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Mealtime interventions for carers of school-aged children who have oropharyngeal dysphagia: A systematic review

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Abstract

Purpose: Oropharyngeal dysphagia (eating, drinking, and swallowing difficulties) in children with neurodisability impacts their whole life. Speech-language pathologists optimise safe, efficient, and enjoyable mealtimes by providing interventions that require carers to adapt their mealtime assistance behaviours. This systematic review identifies and evaluates peer-reviewed mealtime interventions evidence, including content, child, and carer outcomes targeted and effectiveness.

Method: Eleven database and manual searches were completed (January 2024). Eligible studies reported on school-aged children with neurodisability and oropharyngeal dysphagia carer mealtime interventions in any setting against any comparator. Data extraction and quality assessment were completed leading to narrative synthesis.

Result: From 9627 reports, 29 studies (34 reports) were included in this review. Studies had variable designs, only one randomised controlled trial. There were 941 child and 457 carer participants, variably described. Multiple mealtime interventions by varied healthcare professionals targeted different carer behaviours. Twenty-four studies met quality criteria for synthesis with data too heterogeneous for meta-analysis. Studies demonstrated positive outcomes for child and carer mealtime safety, efficiency, and enjoyment using multiple measures.

Conclusion: Mealtime interventions appear better than none. Study evidence is low quality and heterogeneous, with no optimum approach evident. Good quality studies using consistent participant descriptions and core outcome set are required.

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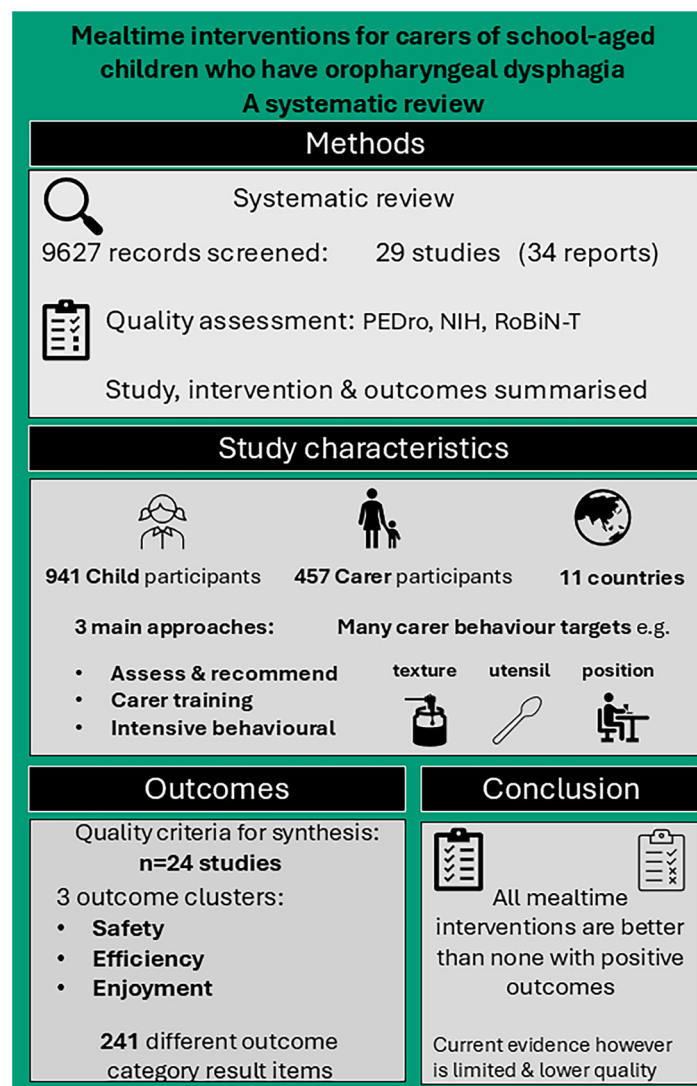
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Graphical Abstract



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Introduction

Children with child-onset disabilities frequently have eating, drinking, and swallowing difficulties termed oropharyngeal dysphagia (Arvedson, 2013; Kooi-van Es et al., 2020; Parr et al., 2021). Oropharyngeal dysphagia can include, problems with the oral preparatory (anticipating the spoon, sucking, biting, chewing), oral (moving the food or liquid to the back of the mouth), and pharyngeal phases of swallowing (swallowing whilst maintaining airway protection) (Morgan et al., 2012). Chronic dysphagia is frequently seen in children with neurodisability who often have life-long impairments, into school-age and beyond (Morris et al., 2013). Within this paper, we will use the term oropharyngeal dysphagia to describe the eating, drinking, and swallowing difficulties/dysfunction in children with neurodisability.

Oropharyngeal dysphagia is a common issue for children with neurodisability (e.g. 50.4% of children with Cerebral Palsy [Speyer et al., 2019] and 47.2% of children with neuromuscular diseases [Kooi-van Es et al., 2020]). It can impact a child's ability to ingest food safely and efficiently within a reasonable time, with some requiring tube feeding to meet hydration and nutritional needs (Arvedson, 2013). Children may also experience pharyngeal aspiration (entry of food or fluid into the airway), one cause of respiratory infections and repeated hospitalisations (Propp et al., 2022). Frequently, children with neurodisability and oropharyngeal dysphagia have physical impairments making feeding themselves difficult and require mealtime assistance from a family member/paid-carer (Sellers et al., 2014). Mothers have reported that providing mealtime assistance is both a

bonding experience and also their most stressful daily activity (Craig, 2013). Family/paid-carers must try to balance competing mealtime outcomes: Safety, efficiency, and enjoyment.

In the UK, the National Institute for Health and Clinical Excellence (NICE) guidelines for Cerebral Palsy (NICE, 2017) recommend that assessment and intervention should balance eating and drinking outcomes of safety, efficiency, and enjoyment. Appropriate assessment and management of oropharyngeal dysphagia by a multidisciplinary healthcare professional team (MDT) is required to address the needs of each child and family (West, 2024). This can include medical and dietetic management (e.g. reflux medication or non-oral feeding). In Australia, the UK, and USA, a speech-language pathologist (SLP) frequently has the primary role, including within mainstream and specialist school-based services (West, 2024), regarding oropharyngeal dysphagia and the mealtime (i.e. food and drink consumed orally). SLPs develop management and treatment plans in collaboration with the family and MDT. These plans are based on thorough assessment and are typically provided to the family/paid-carer through a 'mealtime intervention' (e.g. advice, information, and/or training). SLPs have two main options when providing mealtime interventions (Khamis et al., 2020; Kooi-van Es et al., 2024). One option focuses on how the carer can adapt the mealtime to maximise safety, efficiency (timely nutrition and hydration intake), and potentially enjoyment through compensation (e.g. providing a more easily consumed puree food texture with less refined oro-motor skills required). The second option targets how the carer can encourage child oro-motor skill development (rehabilitation) (e.g. provide harder food textures to encourage biting and chewing skills but may reduce efficiency with fewer calories consumed). Integrating both approaches to optimise skill development whilst maximising safe, efficient, and enjoyable mealtimes, would be ideal.

Mealtime interventions require the family/paid-carer to adapt their typical mealtime assistance behaviour to support the child. Common assistance behaviours targeted include maximising the oral feeding route (e.g. mealtime environment with distractions reduced, child's seating and positioning and, if suitable, supporting the child to complete swallow exercises/manoeuvres) (Arvedson, 2013; Kooi-van Es et al., 2024). The NICE guidelines (2017) and the best practice recommendations for speech-language pathology in children with neuromuscular disorders (Kooi-van Es et al., 2024) suggest multiple carer behaviour mealtime changes. However, they do not provide guidance on target prioritisation, number to change at once, and with the exception of neuromuscular disorders (Kooi-van Es et al., 2024), whether the option should be compensation, rehabilitation, or

both. This requires individualised clinical decision-making, based on a detailed assessment of the child's strengths and needs integrating family/paid carer views. There is little information for SLPs on how to provide mealtime interventions to family/paid-carers to optimise carer behaviour implementation.

Studies investigating family/paid-carers' implementation of SLPs' mealtime interventions have indicated less than optimal adherence (Chadwick et al., 2014; Charpentier et al., 2020) with no consistent pattern of which mealtime carer behaviours are adhered to. Clinicians may use strategies, commonly termed *behaviour change techniques* (Michie et al., 2013), to support family/paid-carers' adherence. Behaviour change techniques are planned processes that are the smallest parts of the content of a behaviour change intervention that are observable, replicable, and individually have the potential to bring about behaviour change (Michie et al., 2013). They include goal setting, information on health consequences, social rewards, and physical environment restructuring. However, little research has examined whether behaviour change techniques are effective when providing mealtime interventions. Most studies have used just one or two techniques with limited effectiveness evaluation. Chadwick et al. (2014) found that verbal training was quickly forgotten, whereas written instructions (instruction on how to perform behaviour) or a visual indicator tube (adding objects to environment) improved family/paid-carers' memory of behaviour targets. Another group (Morgan et al., 2018) surveyed paediatric SLPs' accessible mealtime intervention documents use (instruction on how to perform behaviour), finding little consistency on behaviours targeted (e.g. positioning, communication, and limited adherence monitoring).

There has been little research evidence evaluation exploring the effectiveness of carer targeted mealtime behaviour changes on child and carer outcomes. Previous systematic reviews (Morgan, 2010; Morgan et al., 2012; Parr et al., 2021) explored dysphagia interventions for children with neurodisability evaluating randomised and non-randomised trial studies only. Parr et al. (2021) completed a mapping review of interventions and outcome measures for children (≤ 8 years) with 'physical' and 'non-physical' eating and drinking difficulties in 2017 without reporting all studies identified. Other recent reviews have focussed on infants and/or young children (Khamis et al., 2020; Morgan et al., 2021). These reviews typically identified studies delivered separately from the mealtime (oro-motor programmes) and not always by the family/paid-carer. Studies have rarely described interventions in-depth including adherence support techniques, rather focusing on effectiveness as the main study aim. Therefore, the full evidence base for

mealtime interventions provided to carers of school-aged children has not been evaluated.

In summary, there is not a coherent synthesis of evidence available to guide practice on which mealtime interventions to deliver that balance mealtime safety, efficiency, and enjoyment outcomes for school-aged children with oropharyngeal dysphagia. This systematic review aimed to address this need.

Objectives

The review aimed to answer the following primary question and five sub-questions: What mealtime interventions are provided to family/paid-carers of school-aged children with neurodisability and oropharyngeal dysphagia and are they effective? The sub-questions are:

- (1) Who do mealtime interventions target (carer, child, both)?
- (2) What are the constituents of a mealtime intervention including which health professionals provide them, approach (e.g. individual or group), modality (e.g. face-to-face or online)?
- (3) What carer behaviours are targeted within the mealtime interventions (e.g. provide pureed food, position child in certain way, use a recommended utensil, communicate in a specific style), what is the target direction (e.g. compensatory and/or rehabilitation) and what behaviour change techniques do the interventions include?
- (4) What outcomes (e.g. safety, efficiency, and enjoyment) do mealtime interventions target?
- (5) How effective are these mealtime interventions on the targeted outcomes?

Materials and method

This review was carried out and is reported utilising the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Page et al., 2021). The protocol was registered with the International Prospective Register of Systematic Reviews (PROSPERO): CRD 42021257596.

Eligibility

The Population, Intervention, Comparison and Outcome framework (PICO) (Richardson et al., 1995) was utilised. See Table I. Study eligibility was not restricted by publication date or study design (e.g. single case designs, as long as a comparator was present) to ensure breadth of evidence. Research studies using mixed populations were included if the findings for school-aged children with neurodisability and oropharyngeal dysphagia were reported separately, or if the inclusion criteria population formed 25% or more of the sample.

A mealtime intervention was defined as an intervention provided to carers and which aimed to support child skills through specific carer behaviours at mealtime (oral intake of food and drink). These carer behaviours occurred either immediately before (e.g. activities to help anticipation) or during the meal.

Information sources

Eleven databases were searched for key words within title and abstract from inception to 9th August 2021

Table I. Population, intervention, comparison, and outcome (PICO) framework.

