absent
Clinic/Bedside Oral-Sensorimotor Feeding Assessment Worksheet [81]	Observations	Unspecified (assumed ≈ 0;6–6;0)	Presenting problem (6) Reasons for referral (7) Developmental levels (6) Position for feeding (1) Posture for feeding (1) Primary feeders (1) Liquid (2) food textures (1) Enjoyment/Behaviour during mealtimes (1) Related interfering patterns (3) General problems (6) Oral-motor function during feeding (62) Problem summary (1) PO feeding summary (1)	14 (99) Rang: NR	Mixed: 3/4/5/6-point ordinal scale, Binary Scoring, Multiple Options, Open ended, Ratio Scale	NR	NR

Table 7 continued

Assessment (alphabetical order)	Assessment format	Target population (age)	Scale titles (number of items)	Number of scales (total number of items); Range of score	Response options	Cut off (Normal vs. Abnormal)	Time
Clinical evaluation of pediatric dysphagia [40]	Observations	Unspecified (assumed ≈ 0;0–2;0)	Physiologic status (8) Stress cues During Feeding (5) general postural control/tone (16) Oral structure and function (43) Cranial nerve screening (4) Swallowing/feeding evaluation (16) Presentation information (14) Oral-motor/swallowing Patterns (8)	8 (114) Range: NR	Mixed: 3/4/7-point ordinal scale, Binary scoring, Multiple options, Open ended, Ratio scale	NR	NR
Clinical feeding evaluation of infants [82]	Observations	Infants	State(6) Motor Control (6) Tactile (5) Oral-Motor (7) Suck Swallow Breathe (21) Physiologic Control (23)	6 (63); Range: NR	Mixed: 3/4/6-point ordinal scales, Binary scoring, Multiple options, Open ended, Ratio scale	NR	NR
Developmental Pre-Feeding Checklists [65]	Observations	Infants: 0;1–2;0	1 month (7) 3 months (6) 4–6 months (1) 5 months (1) 5 or 6 months (3) 6 months (11) 7 months (3) 8 months (2) 9 months (9) 10 months (1) 12 months (11) 15 months (5) 18 months (8) 21 months (1) 24 months (13)	15 (82) Range: NR	3-point ordinal	NR, assumed to adjust according to	developmental age of the child
NR							

Table 7 continued

Assessment (alphabetical order)	Assessment format	Target population (age)	Scale titles (number of items)	Number of scales (total number of items); Range of score	Response options	Cut off (Normal vs. Abnormal)	Time
Dysphagia Disorder Survey (DDS) [83]	Observations	Children with developmental disabilities (2–21 years)	Related factors (7) Feeding/swallowing competency (8)	2(15); Range Related Factors: 0–7 Range Swallowing/ feeding competency: 0–8	Binary Scoring	NR	10–15 min
Early Feeding Skills Assessment (EFS) [84]	Observations	Infants	Oral feeding readiness (5): If patient fails this domain cease assessment Oral feeding skills (26) Oral feeding tolerance (4)	3 (35); Range: NR	Mixed: Oral Feeding Readiness: Binary Oral Feeding Skills: 3/4-point scales Oral Feeding Tolerance: Binary	NR	NR
Multidisciplinary Feeding Profile (MFP) [91]	Observations	Children with neurological disability (6;0–18;11)	Physical/Neurological (11) Oral-facial structure (23) Oral-facial sensory inputs (4) Oral-facial motor function (22) Ventilation/phonation (4) Functional feeding assessment (72)	6 (136); Range: 184–583	Mixed: 3/4/5/6-point ordinal scales, Binary scoring, Multiple options	NR	30–45 min
Neonatal Oral-Motor Assessment Scale (NOMAS) [92]	Observations	Neonates born prematurely to 8 weeks corrected	Jaw (13) Tongue (13)	2 (26); Range: NR	Binary scoring	NR	NR
Oral Motor Assessment Scale (OMAS) [93]	Observations	Children with CP (3;0–13;11)	Oral motor skills (7)	1 (7); Range: 0–21	3-point ordinal scale	Normal = 21 Abnormal <21	NR
Oral Motor and Feeding Evaluation [77]	Observations and History	Unspecified (assumed ≈ 0;0–2;0)	History (81) Physical examination (69)	2 (150) Range: NR	Mixed: 2/3/4-point ordinal scale, Binary scoring, Multiple options, Open ended, Ratio scale	NR	NR