PICO	Inclusion criteria and hierarchy	Exclusion criteria
Population	School-aged children (4–17;11 years) with neurodisability and oropharyngeal dysphagia.	Neonates, infants or pre-school children (0–3;11 years) or adults (18 years and over). Oropharyngeal dysphagia due to non-neurodisability impairments/disabilities (e.g. structural [cleft palate], respiratory [tracheostomy]) Eating disorders or paediatric feeding disorders without oropharyngeal dysphagia (e.g. Avoidant Restrictive Food Intake Disorder).
Intervention	Mealtime interventions provided to family/paid-carers. ¹ Mealtime interventions targeting child skills through carer behaviours either immediately before the meal (e.g. preparation activities for the child to anticipate the meal or during a meal i.e. food consumption through regular daytime intervals 3–5 times a day).	Medical and surgical interventions (e.g. surgery, medication). Oropharyngeal dysphagia interventions that are separate from the mealtime or provided more frequently than mealtimes (>5/day; e.g. Innsbruck Sensorimotor Activator and Regulator, E-Stim). Mealtime interventions that were not provided to family/paid-carers.
Comparison	Any type of comparator (e.g. comparison over time [including retrospective studies], group [including single case and n-of-1 designs], task conditions).	
Outcome	Outcomes that relate to safety (e.g. oropharyngeal aspiration, choking), efficiency (e.g. energy intake, fluid intake, nutrient intake, mealtime length, chewing ability), and enjoyment of the mealtime for child and carer (e.g. mealtime interaction).	Outcomes unrelated to safety, efficiency, and enjoyment of the meal.

and then repeated in January 2024. The searches were completed using: EBSCO: CINAHL, Communication Source, Health Policy Reference Centre, MEDLINE, Ovid: AMED Cochrane Trials, Cochrane Systematic Reviews, EMBASE, EMCare, PsychINFO, and Ovid Nursing. Additionally, the reference lists of all included studies and references cited within relevant systematic reviews were considered to identify further studies.

Search strategy

The search's main concepts were 'dysphagia', 'school-aged child', 'neurodisability', and 'intervention'. Relevant previous systematic reviews and consultation with a specialist librarian were used, alongside scoping search trials to ensure a suitable search string. Truncation (*), alternate spellings (EBSCO: #, Ovid: ?), phrase searching, and proximity searching (EBSCO: N, Ovid: Adj) were used to ensure comprehensive results. Consideration of the wide-ranging terms used for neurodisability and dysphagia including historic developments was made. This included synonyms, neurodisability diagnostic labels (e.g. Cerebral Palsy), and terminology changes (e.g. 'mental handicap' to 'learning disability').

Subject heading use was not fruitful in identifying studies during the search term refinement process, so was not used. All search strings sought title and abstract with no other restrictions. See [supplemental material 1 & 2](#) for search terms.

Selection process

The search results were downloaded into Endnote with deduplication administered, followed by manual deduplication within Excel. Results identified as not peer-reviewed articles (conference abstracts, dissertations, etc.) were screened out. The remaining studies were uploaded into Covidence software, with additional deduplication.

The first author (SM) completed title and abstract screening for the primary inclusion criteria (child, neurodisability, oropharyngeal dysphagia) with a second researcher (KW) checking 10%. All remaining titles and abstracts were independently screened against all inclusion and exclusion criteria by two researchers (SM, FS) with disagreements discussed.

Papers of all abstracts meeting inclusion criteria were retrieved for full text review and independently screened against the eligibility criteria by two researchers (SM, FS). Official translation funding was unavailable, therefore non-English papers were translated using Google translate (Jackson et al., 2019) to check eligibility. This provided sufficiently reliable detail to allow the majority to be excluded for reasons other than non-English format. When translations had insufficient detail reports were excluded. Authors were contacted if additional information was required. Any disagreements on inclusion were

resolved via consensus, with a third senior reviewer making a final decision if required.

Data collection process

A data extraction tool was developed using Excel through consensus with the research team considering the review questions, PRISMA (Page et al., 2021) and good practice guidelines. Publication corresponding authors were contacted for missing or insufficient data. SM completed data extraction with a second reviewer (FS) also extracting for 20% of papers to ensure consistency. Disagreements were most common when related to reason for exclusion, rather than inclusion/exclusion decision. They were resolved via discussion between the two reviewers with the third reviewer not required to provide an additional view. Instances of multiple publications for one study were grouped. The most complete data publication was used unless another version had additional relevant data, with version discrepancies noted.

Data items

A data dictionary was developed within the data extraction tool. The data items comprised: Study design, study setting, publication year, funding source, sample size, participant (child, family/paid-carer) characteristics, inclusion and exclusion criteria, oropharyngeal dysphagia type/characteristics (e.g. swallowing problem, suspected aspiration) and intervention details (e.g. recommendation provider [SLP, etc.]), carer mealtime behaviours (carer to puree food, use new utensil, etc.), intervention modality (face to face, online), and behaviour change techniques used (e.g. feedback on behaviour, habit formation, etc.) (Michie et al., 2013).

Evidence on effectiveness was collated by organising outcomes under three clusters with corresponding subcategories, the outcome measure tools, and items used:

- Safety (e.g. health status [chest infections, hospitalisation], nutritional status [growth], oropharyngeal skills [swallowing])
- Efficiency (e.g. intake [recommended/consumed nutritional supplementation], oro-motor skills [chewing, loss from lips, cup use], time [mealtime length])
- Enjoyment (e.g. Child's mood/affect [quality of life, mealtime behaviour], carer's mood/affect [anxiety, quality of life])

See [supplemental material 3](#) for all outcomes and sub-categories. Relevant data were extracted and measures converted to the same unit if necessary (e.g. imperial pounds to metric grams). Descriptive statistics were used to summarise quantitative data (e.g. child participant and carer characteristics, outcome measure scores).

Risk of bias assessment

Two reviewers (SM, FS) rated the included studies' quality at study level. Disagreements in rating were resolved in discussion, with a senior researcher (KH) consulted if required. The following quality assessment tools were used:

- For randomised and non-randomised controlled trials (RCT and non-RCT): The Physiotherapy Evidence Database (PEDro) scale (Maher et al., 2003).
- Before and after studies with no control group: The National Heart, Lung, and Blood Institute quality assessment tool (National Heart Lung & Blood Institute, 2021).
- Single case designs: Risk of Bias in N-of-1 Trials scale (RoBiN-T) (Tate et al., 2015).

Additionally, the Template for intervention description and replication (TIDieR) framework (Hoffmann et al., 2014) was used to assess intervention reporting quality. Outcome reporting bias was assessed by comparing study protocols with the outcomes in linked publications, or if protocols were unavailable, outcomes reported in the results versus methods.

Effect measures

Effect sizes were extracted or calculated when required using Cohen's d (Cohen, 1977) using an online calculator. Effect sizes were interpreted as: Small ($d = 0.2$), medium ($d = 0.5$), large ($d = 0.8$) according to Cohen (Lakens, 2013); small ($\eta^2 = 0.01$), medium ($\eta^2 = 0.06$), large ($\eta^2 = 0.14$); and small (partial $\eta^2 = 0.01$), medium (partial $\eta^2 = 0.06$), large (partial $\eta^2 = 0.14$) both according to Salkind (Salkind, 2010). A heterogeneity assessment using the I^2 measure was planned prior to any meta-analysis. However, a meta-analysis was not conducted due to the variability in interventions and outcome measures used.

Synthesis method

Synthesis was planned if a minimum of five studies met the inclusion criteria and were of adequate quality with the standards being studies:

- Scoring 4 and above on the PEDro scale
- Graded as fair and above on the NIH tool
- Graded as fair and above on the RoBiN-T scale

Given the nature of the data, a narrative synthesis approach was used to describe and combine the qualitative and quantitative data obtained from all included studies. The process was carried out in accordance with the four elements of the Economic and Social Research Council (ESRC) framework for narrative synthesis (Popay et al., 2006) alongside the synthesis without meta-analysis (SWiM) guidelines (Campbell et al., 2020).

Data for narrative synthesis included study design, sample size, participant and intervention characteristics, including the carer behaviours targeted. Finally, the outcomes and outcome measure tools used, alongside intervention effectiveness were described.

Result

Study selection

Searches identified 9627 records with 4543 identified as duplicates. 5084 records were screened at title and abstract stage with 126 records progressing to full text review. Two records were not retrieved and 124 were assessed for eligibility with 99 reports excluded. Citation checking of included studies and relevant systematic reviews identified 37 additional records which were retrieved and assessed. Twenty-eight of these were excluded and nine met criteria for inclusion. Therefore 29 studies from 34 reports were included. See Figure 1 for a combined searches PRISMA flow diagram.

Excluded studies

One hundred and twenty-nine studies were excluded through the full text review process. (Supplemental material 4). Only two studies (Barrón-Garza et al., 2017; Pinto et al., 2013) were excluded as unavailable in English.

Study characteristics

Study design and setting

The 29 studies are presented in Table II. Studies varied in design with one RCT, four non-RCTs, 18 before-after studies, and six studies used single case methodologies. The only RCT (Acar et al., 2022) evaluated physiotherapy intervention, however usual care included a mealtime intervention and so the control group's results were extracted and reported. All five continents were represented. Four studies were in low- or lower-middle-income and 25 in high- or upper-middle-income countries, with the most common being USA ($n = 8$) and the UK ($n = 7$). Studies varied by setting including outpatients/community teams ($n = 10$), school or residential settings ($n = 10$), day/in-patient wards ($n = 6$), and community programmes ($n = 3$).

Participant characteristics (sub-question 1)

Participant characteristics are reported in Table III. Although all studies targeted the clinical population (children with neurodisability and oropharyngeal dysphagia) and provided mealtime interventions to family/paid-carers, they reported outcomes for different participant groups. Sixteen studies reported outcomes for child participants only, 11 for child and carer participants, and two studies solely carer participants. There were 941 child and 457 family/paid-carer participants across the studies, with only two studies comprising relatively large samples, $n = 103$ children, $n = 78$ paid-carers (Colodny et al., 2015) and $n = 91$ children, $n = 91$ family-carers (Acar et al., 2022). Family/paid-carer demographic characteristics were rarely reported ($n = 3$) and predominantly female ($n = 116$ carer participants). Child participants' data

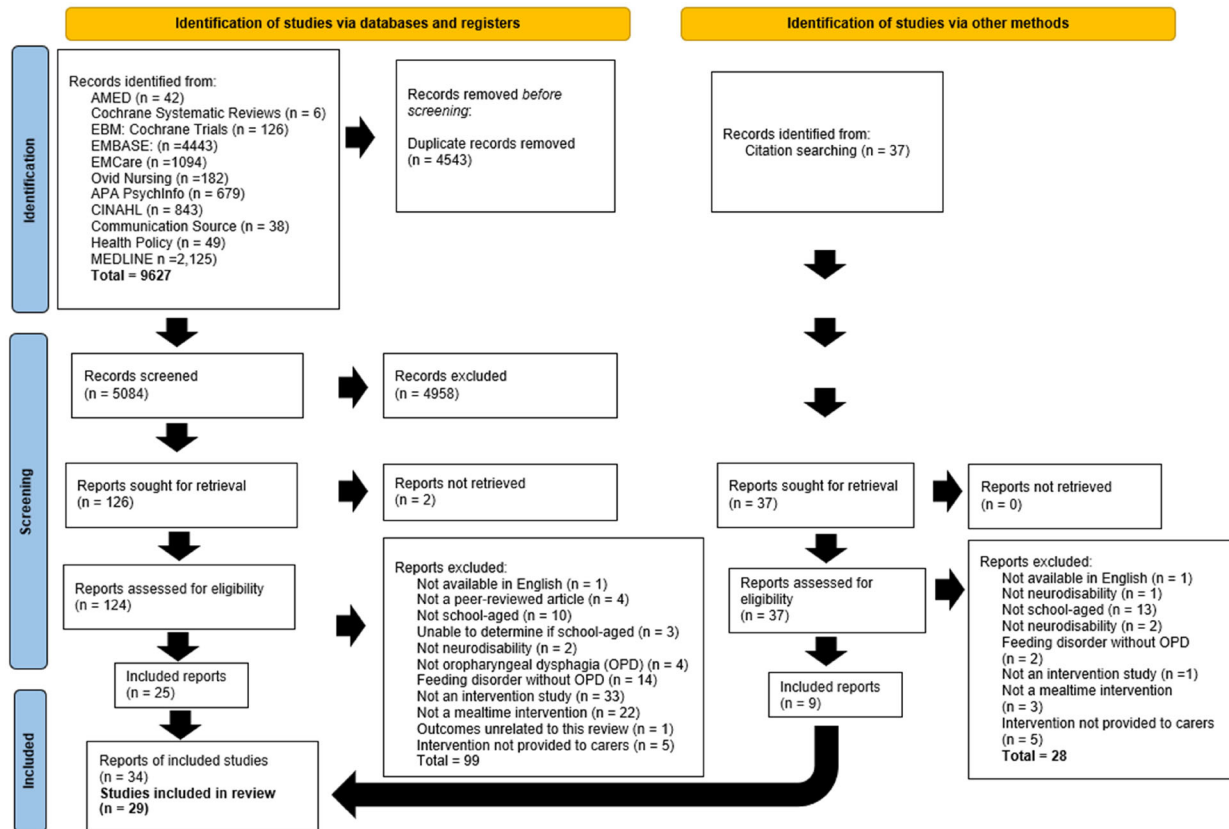


Figure 1. PRISMA flow diagram.

were more consistently reported ($n=26$) with 362 female and 462 male participants with a mean age of 7.07 (SD = 2.92) years. Child participants had multiple neurodisability diagnoses, most commonly Cerebral Palsy, $n=523$ participants reported in 22 studies. Impairment severity reporting was limited, with four studies using classification (e.g. Gross Motor Function Classification System [GMFCS]) (Palisano et al., 1997). The next most common diagnosis was multiple genetic conditions (e.g. CHARGE, Down Syndrome [$n=26$ participants, 8 studies]). Studies described children's oropharyngeal dysphagia variably (a general descriptor [e.g. 'feeding difficulties', 'oral motor deficits' ($n=7$)], signs and symptoms [e.g. coughing, long mealtimes ($n=19$)] with only three studies using classification, Eating and Drinking Ability Classification System (EDACS) (Sellers et al., 2014), and Saliva Severity Scale (Katseni et al., 2021). Child mealtime assistance ability was described in nine studies only, with variable terminology.