Table 7 continued

Assessment (alphabetical order)	Assessment format	Target population (age)	Scale titles (number of items)	Number of scales (total number of items); Range of score	Response options	Cut off (Normal vs. Abnormal)	Time
Pediatric Dysphagia Clinical Evaluation [68]	Observations	Unspecified (assumed ≈ 0;6–6;0)	Alertness (3) Physiologic status (12) Primitive reflexes (10) Abnormal reflexes (3) Physical Strength, stability and posture (6) Oral-facial structures (35) Feeding presentation (15) Sucking observations (19) Spoon feeding observations (10) Cup feeding observations (11) Bite/chew observations (8) Swallow observations (4) Stimulability (1) Recommendations (7)	14 (144) Range: NR	Mixed: 2/3/4/7-point ordinal scale, Binary Scoring, Interval scale, Multiple options, Open ended, Ratio scale	NR	NR
Pre-Speech Assessment Scale (PSAS) [96]	Observations	Children with CP or other significant disabilities (0;0–2;1)	Feeding Behaviour (4) Sucking (3) Swallowing (5) Biting/chewing (4) Respiration/phonation (6) Sound play (5) Positive and negative scores are recorded for each item. Positive scores represent the presence of normally developing skills. Negative scores represent the presence of behaviours not present in typically developing children	6 (27 positive, 27 negative scores); Range Positive score per item: 0–25 Range Negative score per item: 0–9	Both positive and negative scores ordinal scales (number of points varies per item)	Positive score should be equal to age in months (e.g.	24 months = 24 points) Negative score: Normal = 0 Atypical: >0
2½–3 h							
Preterm Infant Breastfeeding Behavior Scale (revised) (PIBBS) [97]	Observations	Infants (both term and pre term)	Breast feeding behaviours (12)	1 (8); Range: NR	Mixed: 3/5/8-point ordinal scales, Binary scoring, Multiple options, Ratio scales	NR	NR

Table 7 continued

Assessment (alphabetical order)	Assessment format	Target population (age)	Scale titles (number of items)	Number of scales (total number of items); Range of score	Response options	Cut off (Normal vs. Abnormal)	Time
Schedule for Oral Motor Assessment (SOMA) [98]	Observations	Infants (0;8–2;0)	Puree (14) Semi-solid (13) Solid (14) Cracker (26) Bottle (14) Trainer cup (19) Cup (13)	4 (113); Range Puree: 0–9 Range Solids: 0–9 Range Cracker: 0–22 Range Bottle: 0–9 Range Trainer cup: 0–14 Range Cup: 0–9	Mixed: Binary scoring, Multiple choice, Open ended, Ratio Scales	Puree: normal <3 Semi Solids: normal <4 Solids: normal <4 Cracker: normal <9 Bottle: normal <5 Trainer Cup: normal <5 Cup: normal <5	Assessment: 15–20 min Scoring: 10–20 min
Systematic Assessment of the Infant at Breast (SAIB) [100]	Observations	Infants	Alignment (5) Areolar grasp (8) Areolar compression (2) Swallow (3)	4 (18); Range: NR	Binary scoring	NR	NR

Table 8 Characteristics of non-instrumental assessment tools for swallowing and feeding function in children: Completed by parents/caregivers or clinicians ($n = 1$)