Intervention characteristics

Intervention description and delivery (sub-question 2)

The intervention approaches studies used are listed within Table II and summarised in Table IV using the TIDieR framework (Hoffmann et al., 2014). For further detail see supplemental material 5. All studies included a mealtime intervention which aimed to

change mealtime aspects through family/paid-carers changing their behaviours to lead to better outcomes.

Three main intervention approaches were identified: Assessment and recommendation, carer training, and intensive behavioural intervention. Eleven studies provided intervention following assessment through verbal recommendations, frequently alongside written programmes. Eight studies delivered a group training intervention, typically with the children present for some/all sessions. All low or lower-middle-income study settings used group training. Six studies provided individual intervention during mealtimes following a behavioural approach. In these interventions, mealtimes were typically initially provided by the professional and then transferred to the carer. Four studies did not describe the intervention to carers, although carers provided it to children during mealtimes.

Additional non-mealtime intervention including medical treatment for reflux, surgery, and non-oral tube feeding or interventions separate from the mealtime (e.g. oro-[sensory]-motor exercises) were evident in six studies. Nine studies indicated this was the carer and child's first mealtime intervention (Adams et al., 2012; Ayça et al., 2021; Carvalho et al., 2013; Colodny et al., 2015; Hetiarachchi & Kitnasamy, 2013; Katseni et al., 2021; Schwarz et al., 2001; Soylu et al., 2008; Zuurmond et al., 2018).

The professional delivering the intervention varied considerably from an MDT ($n=12$) to individuals. MDTs had different professions involved most

Table II. Study characteristics & quality rating (organised in order of participant type and alphabetical).

Study	Setting	Country	Year	Study type	Intervention	assessment points	Quality rating
Family carer-child dyad or carer & child participant outcome studies							
Adams et al., 2012 ^a	Outpatients	Bangladesh	2012	Non-randomised controlled trial (wait list controls but not reported separately)	Carer group training	Pre, post intervention & 4–6 months post intervention (post2)	NIH Before-after(B-a) ² Fair
Ayca et al., 2021 ^{a,b,c}	Outpatients	Turkey	2021	Non-randomised control trial (2 groups of interest)	Nutrition intervention via MDT appointments	Pre & 1 year post intervention	PEDro Five
Carvalho et al., 2013 ^a	Outpatients	Brazil	2013	Non-randomised control trial (2 groups of interest)	Carer group & one to one training	Pre & 30 days post intervention or post baseline (control)	PEDro Six
Colodny et al., 2015 ^a	Orphanage	Guatemala	2015	Before-after study	Carer group training	Children: Pre & post Carers: Pre, post & 3 months post intervention (post2)	NIH B-a Fair
Griggs et al., 1989 ^d	Outpatients	UK	1989	Single case series (Before-after study)	MDT advice following VFSS of positioning plus SLT follow-up	Pre & 3–9 months post intervention (variable)	NIH B-a Poor
Morton et al., 1993 ^d	Outpatients	UK	1993	Single case series (Before-after study)	Multidisciplinary team recommendations following VFSS	Pre & 3 months post intervention	NIH B-a Poor
Secriest-Mertz et al., 1997 ^{a,cli,3}	Outpatients/ School-based service	USA	1997	Retrospective before-after study (3 groups, 1 of interest)	MDT with focus on dietitian as lead	Pre & 16.5 months (mean) post intervention	NIH B-a Poor
Seiverling et al., 2017 ^{a,e}	Outpatients/ Daily clinic	USA	2017	Before-after study (3 groups, 1 of interest)	Intensive behavioural mealtime intervention & carer training	Pre & post intervention	NIH B-a Fair
Seiverling et al., 2020 ^d	Outpatients/ Daily clinic	USA	2020	Retrospective before-after study (3 groups, 1 of interest)	Intensive behavioural mealtime intervention & carer training	Pre & post intervention	NIH B-a Good
Zuurmond et al., 2018 ⁴	Community setting	Ghana	2018	Before-after study	Carer training	Pre & 1–2 months post intervention	NIH B-a Good
Child (only) participant outcome studies							
Acar et al., 2022 ^a	Outpatients	Turkey	2021	Randomised Controlled Trial (2 groups of interest)	Mealtime nutrition training & oro-motor intervention strategies	Pre & 6 weeks post intervention	PEDro Seven
Bailey et al., 2005 ^d	School	USA	2005	Single case series (A-BC-C-BC2-B'C')	IG also received physiotherapy Oro-motor stimulation & positive reinforcement behaviour management programmes	Pre & every intervention session	RoBiNT Fair
Gisel et al., 1996 ^{a,5}	Special School	USA	1996	Before-after study (2 groups of interest)	(Oro-) sensorimotor intervention before lunch or snack & increase food texture of meals	Pre (double baseline 0 & 10 weeks, Pre & Pre2) & post intervention ⁶	(pathway 4) NIH B-a Good
Gisel 1996	Special School	Canada	1996	Randomised Controlled Trial (3 groups of interest, 1 wait list control group)	(Oro-) sensorimotor intervention before lunch or snack & increase food texture of meals	Pre, mid & post intervention (Groups A (chewing only intervention) & B (sensorimotor intervention)), Pre & post (Group C) ⁷	PEDro Seven
Katseni et al., 2021 ^{a,b,c}	Outpatients	Greece	2021	Before-after study	MDT recommendations following medical & dietetic assessment	Pre, mid & post intervention	NIH B-a Good
Korabek et al., (1981)	Residential care	USA	1981	Single case series (AB, multiple baseline)	Carer training	Pre, mid & 70 weeks post intervention	RoBiNT Moderate
Panerai et al., 2018 ^{a,d}	Outpatients/ Daily clinic	Italy	2018	Before-after study (2 groups, 1 of interest)	Intensive behavioural mealtime intervention & carer training	Pre, 10 weeks post intervention (approximately) & 1 year post intervention (post2)	NIH B-a Fair
Petersen and Ottenbacher 1986	Residential	USA	1986	Single case series (AB, multiple baseline)	Lip closure on cup drinking intervention using positive reinforcement behaviour management approach	Pre (multiple), every intervention & 1 month post intervention	RoBiNT Fair (pathway 4)

(Continued)

Table II. (Continued).

Study	Setting	Country	Year	Study type	Intervention	assessment points	Quality rating
Pinnington and Hegarty 2000 ⁸	Special School	UK	2000	Before-after study	Consistent food presentation using a robotic aid	Pre (multiple $n = 6$), mid ($n = 2$), post & post2 intervention	NIH B-a Good
Schwarz et al., 2001 ^{a,c}	Outpatients	USA	2001	Before-after study	MDT recommendations following assessment with medical, surgical &/or SLP feeding therapy & dietitian if required	Pre & 24.6 months (+/- 3 months) post intervention. Two years pre & 2 years post for hospitalisation rate	NIH B-a Fair
Smith et al., 2022 ^d	Day/ Inpatient day treatment programme	USA	2022	Retrospective before-after study	Intensive behavioural mealtime intervention & carer training	Pre & final intervention session	NIH Before-after Poor
Sobsey 1983	Special School	Canada	1983	Single case study (ABAB)	Provision of textured food to encourage chewing	Pre, post, pre, post (multiple measures)	RoBiNT Low (pathway 5)
Sobsey and Orelove 1984 ^d	Special School	Canada	1984	Single case series (ABAB)	Facilitation exercises prior to mealtime	Pre, post, pre, post (multiple measures)	RoBiNT Moderate (pathway 3)
Soylu et al., 2008 ^{b,c}	Outpatients	Turkey	2008	Before-after study	Medical team recommendations (individualised goals) following assessment	Pre, post	NIH B-a Fair
Tamura et al. 2023 ^{a,c}	Outpatient dental clinic	Japan	2022	Retrospective before-after study (2 groups, 2 of interest)	Feeding therapy/rehabilitation intervention	Pre & post intervention	NIH B-a Fair
Taylor et al., 2017 ^{a,d}	Inpatient day treatment programme	USA	2017	Retrospective before-after study (2 groups, 1 of interest)	Intensive behavioural mealtime intervention & carer training	Pre (multiple) & post intervention	NIH B-a Good
Volkert et al., 2013 ^d	Outpatients	USA	2013	Single case series (AB, multiple baseline)	Intensive behavioural mealtime intervention	Pre (multiple), mid (multiple, every session) & post intervention	RoBiNT Fair (pathway 4)
Carer only participant outcome studies							
Harding and Halai 2009 ^a	Special School	UK	2009	Before-after study	Carer training	Pre & post intervention	NIH B-a Fair
Hettiarachchi and Kitmasamy 2013 ^a	Community support centre or special centre	Sri Lanka	2013	Before-after study	Carer training	Pre & post intervention	NIH B-a Fair/Good

^aMet inclusion criteria for age with >25% aged 4y–17y, 11 m. However unable to separate results (mixed sample).^bMet inclusion criteria for neurodisability diagnosis and oropharyngeal dysphagia with >25% but some with no dysphagia. However unable to separate results (mixed sample).^cMet inclusion criteria for neurodisability diagnosis and oropharyngeal dysphagia with >25% but some had intervention with non-oral nutrition and/or prescribed oral supplements. However unable to separate results (mixed sample).^dSome child study participants did not meet inclusion criteria possible to separate with those numbers only reported.^eMet inclusion criteria for neurodisability diagnosis and oropharyngeal dysphagia with >25% with neurodisability but not autism. However unable to separate results (mixed sample).

Key:

□ = Family carer-child dyad or carer & child participant outcome studies.

□ = Child (only) participant outcome studies.

□ = Carer only participant outcome studies.

Underlined Extracted from additional report not primary study.

CG: Control group; IG: Intervention Group Mid: Measures taken mid-way through intervention; MDT: Multidisciplinary Team; NIH B-A: NIH Before-After: Quality assessment tool for before-after (pre-post) studies with no control group (National Heart Lung & Blood Institute, 2021); PEDro: Physiotherapy Evidence Database scale (Tate et al., 2015); Pre: Measures taken prior to intervention starting; Pre2: Measures taken at a second time point prior to intervention starting; RoBiNT: Risk of bias in n-of-1 trials scale (Tate et al., 2015); Post: Measures taken after intervention has ended; Post2: Measures taken at second time point after intervention is complete; VFSS: Videofluoroscopic Swallow Study.

Table III. Participant characteristics.

Study	Participants targeted	Child & carer ^a n(results n)	Child & carer ^a : Age	Child & carer ^a : Sex	Neurodisability diagnosis ^f	Oropharyngeal dysphagia description Self-feeding ability
Family carer-child dyad or carer & child participant outcome studies						
Adams et al. ⁸	Family-carer -child dyad	37 (22)	1.56-10.8y ⁹ Mean = 3.9y SD = 2.25 NR	Sex: 8 M, 14 F ¹⁰ NR	Cerebral Palsy GMFCS levels III-V	Feeding difficulties/ NR (Support for self-feeding is a target)
Ayça et al. ^{a,b,i}	Family-carer -child dyad	91 IG: 45 CG: 46	IG: Mean = 6.8y SD = 3.2y CG: Mean = 7.7y SD = 2.9 NR	51M, 40 F ¹¹	Cerebral Palsy (<i>n</i> = 62), Genetic/Metabolic conditions (<i>n</i> = 15), Seizure disorder ¹² (<i>n</i> = 8) Other neurodisability ¹³ (<i>n</i> = 6) Cerebral Palsy ¹⁶	Dysphagia, coughing, cyanosis, aspiration & prolonged feeding time/ NR NR/ NR
Carvalho et al. ^a	Family-carer -child dyad	30	1-12y IG: Mean = 6.8y SD = 3.8 CG: Mean = 6.2y SD = 3.8 22-37y Mean = 30.8y SD = 6.25 ¹⁴ 0-18 y NR	21M, 9 F IG: 9 M, 6 F CG: 12 M, 3 F 2M, 28 F ¹⁵		
Colodny et al. ^a	Carers and children	103 78 aged 5-18 y	5-17y Mean = 11.86y NR	NR	Genetic condition ¹⁸ Seizure disorder ¹⁹ Other neurodisability ²⁰	Coughing, chest congestion, suctioning, respiratory changes, choking, vomiting/ Dependent for feeding
Griggs et al. ^j	Family-carer -child dyad	7 ²¹	5-17y Mean = 11.86y NR	NR	Cerebral Palsy (<i>n</i> = 9) ²² Genetic condition ²³ (<i>n</i> = 1)10	Choking, choking on lumpy foods, gagging, avoidance/ NR
Morton et al. ^d	Family carer-child dyad & carers	11 ²³	4-16y Mean = 9.6y NR	5M, 6 F NR	Cerebral Palsy (<i>n</i> = 10) Genetic condition ²⁴ (<i>n</i> = 1)	Severe feeding difficulty, only managing mashed solids, difficulty drinking liquids, Meal-times lasting from half to one hour, choking/ Given by the parent or carer
Secrist-Mertz et al. ^{a,c,25}	Family carer-child dyad	46 ²⁶ (35)	1-14yiii 3-5y: <i>n</i> = 6 (17%) 6-14y: <i>n</i> = 16 (46%) Mean = 7y NR	17M, 18F4 NR	Cerebral Palsy Genetic condition ^{27,9} Other neurodisability ²⁸	Requiring food & liquid modifications & precautions Mild-severe oral-motor dysfunction/ NR
Seiverling et al., 2017 ^{a,k}	Family carer-child dyad	50	Mean = 4.1y SD = 2.47 NR	36M, 14 F NR	Autism <i>n</i> = 16 Learning disabilities ²⁹ Specific learning ³⁰ difficulties (<i>n</i> = 22) No special needs (<i>n</i> = 12)	Oral motor deficits/ NR (Support for self-feeding is a target)
Seiverling et al., 2020 ^d	Family carer-child dyad	22 ³¹ (19)	Mean = 4.4y ³² SD = 2.6 NR	40M, 12 F ³³ NR	Cerebral Palsy, Seizure disorders, Learning disabilities ³⁴ Specific learning ³⁵ difficulties ⁹ Other neurodisability ³⁵	Improved chewing as target. No feeding safety concerns/ NR
Zuurmond et al. ^{a,36}	Family carer-child dyad	75 (64)	1.5y-12y Mean = 3.8y SD = 2.69 < 30 y->40y ³⁷	38M, 26 F 1M, 63 F	Cerebral Palsy (<i>n</i> = 75) GMFCS levels I-II (mild), III (mod), IV-V (severe)	Cough/choke, need help during feeding, child not eating enough/ Need help for feeding

Study	Participants targeted	Child & carer ^a n(results n)	Child & carer ^a : Age	Child & carer ^a : Sex	Neurodisability diagnosis	Oropharyngeal dysphagia description <i>Self-feeding ability</i>
Child only participant outcome studies						
Acar et al ^b	Child (via family-carer)	40 IG: n = 20 CG: n = 20	1.5y-4.5y Mean: 3.25y ³⁸ SD = 0.927	19M, 21F (both groups)	Cerebral Palsy (n = 40) GMFCS levels 1-V	Answer yes to >2 questions confirming presence of respiratory symptoms during feeding, extended mealtime length, stressful mealtime experience & weight gain absence for 2-3 months EDACS levels 1-V/ <i>Not reported levels 1-5 on the mini-MACS</i> Decreased chewing, food spills from spoon & mouth when eating, decreased lip closure, passive oral manipulation of food/ <i>Staff feeds or supervision</i> Moderately eating-impaired/NR
Bailey et al ^d	Child (via SLT student & school staff)	5 ³⁹	4-17y Mean = 7y	3M, 2F	Cerebral Palsy (n = 2) Seizure disorder (n = 3)	
Gisel et al ^{a,40}	Child (via paid carer)	27 ⁴¹ Aspirating, Group A: n = 7 Non-aspirating, Group NA: n = 20	2.5-10y Group A: Mean = 4.6y SD = 2.3 ⁴² Group NA: Mean = 5.4y SD = 2.7 ⁴³ 4.3-13.3y	14M, 13F Group A: 7M Group NA: 7M, 13F ⁴⁴ 19M, 16F	Cerebral Palsy	
Gisel	Child (via paid carer)	35 Group A IG: n = 12 (Post:11), Group B IG: n = 12, Group C CG (wait list control) ⁴⁵ n = 12	Group A IG: Mean = 6.3y SD = 4.4 Group B IG: Mean = 7.3y SD = 2.1, Group C CG: Mean = 7.7y SD = 2.7 0.1-18y ⁴⁶	Group A IG: 11M, 6F Group B IG: 8M, 4F Group C CG: 6M, 6F	Cerebral Palsy	Moderately eating-impaired/ NR
Katseni et al ^{a,b,c}	Child (via family carer)	68	4.4y-5.8y Mean = 5.1y 4y (IQR = 3.5(6.03)	2M 8M, 2F 3M	Cerebral Palsy (n = 59) Other neurodisability (n = 9) ⁴⁷ Cerebral Palsy (n = 1) Seizure disorder (n = 1) Learning disabilities ²² Cerebral Palsy	Functional feeding disorder Mild-profound disorder using the Dysphagia Disorders Survey/NR Tongue thrust, vomiting after meals/ <i>Self-feeding programme contraindicated</i> Atypical oral-motor movements, ineffective chewing/NR Unable to drink from an open cup using a normal drinking pattern/ <i>Cup provided by carer</i> Impairments in oral-motor ability/ <i>Dependent for feeding</i> Oromotor or pharyngeal dysfunction, aversive feeding behaviours (oral hypersensitivity, patterns of food texture preferences & refusals but unremarkable feeding evaluations ³⁴ /NR Food refusal, aspiration with liquids thickened with baby cereal & offered via spoon, significant oral-motor weakness & coordination problems/ <i>Non-self-feeder</i> Gagging, lip spilling/ NR
Korabek et al.	Child (via paid carers)	2	4.4y-5.8y Mean = 5.1y 4y (IQR = 3.5(6.03)	2M 8M, 2F 3M	Cerebral Palsy (n = 1) Seizure disorder (n = 1) Learning disabilities ²² Cerebral Palsy	Functional feeding disorder Mild-profound disorder using the Dysphagia Disorders Survey/NR Tongue thrust, vomiting after meals/ <i>Self-feeding programme contraindicated</i> Atypical oral-motor movements, ineffective chewing/NR Unable to drink from an open cup using a normal drinking pattern/ <i>Cup provided by carer</i> Impairments in oral-motor ability/ <i>Dependent for feeding</i> Oromotor or pharyngeal dysfunction, aversive feeding behaviours (oral hypersensitivity, patterns of food texture preferences & refusals but unremarkable feeding evaluations ³⁴ /NR Food refusal, aspiration with liquids thickened with baby cereal & offered via spoon, significant oral-motor weakness & coordination problems/ <i>Non-self-feeder</i> Gagging, lip spilling/ NR
Panerai et al ^{a,d}	Child (via family carer)	10 ⁴⁸	4.4y-5.8y Mean = 5.1y 4y (IQR = 3.5(6.03)	2M 8M, 2F 3M	Cerebral Palsy (n = 1) Seizure disorder (n = 1) Learning disabilities ²² Cerebral Palsy	Functional feeding disorder Mild-profound disorder using the Dysphagia Disorders Survey/NR Tongue thrust, vomiting after meals/ <i>Self-feeding programme contraindicated</i> Atypical oral-motor movements, ineffective chewing/NR Unable to drink from an open cup using a normal drinking pattern/ <i>Cup provided by carer</i> Impairments in oral-motor ability/ <i>Dependent for feeding</i> Oromotor or pharyngeal dysfunction, aversive feeding behaviours (oral hypersensitivity, patterns of food texture preferences & refusals but unremarkable feeding evaluations ³⁴ /NR Food refusal, aspiration with liquids thickened with baby cereal & offered via spoon, significant oral-motor weakness & coordination problems/ <i>Non-self-feeder</i> Gagging, lip spilling/ NR
Petersen & Ottenbacher	Child (via paid carer)	3	9-13y	3M	Cerebral Palsy	Functional feeding disorder Mild-profound disorder using the Dysphagia Disorders Survey/NR Tongue thrust, vomiting after meals/ <i>Self-feeding programme contraindicated</i> Atypical oral-motor movements, ineffective chewing/NR Unable to drink from an open cup using a normal drinking pattern/ <i>Cup provided by carer</i> Impairments in oral-motor ability/ <i>Dependent for feeding</i> Oromotor or pharyngeal dysfunction, aversive feeding behaviours (oral hypersensitivity, patterns of food texture preferences & refusals but unremarkable feeding evaluations ³⁴ /NR Food refusal, aspiration with liquids thickened with baby cereal & offered via spoon, significant oral-motor weakness & coordination problems/ <i>Non-self-feeder</i> Gagging, lip spilling/ NR
Pinnington & Hegarty ⁴⁹	Child (via paid carer)	20 (16)	7-17y Mean = 12y SD = 3.06 ⁵⁰ 0.2-17.5y	12M, 8F NR	Cerebral Palsy (n = 13) Other neurodisability (n = 3) ⁵¹ Cerebral palsy (n = 39) Genetic condition ¹⁵ (n = 8), Other neurodisability (n = 34) ⁵³	Functional feeding disorder Mild-profound disorder using the Dysphagia Disorders Survey/NR Tongue thrust, vomiting after meals/ <i>Self-feeding programme contraindicated</i> Atypical oral-motor movements, ineffective chewing/NR Unable to drink from an open cup using a normal drinking pattern/ <i>Cup provided by carer</i> Impairments in oral-motor ability/ <i>Dependent for feeding</i> Oromotor or pharyngeal dysfunction, aversive feeding behaviours (oral hypersensitivity, patterns of food texture preferences & refusals but unremarkable feeding evaluations ³⁴ /NR Food refusal, aspiration with liquids thickened with baby cereal & offered via spoon, significant oral-motor weakness & coordination problems/ <i>Non-self-feeder</i> Gagging, lip spilling/ NR
Schwarz et al ^{a,c}	Child (via family-carer)	79 ⁵²	Mean = 5.8y SD = 3.7	NR	Cerebral Palsy (n = 13) Other neurodisability (n = 3) ⁵¹ Cerebral palsy (n = 39) Genetic condition ¹⁵ (n = 8), Other neurodisability (n = 34) ⁵³	Functional feeding disorder Mild-profound disorder using the Dysphagia Disorders Survey/NR Tongue thrust, vomiting after meals/ <i>Self-feeding programme contraindicated</i> Atypical oral-motor movements, ineffective chewing/NR Unable to drink from an open cup using a normal drinking pattern/ <i>Cup provided by carer</i> Impairments in oral-motor ability/ <i>Dependent for feeding</i> Oromotor or pharyngeal dysfunction, aversive feeding behaviours (oral hypersensitivity, patterns of food texture preferences & refusals but unremarkable feeding evaluations ³⁴ /NR Food refusal, aspiration with liquids thickened with baby cereal & offered via spoon, significant oral-motor weakness & coordination problems/ <i>Non-self-feeder</i> Gagging, lip spilling/ NR
Smith et al ^d	Child (via family-carer)	1 ⁵⁵	12y	1F	Genetic condition ⁵⁶	Functional feeding disorder Mild-profound disorder using the Dysphagia Disorders Survey/NR Tongue thrust, vomiting after meals/ <i>Self-feeding programme contraindicated</i> Atypical oral-motor movements, ineffective chewing/NR Unable to drink from an open cup using a normal drinking pattern/ <i>Cup provided by carer</i> Impairments in oral-motor ability/ <i>Dependent for feeding</i> Oromotor or pharyngeal dysfunction, aversive feeding behaviours (oral hypersensitivity, patterns of food texture preferences & refusals but unremarkable feeding evaluations ³⁴ /NR Food refusal, aspiration with liquids thickened with baby cereal & offered via spoon, significant oral-motor weakness & coordination problems/ <i>Non-self-feeder</i> Gagging, lip spilling/ NR
Sobsey, 1983	Child (via paid carer)	1	12	1F	Cerebral Palsy ⁵⁷	Functional feeding disorder Mild-profound disorder using the Dysphagia Disorders Survey/NR Tongue thrust, vomiting after meals/ <i>Self-feeding programme contraindicated</i> Atypical oral-motor movements, ineffective chewing/NR Unable to drink from an open cup using a normal drinking pattern/ <i>Cup provided by carer</i> Impairments in oral-motor ability/ <i>Dependent for feeding</i> Oromotor or pharyngeal dysfunction, aversive feeding behaviours (oral hypersensitivity, patterns of food texture preferences & refusals but unremarkable feeding evaluations ³⁴ /NR Food refusal, aspiration with liquids thickened with baby cereal & offered via spoon, significant oral-motor weakness & coordination problems/ <i>Non-self-feeder</i> Gagging, lip spilling/ NR
Sobsey & Orelowe ^d	Child (via paid carer)	2 ⁵⁸	7 & 12 y Mean = 9.8y	2F	Cerebral Palsy ³⁰	Functional feeding disorder Mild-profound disorder using the Dysphagia Disorders Survey/NR Tongue thrust, vomiting after meals/ <i>Self-feeding programme contraindicated</i> Atypical oral-motor movements, ineffective chewing/NR Unable to drink from an open cup using a normal drinking pattern/ <i>Cup provided by carer</i> Impairments in oral-motor ability/ <i>Dependent for feeding</i> Oromotor or pharyngeal dysfunction, aversive feeding behaviours (oral hypersensitivity, patterns of food texture preferences & refusals but unremarkable feeding evaluations ³⁴ /NR Food refusal, aspiration with liquids thickened with baby cereal & offered via spoon, significant oral-motor weakness & coordination problems/ <i>Non-self-feeder</i> Gagging, lip spilling/ NR
Soylu et al ^{b,c}	Child (via family carer)	45 (31)	Mean = 5.5y SD = 3.6y	29M, 16F	Cerebral Palsy ³⁰ GMFCS levels 1-V	Functional feeding disorder Mild-profound disorder using the Dysphagia Disorders Survey/NR Tongue thrust, vomiting after meals/ <i>Self-feeding programme contraindicated</i> Atypical oral-motor movements, ineffective chewing/NR Unable to drink from an open cup using a normal drinking pattern/ <i>Cup provided by carer</i> Impairments in oral-motor ability/ <i>Dependent for feeding</i> Oromotor or pharyngeal dysfunction, aversive feeding behaviours (oral hypersensitivity, patterns of food texture preferences & refusals but unremarkable feeding evaluations ³⁴ /NR Food refusal, aspiration with liquids thickened with baby cereal & offered via spoon, significant oral-motor weakness & coordination problems/ <i>Non-self-feeder</i> Gagging, lip spilling/ NR