Assessment (alphabetical order)	Assessment format	Target population (age)	Scale titles (number of items)	Number of scales (total number of items); Range of score	Response options	Cut off (Normal vs. Abnormal)	Time
Pediatric Assessment Scale for Severe Feeding Problems (PASSFP) [95]	History	Infants (>0;4) with severe feeding problems who feed orally	If patient fails Part A of the tool, do not conduct assessment. Feeding and swallowing skills (15)	1 (15); Range: 0–66	Mixed: 5/6-point ordinal scale, Multiple options	Normal >37	5 min

and Feeding Evaluation [77], Pediatric Dysphagia Clinical Evaluation [68], Schedule for Oral Motor Assessment (SOMA) [98], and Systematic Assessment of the Infant at Breast (SAIB) [100]. Three assessments were developed to assess swallowing and feeding function in infants born prematurely: Feeding Questionnaire [88], Neonatal Oral-Motor Assessment Scale (NOMAS) [92], and Preterm Infant Breastfeeding Behavior Scale (revised) (PIBBS) [97]. One assessment was specifically developed to investigate infants (of unspecified gestational ages) with severe swallowing and feeding difficulties: Pediatric Assessment Scale for Severe Feeding Problems (PASSFP) [95].

Six assessments were developed to assess children with no specified illnesses other than having potential swallowing or feeding difficulties: Behavior Focused Feeding Assessment [76], Brief Assessment of Motor Function (Oral Motor Deglutition scale) (BAMF-OMD) [78], Children's Eating Behavior Inventory (CEBI) [80], Feeding Strategies Questionnaire [89], Mealtime Behavior Questionnaire [90], and Parental Feeding Questionnaire [94]. Three assessments were developed to assess swallowing or feeding difficulties in children with autism spectrum disorders (ASD) as the target population: BAMBI, Eating Profile [85], and Screening Tool of Feeding Problems, modified for children (STEP-Child) [99]. Four assessments were developed to assess swallowing and feeding difficulties in children with cerebral palsy (CP) or other neurological conditions as the target populations: Feeding and Swallowing Questionnaire [86], Multidisciplinary Feeding Profile (MFP) [91], Oral Motor Assessment Scale (OMAS) [93], and Pre-Speech Assessment Scale (PSAS) [96]. Two assessments were developed to assess swallowing or feeding function in children with "developmental delay" as the target population: behavioral assessment scale of oral functions in feeding (BASOFF) [77] and Dysphagia Disorder Survey (DDS) [83]. One assessment was developed to assess swallowing or feeding difficulties in children with chronic illnesses as the target population: About Your Child's Eating (AYCE) [75], and one assessment was developed to assess swallowing or feeding difficulties in children with phenylketonuria as the target population: Feeding Assessment [87].

Age ranges for all the assessment varied greatly, ranging from birth of premature infants to adults (Fig. 2). Twelve assessments targeted infants and children between birth and 2 years of age (only); a time where typically developing children are still developing their ability to swallow and feed [1]: Clinical Evaluation of Pediatric Dysphagia, Clinical Feeding Evaluation of Infants, Developmental Pre-Feeding Checklists, EFS, Feeding Questionnaire, NOMAS, Oral Motor and Feeding Evaluation, PASSFP, PSAS, PIBBS, SOMA, and SAIB. Seven assessments investigated swallowing and feeding function in a range of ages beginning within 0–2 years and continuing up to childhood or adulthood: BASOFF, BAMF- OMD, Clinic/Bedside Oral-Sensorimotor Feeding Assessment Worksheet, Feeding and Swallowing Questionnaire, Feeding Assessment, Parental Feeding questionnaire, and Pediatric Dysphagia Clinical Evaluation. Finally, 11 assessments investigated swallowing or feeding function in populations with ages beginning in early childhood and extending through to middle childhood or up to adulthood: Behavior Focused Feeding Assessment, BAMBI, CEBI, Eating Profile, Feeding Strategies Questionnaire, Mealtime Behavior Questionnaire, OMAS, AYCE, DDS, MFP, and STEP-Child.