(Continued)

Table III. (Continued).

Study	Participants targeted	Child & carer ^a n(results n)	Child & carer ^a : Age	Child & carer ^a : Sex	Neurodisability diagnosis	Oropharyngeal dysphagia description <i>Self-feeding ability</i>
Tamura et al ^{b,c}	Child (via family carer)	72 ⁵⁹	Mean = 4.4y SD = 3.2 ⁶⁰	31M, 41F IG: 16 M, 20F CG: 15 M, 21 F	Cerebral Palsy Genetic condition ¹⁵ Learning disabilities ⁶¹ Other neurodisabilities ⁶² Other disabilities- no diagnosis identified ⁶³ Cerebral Palsy (n = 33) Autism (n = 25) Other neurodisability ⁶⁴	Dysphagia, delayed feeding function (ability to swallow with lips closed, take food with lips closed, push the mashed food against anterior hard palate, perform mastication)/ NR Feeding difficulties & tube dependence, food refusal/NR Minimal chewing, 80% nutrition via Carnation Instant Breakfast, limited chewing when often more textured food, doctor stated 'safe oral feeder'/NR
Taylor et al ^{a,d}	Child (via family-carer)	58	1.7-12.3y, Mean = 5.79y SD = 2.56	35M, 23 F		
Volkert et al ^d	Child (via family-carer)	1 ⁶³	14y	1M		
Carer only participant outcome studies Harding & Hala ^a Paid carer		NR	23	NR	Other neurodisability ⁶⁵	NR/ NR
Hettiaratchi & Kitnasamy ^a	Family carer	25 ⁶⁶ 25 ⁶⁷	3-24y Mean = 7.9y ⁶⁸ 22-45y 25F	17M 8 F ⁶⁹	Cerebral Palsy	Feeding difficulties/NR

^a Met inclusion criteria for age with >25% aged 4y-17y, 11 m. However unable to separate results (mixed sample).

^b Met inclusion criteria for neurodisability diagnosis and oropharyngeal dysphagia with >25% but some with no dysphagia. However unable to separate results (mixed sample).

^c Met inclusion criteria for neurodisability diagnosis and oropharyngeal dysphagia with >25% but some had intervention with non-oral nutrition and/or prescribed oral supplements. However unable to separate results (mixed sample).

^d Some child study participants did not meet inclusion criteria possible to separate with those numbers only reported.

^e Child & Carer numbers reported when present when a participant with the study with reported outcomes & not present indicated as NR = Not reported.

^f Summarised as: Autism, Cerebral Palsy, Genetic conditions, Learning Disabilities, Seizure Disorder, Specific Learning Difficulties, Other neurodisability diagnosis.

^g Met inclusion criteria for age with >25% aged 4y-17y, 11 m. However unable to separate results (mixed sample).

^h Met inclusion criteria for neurodisability diagnosis & oropharyngeal dysphagia with >25% but some with no dysphagia. However unable to separate results (mixed sample).

ⁱ Met inclusion criteria for neurodisability diagnosis & oropharyngeal dysphagia with >25% but some had intervention with non-oral nutrition &/or prescribed oral supplements. However unable to separate results (mixed sample).

^j Some child study participants did not meet inclusion criteria. Possible to separate with those numbers only reported.

^k Met inclusion criteria for neurodisability diagnosis & oropharyngeal dysphagia with >25% with neurodisability but not autism. However unable to separate results (mixed sample).

^l Child & Carer numbers reported when present when a participant within the study with reported outcomes & not present indicated as NR = Not reported.

Key.

= Family carer-child dyad or carer & child participant outcome studies.

= Child (only) participant outcome studies.

= Carer only participant outcome studies.

Underlined Carers. Extracted from additional report not primary study.

Bold Carers.

CG: Control group; DDS: Dysphagia Disorders Survey; EDACS: Eating & Drinking Ability Classification System; F: Female; GMFCS: Gross Motor Function Classification System; IG: Intervention Group;

M: Male; MACS: Manual ability Classification System; NR: Not reported; y: years.

Table IV. Intervention description.

Study	Intervention prescriber/deliverer	Delivered to			Delivery mode			Dosage (total number of sessions)			Frequency			Child (total number of mealtime sessions)
		Carer	Carer & child	Group	Individual	Separate to meal	Within a meal	Separate to meal	Within a meal	Group	Individual			
Family-carer-child dyad or carer-child outcome studies														
Adams et al	SLP/Generic therapists	Y	Y	Y	N	Y	Y	6	6	Fortnightly	NR	NR	NR	
Ayca et al	Dietitian	Y	NR	N	Y	Y	N	4	N/A	N/A	1-2-6 monthly	NR	NR	
Carvalho et al	SLP	Y	Y	Y	Y	Y	Y	1	1	Time between sessions	1 week	NR	NR	
Colodny et al	SLP	Y	Y	Y	N	Y	Y	1	1	Time between sessions	1-5 days	NR	NR	
Griggs et al	MDT (Paediatrician, Radiologist & SLP)	Y	N	N	Y	Y	N	1 + NR ⁷⁰	N/A	N/A	NR	NR	NR	
Morton et al	MDT (Paediatrician, SLP, sometimes OT)	Y	N	N	Y	Y	N	1 + NR ⁷⁰	N/A	N/A	NR	NR	NR	
Secrist-Mertz et al	MDT (Dietitian, nurse, OT, SLP)	Y	N	N	Y	Y	N	1 + NR ⁷⁰	N/A	N/A	NR	NR	NR	
Seiverling et al., 2017	MDT (Dietitian, Gastroenterologist, Nurse, Psychologist, SLP)/Behavioural therapists & SLP	Y	Y	N	Y	NR	Y	NR	50-200	N/A	4/day, 5 days/week	50-200		
Seiverling et al., 2020	MDT (Dietitian, Gastroenterologist, Nurse, Psychologist, SLP)/SLP & Behavioural therapists	NR	Y	N	Y	NR	Y	NR	90-160	N/A	4-5/day, 5 days/week	90-160		
Zuurmond et al	'Master trainer'/Facilitators'	Y	Y	Y	Y	Y	NR	1	NR	Monthly	NR	NR	NR	
Child only outcome studies	NR	Y	N	N	Y	Y	N		1	N/a	NR	NR	NR	
	SLP/	Y	Y	Y	Y	Y	Y	NR	NR	NR	NR	NR	52	
Acar et al	SLP students & school staff	Y	Y	NR	Y	Y	N	NR	NR	N/A	NR	NR	50	
Bailey et al	School staff	Y	Y	NR	NR	Y	N	NR	NR	N/A	NR	NR	100	
Gisel et al	School staff	Y	N	N	Y	Y	N	2	N/A	N/A	6 monthly	NR	NR	
Katseni et al	MDT (Dietitian & Neurologist)	Y	Y	Y	Y	Y	N	4 ⁷¹ +210+161=375	N/A	3/week	2-3 ⁷² /week	NR	NR	
Korabek et al	Dietitian/Mealtime supervisor & residential care staff	Y	Y	N	Y	Y	Y	NR	150	N/A	1/day, 5 days/week	150		
Panerai et al	MDT (SLP, Nutritionist, Psychologist-psychotherapist)/Therapists	N	Y	N	Y	N	Y	N/A	33	N/A	NR	29		
Petersen & Ottenbacher	NR/School staff	Y	Y	NR	NR	NR	NR	NR	NR	NR	NR	60-75		
Pinnington & Hegarty	School staff	Y	NR	N	Y	Y	NR	1 + NR ⁷⁰	N/A	N/A	NR	NR	NR	
Schwarz et al	MDT (NR)/SLP follow-up	Y	Y	N	Y	NR	Y	N/A	123	N/A	3/day, 5 days/week	123		
Smith et al	MDT (Behavioural psychology professional, Dietitian, Doctor or nurse, SLP & OT)/	Y	Y	N	Y	NR	Y	N/A						

(Continued)

(Continued)

Table IV. (Continued).

Study	Intervention prescriber/deliverer	Delivered to			Delivery mode			Dosage (total number of sessions)			Frequency		Child (total number of mealtime sessions)
		Carer	Carer & child	Group	Individual	Separate to meal	Within a meal	Separate to meal	Within a meal	Group	Individual		
Sobsey	Behavioural psychology professional	N	Y	N	Y	N	Y	N/A	12	N/A	1/day, 5 days/week	12	
	Primary Investigator/ School staff	Y	Y	NR	NR	Y	Y	NR	NR	N/A	NR	39 & 70	
Sobsey & Orelove	Primary Investigator & physiotherapist/School staff	Y	Y	N	Y	Y	N	1	N/A	N/A	NR	NR	
	Doctor	Y	N	N	Y	Y	N	4	N/A	N/A	NR	NR	
	Dentist or dental hygienists	Y	Y	N	Y	Y	N	NR	NR	N/A	3/day, 5–7 days/week	54–219	
	MDT (Behavioural Therapist or Psychologist, Dietitian, Doctor or Nurse, OT or SLP & Oral motor therapist)/	NR	Y	N	Y	NR	Y	NR	NR	N/A	Weekly	102	
Volkert et al	Behavioural therapist MDT (Behavioural Therapist or Psychologist & Doctor)	NR	Y	N	Y	N	Y	N/A	102	N/A	Weekly	102	
Carer only participant outcome studies													
Harding & Halai	SLPs	Y	N	Y	N	Y	N	4	N/A	Weekly	N/A	N/A	
Hettiarachchi & Kitmasamy	SLPs	Y	N	Y	Y	Y	Y	2	N/A	Time between sessions	NR	NR	

Key: MDT: Multidisciplinary team; N: No; N/A: Not applicable; NR: Not reported; SLP: speech-language pathologist; OT: occupational therapist; Y: Yes.

 = Family carer-child dyad or carer & child participant outcome studies.

 = Child (only) participant outcome studies.

 = Carer only participant outcome studies.

Bold=Carer.

Table V. Intervention content: Number of carer behaviours targeted and behaviour change techniques.

Study	Mealtime changes targeted						Behaviour change techniques ⁷⁴ used (n) ⁷⁵
	Prepare child (n)	Position & posture (n)	Food & drink changes (n)	Mealtime process: physical (n)	Mealtime process: communication/behaviour (n)	Environment (n)	
Family carer-child dyad or carer and child participant outcome studies							
Adams et al	NR	3	3	⁷⁶	2	2	5
Acar et al	NR	NR	1	NR	NR	NR	1
Carvalho et al	NR	2	1	2	4	NR	2
Colodny et al	NR	2	2	2	1	⁷⁶	6
Griggs et al	1	1	3	2	NR	NR	1
Morton et al	NR	2	1	1	NR	NR	2
Secrist-Mertz et al	NR	NR	⁷⁶	NR	NR	NR	1
Seiverling et al., 2017	NR	NR	1	NR	NR	NR	1
Seiverling et al., 2020	NR	NR	1	NR	NR	NR	7
Zuurmond et al	NR	NR	⁷⁶	NR	NR	NR	5
Child (only) participant outcome studies							
Acar et al	1	3	3	1	NR	⁷⁶	1
Bailey et al	1	⁷⁷	⁷⁷	⁷⁷	2	NR	8
Gisel et al	1	⁷⁷	⁷⁷	⁷⁷	NR	NR	4
Gisel	1	2	1	1	NR	NR	4
Katseni et al	NR	2	3 ⁷⁶	1	NR	2	3
Korabek et al	NR	NR	1	NR	NR	1	17
Panerai et al	⁷⁶	1	2	1	1	1	7
Petersen & Ottenbacher	NR	2	NR	1	1	NR	1
Pinnington & Hegarty	NR	1	NR	1	NR	NR	2
Schwarz et al	NR	NR	2	NR	NR	NR	3
Smith et al	NR	2	2	1	3	1	4
Sobsey	NR	NR	1	NR	NR	NR	1
Sobsey & Orelowe	1	NR	NR	NR	NR	NR	5
Soylu et al	NR	1	2	NR	NR	NR	2
Tamura et al	NR	1	1	⁷⁶	⁷⁶	NR	3
Taylor et al	NR	NR	2	⁷⁶	1	NR	6
Volkert et al	NR	NR	2	NR	2	NR	2
Carer only participant outcome studies							
Harding & Halai	NR	2	3	2	2	NR	5
Hettiarachchi & Kitnasamy	NR	2	2	1	1	NR	6

Key: NR: Not reported.

 = Family carer-child dyad or carer & child participant outcome studies. = Child (only) participant outcome studies. = Carer only participant outcome studies.

Table VI. Summary of study outcomes and results for studies included within the synthesis.

Study	Cluster	Outcome	Specific Sub-outcome	Measure used	Collection route	Results	Effect size
Family carer-child dyad Adams et al	Safety	Health Nutrition	Chest infections	At least 1 per 3 months	Carer report		
			Adequate growth	WAZ	Direct		Small
			Growth	MUAC	Direct measure		Small-medium
			Meatime length	Meals >30 minutes (n)	Carer report		
			Total intake	Meals <30 minutes (n)	Obs. tool		
Efficiency	Time	Intake OM skills	Chewing	Fluid intake (mLs)	Carer report		
			Mood (general)	Munching/chewing y/n	Obs. tool		Medium
			Child mood (mealtimes)	Negative mood predominately (y/n)	Carer report		
			Resistance to eating	Distressed (mostly/sometimes/never)	Obs. tool		
			Fussiness	Resistance (Always, sometimes, never)	Carer report		
Ayca et al	Safety	Mood Nutrition	Meatime anxiety/stress	Fussiness during mealtime (y/n)	Carer report		
			Adequate growth	4-point scale	Carer report		
			Growth	Reach target weight (% of children)	Direct measure		
			Mood (environment)	Weight gain (% of children)	Direct measure		
			Mood (physical health)	WHOQoL-BREF (one domain)	Carer report		Large
Carvalho et al	Enjoyment	Mood	Mood (psychological health)	WHOQoL-BREF (one domain)	Carer report		Large
			Mood (social relationships)	WHOQoL-BREF (one domain)	Carer report		Large
			Perception of child's difficulty	WHOQoL-BREF (one domain)	Carer report		Medium
			Change in behaviour	Y/N (%)	Obs. tool	NS	
			Strategy used to improve difficulty	Y/N (%)	Obs. tool		
Colodny et al	Safety	Skills Knowledge	Aspiration knowledge (definition)	Y/N (%)	Survey		
			Concordance between definition of aspiration and clinical complications	3-point scale (adequate)	Survey		
			Relation between voice and swallowing	Y/N (%)	Survey		
			Relation between breathing and swallowing	Y/N (%)	Survey		
			Concordance between perception of voice & relation to voice/swallowing	Y/N (%)	Survey		
			Concordance between perception of breathing & relation to breathing/swallowing	Y/N (%)	Survey		
			Verbal interaction/stimulation with child	Y/N (%)	Obs. tool	NS	
			Commands related to feeding	Y/N (%)	Obs. tool	NS	
			Feeding & positioning knowledge	Correct, Incorrect (mean)	Survey		Large
			Signs, symptoms & complications of dysphagia	Correct, Incorrect (mean)	Survey		Large
			Sitting	Correct, Incorrect (n)	Obs. tool		
			Positioning	Correct, Incorrect (n)	Obs. tool		
			Neutral head posture	Correct, Incorrect (n)	Obs. tool		
			Facilitate head and trunk support	Correct, Incorrect (n)	Obs. tool		
			Midline	Correct, Incorrect (n)	Obs. tool		
			Clearance time offered	Correct, Incorrect (n)	Obs. tool		

(Continued)

Table VI. (Continued).

Study	Cluster	Outcome	Specific Sub-outcome	Measure used	Collection route	Results	Effect size
Seiverling et al., 2017	Efficiency	Nutrition Health	Appropriate drink amount presented	Correct, Incorrect (n)	Obs. tool		
			Appropriate food amount presented	Correct, Incorrect (n)	Obs. tool		
			Appropriate feeding rate (slower)	Correct, Incorrect (n)	Obs. tool		
	Enjoyment	Skills OM skills	Growth	Weight gain (average increase)	Direct measure	UTD ⁷⁸	
			Pneumonia	Height gain (average increase)	Direct measure	None	
			Use of nebuliser	Pneumonia cases (n)	Case note audit		
	Safety	Nutrition Intake	Death	Deaths (n)	Case note audit		
			Promote lip closure	Correct, Incorrect (n)	Obs. tool		
			Facilitate lip closure	Correct, Incorrect (n)	Obs. tool		
	Efficiency	Mood	Cup drinking	Present, Absent (n)	Obs. tool		
Eye contact			Correct, Incorrect (n)	Obs. tool			
Verbal stimulation			Correct, Incorrect (n)	Obs. tool			
Seiverling et al., 2020	Enjoyment	Mood	Adequate growth	Weight gain goals met (y/n)	Carer report		
			Reaching recommended/consumed intake	Food intake (met goal, y/n)	Carer report		
			Resistance to eating/food refusal	AYCE subscale	Carer report	Positive	Large
	Efficiency	Intake Mood	Mealtime behaviours	Improved mealtime behaviours (y/n)	Carer report		
			Positive mealtime environment	AYCE subscale	Carer report		Large
			Aversion to mealtimes	AYCE subscale	Carer report		Large
	Enjoyment	Mood	Food variety consumed	BAMBIC subscale (limited variety)	Carer report		Large
			Resistance to eating/food refusal	AYCE subscale	Carer report		Medium
			Mealtime behaviours	BAMBIC subscale	Carer report		Large
	Safety	Nutrition Health	Positive mealtime environment	AYCE subscale	Carer report		Small
Aversion to mealtimes			AYCE subscale	Carer report		Small	
Adequate growth			Weight for age (WAZ)	Direct measure	NS		
Zuurmond et al	Efficiency	Skills Beliefs Knowledge & confidence	Chest infections	Height for age (%)	Direct measure	NS	
			General health	Cough/difficulty breathing in last 2 weeks	Carer report	NS	
			Positioning skill	Diarrhoea/fever/cough in last 2 weeks	Carer report	NS	
	Efficiency	Intake Skills Time	Family-carer perception of positioning	5-point scale (%)	Carer report		
			Family-carer confidence	Position used, upright (n)	Observation	Variable ⁷⁹	
			Family-carer knowledge & confidence	Qualitative responses	Carer report	Variable ⁸⁰	
	Efficiency	Intake Skills Time	Family-carer confidence	4-point scale	Carer report		
			Family-carer knowledge & confidence	Qualitative responses	Interview	Increase	
			Limited protein intake	n	Carer report		
	Efficiency	Intake Skills Time	Food quality & quantity provision	n	Carer report		
Mealtime length			Description	Observation			

(Continued)

Table VI. (Continued).

Study	Cluster	Outcome	Specific Sub-outcome	Measure used	Collection route	Results	Effect size
Child only participant outcome studies Acar et al ⁸¹	Enjoyment	Mood Mood	Child mood (general) Mood (general) Mood (physical functioning) Mood (emotional functioning) Mood (social functioning) Mood (cognitive functioning) Mood (communication functioning) Mood (worry) Mood (daily activities) Mood (family relationships) Mood (frustration) Eating & drinking difficulties frequency	Child emotional health 5-point scale <i>PedsQL-FIM (total)</i> <i>PedsQL-FIM (one domain)</i> <i>PedsQL-FIM (one domain)</i> <i>PedsQL-FIM (one domain)</i> <i>PedsQL-FIM (one domain)</i> <i>PedsQL-FIM (one domain)</i> <i>PedsQL-FIM (one domain)</i> <i>PedsQL-FIM (one domain)</i> <i>PedsQL-FIM (one domain)</i> <i>PedsQL-FIM (one domain)</i> Description 5-point scale	Carer report <i>Carer report</i> <i>Carer report</i> <i>Carer report</i> <i>Carer report</i> <i>Carer report</i> <i>Carer report</i> <i>Carer report</i> <i>Carer report</i> <i>Carer report</i> Observation Interview Carer report		
	Efficiency	OM skills	Bottle drinking skills Trainer cup skills Cup drinking skills Puree skills Semi solid skills Solids skills Cracker skills Bottle drinking skills Trainer cup drinking skills Cup drinking skills Puree skills Semi solid skills Solids skills Cracker skills	SOMA (bottle) SOMA (trainer cup) SOMA (cup) SOMA (puree) SOMA (semi solids) SOMA (solids), Pre-post difference (n) SOMA (cracker), Pre-post difference (n) SOMA (bottle), Pre-post difference (n) SOMA (trainer cup), Pre-post difference (n) SOMA (cup), Pre-post difference (n) SOMA (puree), Pre-post difference (n) SOMA (semi solids), Pre-post difference (n) SOMA (solids), Pre-post difference (n) SOMA (cracker), Pre-post difference (n)	Obs. tool Obs. tool Obs. tool Obs. tool Obs. tool Obs. tool Obs. tool Obs. tool Obs. tool Obs. tool Obs. tool Obs. tool Obs. tool Obs. tool	IG: NS CG: NS IG CG: NS NS NS NS CG: NS	
	Enjoyment	Mood	Child mood (general)	<i>PedsQL</i>	Carer report	Medium	
	Efficiency	OM skills	Lip closure (chewing) Chewing development Mouth opening Lip closure (spoon) Active lips (spoon) Active lips (spoon)	Y/N (%) Up & down twice (Y/N) Y/N (%) Y/N (%) Y/N (%) Y/N (%)	Observation Observation Observation Observation Observation Observation	Increase Increase Increase Increase Increase Increase	
	Safety	Nutrition	Adequate growth	Weight for age (average percentile for age)	Direct measure	NS	No effect
			Triceps skinfold thickness, centile Subscapular skinfold thickness (centile)		Direct measure Direct measure	82	No effect
		OP motor skills	Oral clearance/packing	FFA-s (m) clearing Normal/abnormal	Obs. tool	A: NS ⁸³ NA: NS	
			Swallowing	FFA-s (m) swallowing Normal/abnormal	Obs. tool	NS	
	Efficiency	OM skills	Spoon feeding skills	FFA-s (m) spoon feeding Normal/abnormal	Obs. tool	NS	
			Biting skills	FFA-s (m) Normal/abnormal	Obs. tool	NS	

(Continued)

Table VI. (Continued).