Assessment Design

There were many different response options used in the assessments including binary scoring, ordinal scales, ratio scales, visual analogue scales (VAS), questions with multiple options, and open questions; 17 of the 30 assessments used a combination of multiple response options (Tables 6, 7, 8). The length of assessments also varied; one assessment consisted of a single scale and seven items (OMAS), while another had 12 subscales and 157 items (Eating

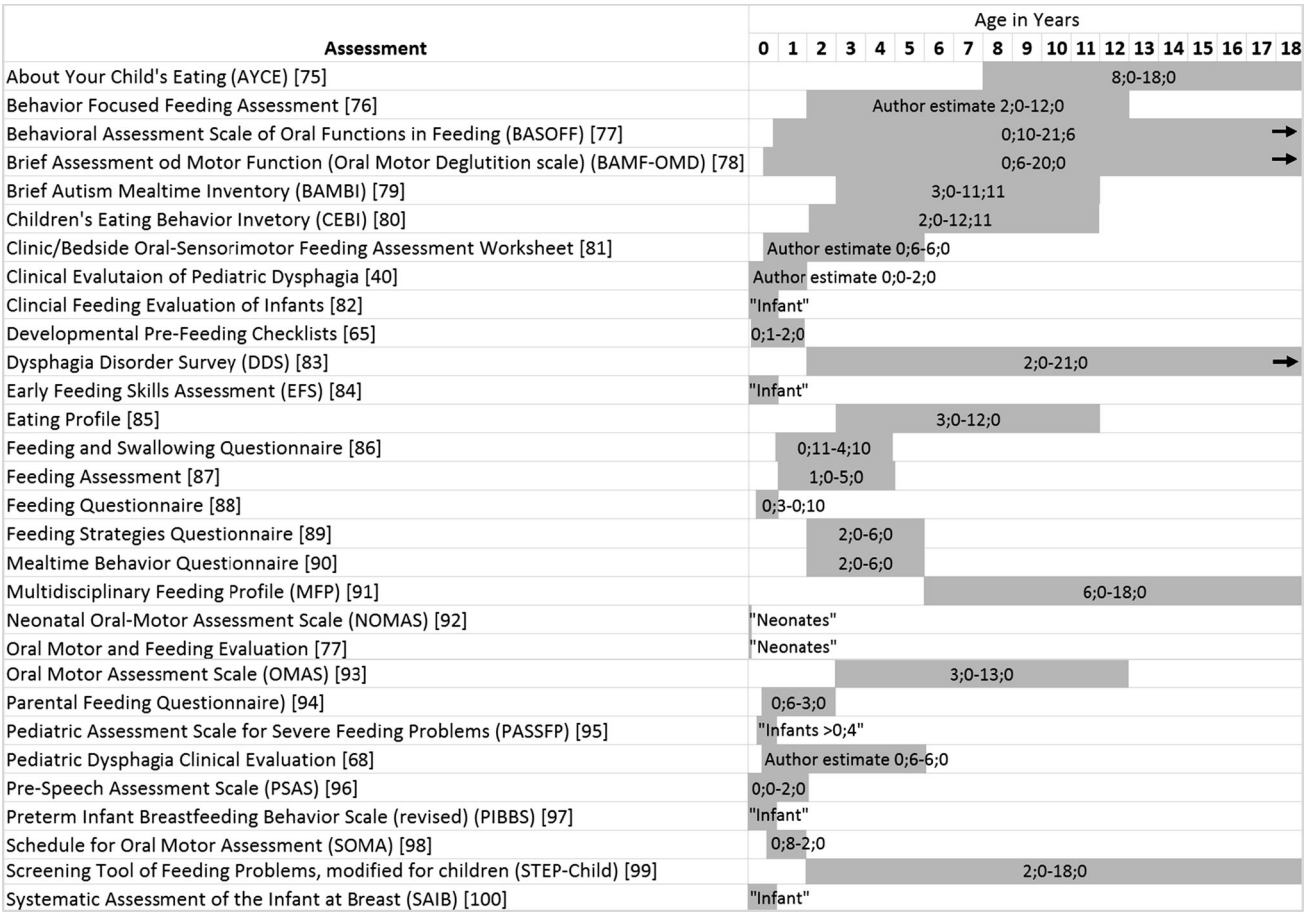

Fig. 2 Overview of non-instrumental assessment tools for swallowing and feeding function in children: Age ranges are shown for each assessment. *Arrows* indicate assessments with age ranges extending higher than 18 years. Where no specific ages were given, the terms used within the text have been provided (where possible) and estimates of appropriate ages have been given according to the authors' discretion

Profile) (Tables 6, 7, 8). Twenty-three of the 30 assessments did not specify the time required to administer the assessment; however, the administration times that were reported ranged from 5 min (BAMF-OMD and PASSFP) to 2 ½–3 h (PSAS).