Study	Cluster	Outcome	Specific Sub-outcome	Measure used	Collection route	Results	Effect size
Gisel		Time	Chewing	FFA-s (m) chewing Normal/abnormal	Obs. tool	NS	
			Cup drinking skills	FFA-s (m) cup drinking Normal/abnormal	Obs. tool	NS	
			Straw drinking skills	FFA-s (m) straw drinking Normal/abnormal	Obs. tool	NS	Medium
			Mealtime length	Start to end (minutes)	Observation	NS	
		OS skills	Eating time	For puree texture (apple sauce, seconds)	Observation	A	Large
				For viscous texture (raisin or fruit gelatine), seconds	Observation	NA: NS	
				For solid texture (biscuit or cracker, seconds)	Observation	A	Large ⁸⁴
				Item used for viscous texture for trials (gelatine -> raisins)	Observation	NS	
		Nutrition	Mealtime textures accepted	FFA-s (m)	Obs. tool	A	
			Mealtime textures (puree/mash (decrease) vs viscous/solid (increase))			NA: NS	
Katseni et al		Safety	Adequate growth	Weight for age (average percentile/age)	Direct measure	A	Small
			Eating time	For puree texture (apple sauce, seconds)	Observation	B & C	Small
				For viscous texture (raisin, seconds)	Observation	NS	Small ⁸⁶
				For viscous texture (fruit gelatine, seconds)	Observation	NS	Small ⁸⁷ medium ⁸⁸
		OS skills	Mealtime length	For solid texture (biscuit, seconds)	Observation	NS	Small ⁸⁹
				For solid texture (cereal ring, seconds)	Observation	C: NS	Large ⁹⁰
				First to final swallow (on a puree bolus, seconds)	Observation	NS	Small ⁹¹ /medium ⁹²
				First to final swallow (on a viscous raisins bolus, seconds)	Observation	NS	Small-medium ⁹³ /Large ⁹⁴
		Nutrition	Adequate growth	First to final swallow (on a viscous fruit gelatine bolus, seconds)	Observation	C: NS	Small ⁹⁵ /Medium ⁹⁶
				First to final swallow (on a solid biscuit bolus, seconds)	Observation	B: NS	Small ⁹⁷ /Medium ⁹⁸
Korabek et al		Safety	Mealtime length	First to final swallow (on a solid cereal ring bolus, seconds)	Observation	NS	
			Mealtime textures accepted	Minutes	Observation	NS	
			Adequate growth	Most advanced texture eaten	Observation	NS ⁹⁹	Small
				WAZ	Direct measure	NS	
		Intake	Reaching recommended/consumed intake	Height for age z score (HAZ)	Direct measure	NS	
				Body Mass Index (kg/m ²)	Direct measure	NS ¹⁰⁰	Medium
				MUACz	Direct measure	NS	Medium
				Triceps skinfold thickness z-score (STz)	Direct measure	NS	
		Skills	Food quality & quantity provision	Kilocalories intake gs/kg of body weight	Carer report		Medium
				Protein intake gs/kg of body weight	Carer report		Small
(Continued)		Efficiency	Mealtime length	Carbs intake gs/kg of body weight	Carer report	NS	
				Fat intake gs/kg of body weight	Carer report		Medium
				Recommended daily amount	Carer report	NS	Large

Table VI. (Continued).

Study	Cluster	Outcome	Specific Sub-outcome	Measure used	Collection route	Results	Effect size
Panerai et al	Safety	Nutrition	Adequate growth/catch-up growth/reach target weight	Weight gain (g)	Direct measure		Medium
	Efficiency	Time	Mealtimes length	minutes (difference reported, minutes)	Observation	NS	
		OM skills	Chewing	Effective chewing (v/n)	Observation		
		Intake	Food variety consumed	Number of foods eaten (n)	Observation		Medium
		OS skills	Mealtimes textures accepted	n of textures eaten (liquid, puree, semisolid, solid)	Observation		Medium
	Enjoyment	Mood	Mealtimes behaviours	BAMBI	Carer report	NS	Medium
				BAMBI (subscale)	Carer report		Small
				BAMBI food refusal subscale	Carer report		Small
	Efficiency	OM skills	Resistance to eating/food refusal	Y/N (%)	Observation	Positive	
	Safety	OPM Skills	Lip closure (trainer cup) Swallowing	Adapted SOMA (control of swallowing)	Obs. tool	NS	
Petersen & Ottenbacher Pinnington & Hegarty		Nutrition	Adequate growth	Weight (% of n)	Obs. tool		
		Time	Mealtimes length	Dinner and tea (minutes)	Observation	NS	
			Time to consume spoonful	Mean of dinner & tea meals (seconds)	Observation	NS	
		OM skills	Range and control of lip movement	Adapted SOMA (control of lip)	Obs. tool		
			Range and control of tongue movement	Adapted SOMA (control of tongue)	Obs. tool		
			Range and control of jaw movement	Adapted SOMA (control of jaw)	Obs. tool		
			Chewing development	Adapted SOMA (control of mastication)	Obs. tool	WNS	
		Intake	Reaching recommended/consumed intakes	EAR & RNI(%). Food intake and loss diary	Direct measure/case note audit	WSS: NS	
			Adequate growth	Weight (Z score)	Direct measure/case note audit	NS	Large
	Safety	Nutrition		Height (Z score)	Direct measure/case note audit		Large
Schwarz et al				Triceps skinfold thickness (n change)	Direct measure		Large
		Health	Hospital admission/inpatient length of stay	n	Case note audit		
	Efficiency	Intake	Reaching recommended/consumed intake	Intake: Recommended daily amount ratio	Direct measure/case note audit	Increase	
	Efficiency	OM skills	Lip closure (mealtime)	Bites with skill/days in phase (%)	Observation	Increase	
			Chewing	Bites with skill/days in phase (%)	Observation	N/A ¹⁰¹	
			Lip spillage (drink)	%	Observation	Decrease	
			Lip spillage (food)	Spills per bite	Observation	Decrease	
	Safety	Nutrition	Growth	Weight gain (kg)	Direct measure/case note audit		Small
			Adequate growth	Weight (Z score)	Direct measure/case note audit		Small
				Weight for age (%)	Direct measure		Medium
Sobsey & Orelove				Body Mass Index (kg/m ²)	Direct measure		Small
				Height (Z score)	Direct measure	NS	Medium
				Height for age (%)	Direct measure	NS	Small
				Weight for height (%)	Direct measure		Small
				Weight for age (n within National Centre for Statistics centile bands)	Direct measure		
						¹⁰²	
					Direct measure		
Soylu et al							

(Continued)

Table VI. (Continued).

Study	Cluster	Outcome	Specific Sub-outcome	Measure used	Collection route	Results	Effect size
Tamura et al		Health	Growth	Weight for age (n within Cerebral Palsy centile bands)	Direct measure		
				Height gain (cm)	Direct measure		
				Head Circumference (cm)	Direct measure	NS	Large
				MUAC	Direct measure		Small
Taylor et al	Efficiency	OM skills	Chest infections Chewing	Triceps skinfold thickness (mm)	Direct measure		
				Not reported (n)	Carer report		Small
				Developmental level progression score (n)	Observation		
				Weight gain (kg)	Direct measure		Large
Volkert et al	Safety	Nutrition	Growth	Food intake (g)	Observation		Large
				Total amount of intake consumed	Observation		Large
				Mealtimes textures accepted	Observation	N/A ¹⁰³	
				MEALTIME BEHAVIOURS	Carer report		Large
	Safety	OPM Skills	Resistance to eating/food refusal Oral clearance/packing	Times during meal (n)	Observation		Large
				Refusal of spoon during meal (n)	Observation		Large
				Food, rice size or larger remaining in mouth 30s after bite entered	Observation		Large
				Food, (5 bites/meal, %)	Observation	Decrease	
Carer only participant outcome studies Harding & Hala	Safety	OM skills	Chewing	Chews per bite	Observation	Increase	
				Food with pieces no larger than 0.2 cm x 0.2 cm in a liquid medium after chewing, (5 bites/meal, %)	Observation	Increase	
Hettiarachchi & Kitnasamy	Safety	Knowledge	Mixing thickeners and modifying textures	(Z score)	Survey		
			Mixing thickeners	7-point confidence scale (Z score)	Survey		
			Understanding carer behaviour changes recommended by SLT	7-point confidence scale (Z score)	Survey		
			Positioning	7-point confidence scale (Z score)	Survey		
		Beliefs	Importance of carer behaviour changes recommended by SLT	7-point confidence scale (Z score)	Survey		
			Textures (bite-dissolve vs. puree)	7-point likert scale (Z score)	Survey		
			Aspiration signs (coughing)	7-point likert scale (Z score)	Survey		
			Bolus volume knowledge	7-point likert scale (Z score)	Survey		
		Risk assessment knowledge	Positioning (seating, foot support)	7-point likert scale (Z score)	Survey		
			Texture (lumpy vs puree)	7-point likert scale (Z score)	Survey	NS ¹⁰⁴	
			Aspiration signs (colour change)	7-point likert scale (Z score)	Survey	NS ¹⁰⁵	
		Beliefs	Mealtime communication importance	(Z score)	Survey		
		Knowledge	Positioning	Mean	Survey		
		Confidence	Aspiration To feed child	Qualitative responses	Interview		
				Qualitative responses	Survey		

(Continued)

frequently SLP ($n=9$), dietitian ($n=7$), medical ($n=7$), and psychology colleagues ($n=6$), alongside Occupational Therapist (OT) ($n=3$), Physiotherapist ($n=3$). In 12 studies a solo professional was evident (e.g. SLP, OT, dietitian, doctor, or dentist), and in five the professional was undetermined. All interventions were delivered face to face, except one comparing on-site and telehealth delivery (Tamura et al., 2023).

The amount of intervention provided also varied. Dosage was not consistently reported. Where reported, dosage for assessment and recommendation approaches ranged from 1–2 to 4–6 sessions. Group training dosage was between 1–6 sessions, typically alongside additional individual sessions. The studies delivering individual behavioural approaches did not specify the number of carer mealtime intervention sessions, rather the amount the child received. Several other studies also reported the carer-assisted mealtime dosage for the child, rather than the amount of intervention delivered to carers. The amount of intervention mealtimes children received varied in number (33–200), and frequency from once per day (usually in school-based studies) to once per week, or intensively 3–4 times per day, typically 5–7 days per week. Assessment and recommendation or group training approach studies tended not to report child mealtime dosage with the potential implication the carer should follow the intervention recommendations every carer-assisted mealtime. The intervention amount a child and/or carer participant received differed, often individualised to the child's needs or study methodology.

Carer mealtime behaviours targeted (sub-question 3)

The carer mealtime behaviours targeted within each intervention are summarised in Table V (supplemental material 6). Interventions were grouped into six broad areas. Across the studies all six areas were targeted: Changes to food and drink ($n=26$), position and posture ($n=15$), physical assistance process ($n=15$), feeding process (communication/behaviour) ($n=14$), environment ($n=7$), and changes prior to the meal ($n=7$). Sometimes studies described some carer behaviour areas as part of usual treatment: Position ($n=4$), physical assistance process ($n=2$), with additional changes targeted within the intervention. Interventions varied in the number of carer behaviour areas targeted from one ($n=8$) or two ($n=6$), to potentially multiple ($n=15$). In addition, under each area multiple carer behaviours (maximum four) were targeted (e.g. food changes included texture and calorific density).

The behaviours targeted were developed through an assessment process and were child-specific, except when training school-staff working with multiple children or in the study by Soylu et al. (2008), who described generic position angle (30° reclined) advice. Some carer mealtime behaviours targeted an area in

opposing directions. For example, in three studies carers were requested to provide less textured, smooth food, reducing need for chewing (compensation) but in eight studies to provide more textured food to increase chewing ability (rehabilitation). No studies explored both directions explicitly, while six studies did not specify the direction, just stating 'texture modification'.

Behaviour change techniques were extracted with the number reported varying from one to 17 (median $n=3$, IQR = 3). Twenty-three different behaviour change techniques were reported between one and 22 times. The most reported were instruction on how to perform the behaviour ($n=22$), presenting information by a credible source ($n=17$), adding objects to the environment ($n=12$), and demonstration of the behaviour ($n=11$).