Scoring

Six assessments provided instruction for scoring and were designed with cut-off scores to distinguish between normal versus abnormal swallowing or feeding function: Mealtime Behavior Questionnaire, OMAS, PSAS, PASSFP, SOMA, and STEP-Child. Sixteen of the 30 assessments used qualitative descriptors rather than a numerical scoring system: Behavior Focused Feeding Assessment, Clinical Evaluation of Pediatric Dysphagia, Clinical Feeding Evaluation of Infants, Clinic/Bedside Oral-Sensorimotor Feeding Assessment Worksheet, Developmental Pre-Feeding Checklists, Eating Profile, EFS, Feeding and Swallowing Questionnaire, Feeding Assessment, Feeding Questionnaire, NOMAS, Oral Motor and Feeding Evaluation, Parental Feeding Questionnaire, Pediatric Dysphagia Clinical Evaluation, PIBBS, and SAIB. The remaining eight assessments provided no instruction for interpretation of the results.

Assessment Domains

The following assessment domains were identified: oral motor skills, behaviors related to swallowing or feeding function, environmental factors related to functional swallowing and feeding, physical swallowing or feeding skills, QoL in relation to swallowing or feeding difficulties, and sensory aspects of swallowing or feeding function (Table 9). Twenty-three assessments included items specific to the domain of swallowing or feeding skills, 17 assessments included items specific to oral-motor skills, 10 included items specific to behavioral aspects of swallowing or feeding, six included items specific to environmental aspects of swallowing and feeding, five included items related to sensory aspects of swallowing or feeding, and

Table 9 Overview of non-instrumental assessment tools for swallowing and feeding function in children: Assessment domains

Assessment	Assessment domains						
	Oral motor	Behavioural	Environmental	Feeding/ swallowing	QoL	Sensory	Additional areas of assessment
About Your Child's Eating (AYCE) [75]		●					
Behavior Focused Feeding Assessment [76]		●	○	●		○	
Behavioral Assessment Scale of Oral Functions in Feeding (BASOFF) [77]	●		●				
Brief Assessment of Motor Function (Oral Motor Deglutition scale) (BAMF-OMD) [78]	●			●			
Brief Autism Mealtime Behavior Inventory (BAMBI) [79]		●				○	
Children's Eating Behavior Inventory (CEBI) [80]		●	○	●			QoL of parents
Clinic/Bedside Oral-Sensorimotor Feeding Assessment Worksheet [81]	●			●			History of feeding
Clinical Evaluation of Pediatric Dysphagia [40]	●			●			Anatomical structures, physiological stability
Clinical Feeding Evaluation of Infants [82]	●			●			Physiological stability during feeding
Developmental Pre-Feeding Checklists [65]				●			
Dysphagia Disorder Survey (DDS) [83]	●	○	○	●			
Early Feeding Skills Assessment (EFS) [84]	●			●			
Eating Profile [85]		●	●				
Feeding and Swallowing Questionnaire [86]				●			
Feeding Assessment [87]			●		○		
Feeding Questionnaire [88]				●			
Feeding Strategies Questionnaire [89]		●					
Mealtime Behavior Questionnaire [90]		●					
Multidisciplinary Feeding Profile (MFP) [91]	●			●		●	Neurological and anatomical
Neonatal Oral-Motor Assessment Scale (NOMAS) [92]	●			●			
Oral Motor and Feeding Evaluation [77]	●			●			Physical examination
Oral Motor Assessment Scale (OMAS) [93]	●			●			
Parental Feeding Questionnaire [94]		○		●			
Pediatric Assessment Scale for Severe Feeding Problems (PASSFP) [95]	●	○		●	○	○	
Pediatric Dysphagia Clinical Evaluation [68]	●			●			Physical examination
Pre-Speech Assessment Scale (PSAS) [96]	○			●			
Preterm Infant Breastfeeding Behavior Scale (revised) (PIBBS) [97]	●			●			
Schedule for Oral Motor Assessment (SOMA) [98]	○			●			
Screening Tool of Feeding Problems, modified for children (STEP-Child) [99]		●		○		○	
Systematic Assessment of the Infant at Breast (SAIB) [100]	●			●			Alignment and positioning of infant during breastfeeding

● Denotes categories comprising a major portion of the assessment

○ Denotes categories present but only comprising a minor portion of the assessment

two included items specific to QoL aspects of swallowing or feeding. Twenty-three of the 30 assessments covered more than one domain, with two of the assessments covering four of the six domains.

Discussion

Variations Among Assessments

The swallowing and feeding assessments included in this review demonstrated variability in terms of target populations, the design of each assessment, and the assessment domains. This variation likely reflects the need to capture a wide range of children with swallowing or feeding difficulties across multiple domains (e.g., a combination of behavioral and sensory difficulties) and who have multiple risk factors (e.g., neurological conditions and a developmental disorder) [27, 101]. As a result, the variation among these assessments reflects the diversity and complexity of the target populations and is also likely to reflect the diversity of both the professionals involved and their clinical settings, each with their unique approach to clinical practice and resource restrictions (such as availability of time, equipment, or finances).

Validity and Reliability

The aim of this report was to provide clinicians with an overview of a broad range of non-instrumental swallowing and feeding assessments. While this manuscript does not investigate the psychometric quality of the assessments, the review of the assessments made it apparent that there is a proliferation of feeding assessments that have been developed for infants and children with limited research investigating the quality of the psychometric properties of these assessments. This gap became apparent with the lack of information available to support standardized interpretation of many of the assessment scores, and also in a lack of consideration for validity and reliability of many of the assessments during their development.

It is also concerning to note that many assessments within this review appear not to have been assessed for validity and reliability within the populations they are being used, raising the question as to whether they should be used at all. A recent psychometric review has been conducted on the quality of psychometric properties of measures assessing swallowing function in children with CP and other neurological conditions [30]. However, more research is needed to cover areas of swallowing and/or feeding function in other populations. It is recommended that further evaluation of the quality of psychometric properties of these assessments is to be performed using a standardized appraisal tool that is valid and reliable itself, such as the consensus-based standards for the selection of health measurement instruments (COSMIN) in order to inform clinicians about the reliability and validity of the assessments that they use [102, 103].

With so little research into the reliability and validity of existing assessments, it would be beneficial to prioritise research on developing the psychometric characteristics of existing assessments to build this area of research to a higher, more rigorous, and evidence-based standing. Selecting the most robust clinical assessments based on the quality of its psychometric properties will result in more sound clinical reasoning, selecting appropriate interventions based on valid and reliable assessment scores, and greater confidence in documenting clinical progress and changes over time [104].

Conclusion

Many non-instrumental assessments are available to clinicians to evaluate swallowing and feeding function in pediatric populations. These assessments vary widely in design, assessment domains, and target groups or populations. A lack of instruction for use and interpretation of assessment scores was evident, indicating that many of these assessments may be at risk for inconsistent use and misinterpretation of results. This review highlights characteristics of the assessments for clinicians to support them in selecting appropriate assessments for clinical practice. This paper also highlights the need for future research to comprehensively evaluate the quality of psychometric properties of the retrieved assessments as many tools appeared to lack robust data on their reliability and validity. As the use of assessments without known psychometric properties may result in outcome data that are not evidence-based and cannot be interpreted correctly, a psychometric review will assist in guiding future choices in the assessment and treatment planning.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

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