Fidelity

Mealtime interventions had different approaches to fidelity and adherence monitoring. Only two studies reported fidelity monitoring of the health professionals' mealtime intervention delivery to carers. While 11 monitored carer adherence to intervention recommendations with four as per study design, not intervention approach (supplemental material 5).

Attrition

Attrition was reported in seven studies ($n=40$ child-carer dyads and $n=19$ child participants). The reasons typically were non-attendance at follow-up and/or post outcome measurement assessment. Pinnington and Hegarty (2000) had two child participants unable to operate the intervention device and two other participants used it insufficiently in the pilot to be included later. Acar et al. (2022) excluded two participants, in both groups, assessed as aspirating with tube feeding provided instead. Gisel et al. (1996) reported one child participant death deemed unrelated to the study. Zuurmond et al. (2018) reported participants (children with disability and oropharyngeal dysphagia) at higher risk of death ($n=8$) than the local child population, standard mortality ratio: 5.88 ($p<0.05$). Colodny et al. (2015) reported two deaths during 11 months post-intervention ($n=5$ in pre-intervention year).

Adverse effects

The only adverse reported event related to an intervention was in Seiverling et al. (2020) where three participants were put on 'medical hold' due to gastrointestinal discomfort.

Outcomes and outcome measure tools used (sub-question 4)

The outcomes and outcome measures used are summarised in Table VI alongside supplemental material 7.

Outcomes were identified under the three outcome clusters of safety, efficiency, and enjoyment following NICE (2017) and were grouped under different outcomes and subcategories (supplemental material 3) with multiple different measures reported (Table VI, supplemental material 7).

Studies did not always report data on all three outcome clusters: Safety ($n=21$ studies), efficiency ($n=22$ studies), and enjoyment ($n=15$ studies) however all intervention approaches did cover all three. Behavioural interventions reported on safety less frequently and carer training interventions tended to a focus on enjoyment, though not solely.

Under safety there were three child outcomes (health, nutrition, and oropharyngeal skills) and three carer outcomes (knowledge, skills, and confidence). The subcategory and measures differed (e.g. health outcome had seven subcategories: General health, coughing/choking, chest infections, pneumonia, nebuliser use, hospital admission, death). In addition, multiple outcome measures were evident for the same outcome subcategory (e.g. chest infection [at least one in last three months vs. cough/difficulty breathing in last two weeks]). Under efficiency there were four child outcomes (intake, oro-motor skills, oro-sensory skills, time) and only one outcome for carers (skills). There were fewer enjoyment cluster outcomes with one child subcategory (mood/affect) and two carer subcategories (mood/affect, knowledge, and skills). A pattern of multiple subcategories within an outcome was evident (e.g. efficiency: Oro-motor skills having 24 different subcategories reported). Some outcomes were short-term, related to the meal or child's skills (e.g. lip closure skill, carer knowledge), with others longer-term consequences (e.g. quality of life, growth). The most frequent reported outcome results were child nutritional status (two categories with $n=43$ results) alongside multiple family/paid carer knowledge, skills, and confidence ($n=44$ results).

There were very few validated measures used across studies. Direct child eating and drinking skills observational assessments were the Dysphagia Disorders Survey (DDS), an adapted version of the Functional Feeding Assessment (Gisel et al., 1996) and the Schedule of Oral Motor Assessment (SOMA) (Skuse et al., 1995) in full and adapted form. The carer-reported measures were About Your Child's Eating scale (AYCE) (Davies et al., 2007), the Brief Autism Mealtime Behaviour Inventory (BAMBI) (Lukens & Linscheid, 2008), Brief Assessment of Mealtime Behaviour in Children (BAMBIC), and the Children's Eating Behaviour Inventory (CEBI) (Taylor et al., 2017). Three different carer reported quality of life measures were used: World Health Organization Quality of Life scale (WHOQoL-BREF) (The WHOQOL, 1998), the parent version of the Pediatric Quality of Life Inventory (Peds-QL) (Varni et al., 1999), and Family

Impact Module (PedsQL-FIM) (Varni et al., 2004). All measures were evident once within the review except for two studies by the same author.

Many studies developed their own measure, either child-carer mealtime observation ($n=13$), family/paid-carer survey ($n=8$), and/or other carer report approaches (e.g. food diary). Six studies reported direct growth measurement with variable approaches (e.g. weight, height, mean upper arm circumference, triceps skin fold thickness). This was usually alongside adequacy analysis (e.g. body mass index (kg/m^2), weight for age) though not always. Child outcomes were based on direct measurement, observation, case note review, or carer report; never child report. Frequently studies reported multiple outcome results (e.g. every outcome measure item) rather than a sole total. Therefore 241 different outcome category result items were extracted across the studies. These were for Safety (six outcomes, $n=101$ results, $n=60$ child outcome results), Efficiency (five outcomes, $n=96$ results, $n=89$ child outcome results), and Enjoyment (four outcomes, $n=53$ results, 24 child outcome results). One outcome item combined clusters (goals met).

Study quality and risk of bias

Studies were evaluated with the three quality rating tools (Maher et al., 2003; National Heart Lung & Blood Institute, 2021; Tate et al., 2015) (Table II and supplemental material 8–10). No study protocols were identified, however the outcomes reported in studies' results and methods were generally consistent. A few studies did not report or had inconsistent outcome reporting (Morton et al., 1993; Schwarz et al., 2001; Seiverling et al., 2017; Taylor et al., 2017). One study amalgamated the results for the intervention and wait list control group due to low follow-up (Adams et al., 2012). Twenty-four studies met the quality level for inclusion. Four studies were scored 4–6 (fair–good) on the PEDro, fifteen studies were rated fair–good on the NIH quality tool and six studies rated fair–moderate using the RoBiNT. Five studies were excluded as below the inclusion quality level (Griggs et al., 1989; Morton et al., 1993; Secrist-Mertz et al., 1997; Smith et al., 2022; Sobsey, 1983).

Result of individual studies

Results for each study are presented in Table VI which summarises intervention effectiveness of the studies within the synthesis and supplemental material 7.

Data synthesis (sub-question 5)

The 24 studies comprised $n=1274$ participants ($n=874$ child, $n=400$ carer) alongside family/paid-carers who provided intervention but were not treated as participants.

Intervention description and theory. All studies included a mealtime intervention targeting mealtime aspects through family/paid-carers changing their behaviours with the assumption it would lead to better child and/or carer outcomes. Studies demonstrated heterogeneity in their aims, interventions (including carer behaviours targeted), and outcomes. Typically, studies used previous research from two main areas as their theoretical basis, applied behavioural analysis (psychological) ($n = 5$), child development research focussing on nutrition and/or oro-motor skills (medical) ($n = 17$), or both ($n = 2$). Only three studies discussed mealtime intervention development literature specifically and only Katseni et al. (2021) reported using guidelines (Santoro et al., 2012). Studies using behavioural approaches focussed on specific communication/interaction approaches (e.g. escape extinction) which were not evident in the other studies. These studies typically focused on aims of children accepting increased food texture and variety, predominately with outcomes related to enjoyment (child and carer) and efficiency (intake, oro-sensory skills). Studies that did not take a behavioural standpoint typically targeted different communication approaches (e.g. carer's ability to read the child, i.e. recognise and interpret cues) alongside a wider range of carer behaviours (e.g. position and posture). Studies indicated the carer behaviours targeted were child-specific, although Soylu et al. (2008) used generic positioning and texture advice.

Synthesis of findings and exploration of relationships within the data. The studies had heterogeneous outcome measures and so the different interventions are described narratively, grouped under outcome cluster: Safety, efficiency, and enjoyment.

Safety

Seventeen studies reported outcomes for the safety cluster. These were measured within all intervention approaches: Carer training, behavioural intervention, and assessment and recommendation studies. Fourteen studies reported child safety cluster outcomes in the subcategories of nutrition ($n = 13$), health ($n = 5$), and oropharyngeal skills ($n = 3$).

A wide range of nutritional status outcomes related to adequate/catch up growth were reported. Studies reporting catch-up growth ($n = 9$) found that the intervention achieved this across various categories and measures, with minimal exceptions. Although some were not at a statistically significant level, five demonstrated a small-large effect (Adams et al., 2012; Katseni et al., 2021; Panerai et al., 2018; Schwarz et al., 2001; Soylu et al., 2008). However, all five of these studies included additional nutrition optimisation interventions, with three providing medical management including potential tube feeding.

All child health results were consistent with the desired direction of effect. Two demonstrated statistical significance (Adams et al., 2012; Zuurmond et al., 2018), one a small effect size in reducing chest infections (Soylu et al., 2008), and one large for hospital admission reduction (Schwarz et al., 2001). Again, all studies that included medical interventions.

Only three studies reported on oropharyngeal motor skills. Pinnington and Hegarty (2000) reported a non-significant improvement in swallowing ability and Volkert et al.'s (2013) single case design identified food bolus oral clearance improvements. Gisel et al. (1996) reported an increase in 'normal' swallowing ability ($p = 0.003$) across groups, but mixed non-significant results for oral clearance by severity groups.

Five studies evaluated carer knowledge, confidence/beliefs, and skills related to safety following a training intervention. All studies used a bespoke survey, and three an additional carer mealtime observation. Five studies found family/paid-carers knowledge increased with some large effect sizes (Colodny et al., 2015). All results reached statistical significance, except when participants had good prior knowledge (Harding & Halai, 2009). Three studies explored carer skills with improvements evident across multiple abilities ($n = 13$), at statistical significance ($n = 11$) (e.g. perception of child's difficulty; Carvalho et al., 2013), mealtime pace, and positioning (Colodny et al., 2015). Finally, three studies investigated confidence improvements with statistically significant changes in all measures ($n = 6$), matched by qualitative reports.

Efficiency

Nineteen studies reported efficiency outcomes measured within all intervention approaches. All included child outcomes reporting on oro-motor skills ($n = 11$), oro-sensory skills ($n = 4$), intake ($n = 10$), and time ($n = 7$).

Oro-motor skill outcomes were varied with all eight studies reporting chewing outcomes finding improvements, three at statistical significance, when chewable textures were deemed safe and included in intervention. Interestingly (Volkert et al., 2013) identified that a participant's chewing skills advanced when offered larger food pieces, without behavioural intervention. It was frequently difficult to ascertain if interventions were targeting motor skills (learning to chew), sensory skills (tolerating the sensation of chewable foods), or both. Other oro-motor outcomes were utensil or oral musculature control (e.g. spoon use, lip spillage). Two studies reported statistically significant utensil skill results (Acar et al., 2022; Gisel et al., 1996) (e.g. straw drinking skills, medium effect), and reflected positive trends from three other studies. All other oro-motor skills showed a positive trend with some significant improvements: Puree

skills (Acar et al., 2022), range and control of jaw, lips, tongue (Pinnington & Hegarty, 2000). Four studies reported oro-sensory skills results, all targeting an increase in more advanced food textures accepted. Significant improvements (medium effect) were reported by Panerai et al. (2018), both studies by Gisel (Gisel et al. 1996; Gisel, 1996) found improvements but not at significance and data was absent in another (Taylor et al., 2017).

Child intake (food/fluid volume and energy value) outcomes ($n=10$) typically focussed on increasing nutrition predominately to recommended amounts ($n=8$). These were based on carer report with Korabek et al. (1981) an exception using direct meal measurement. All intervention approaches measured this outcome but used different measures. All studies identified intake volume increases, some at statistical significance (small–large effect) (Adams et al., 2012; Katseni et al., 2021; Taylor et al., 2017) with some also increasing food variety (medium–large) (Panerai et al., 2018; Seiverling et al., 2020).

Time was also considered within seven studies usually related to mealtime length ($n=5$). Although Adams et al. (2012) found a significant reduction in carer's reporting meals lasting longer than 30 minutes ($p=0.005$), all others found mixed or non-significant results. Korabek et al. (1981) identified that although intake increased effectively, so did mealtime length ($M=38$ minutes increased to $M=58$ minutes). Three studies measured food item consumption times with inconsistent findings. Gisel (1996) found non-significant improvements in eating and clearing times, although some group small-large effect sizes. Gisel et al. (1996) found mixed group results, and Pinnington and Hegarty (2000) non-significant changes. Potential other efficiency outcomes; oral nutrition supplementation and tube: Oral intake ratio were unreported within studies.

Three studies measured carer efficiency outcomes, with mixed findings. Colodny et al. (2015) found significant improvements for carer skills in facilitating child oro-motor skills (e.g. facilitating lip closure; $p<0.01$). However Katseni et al. (2021) found non-significant improvements in their diet quality index and Zuurmond et al. (2018) identified variability in food variety provision of their smaller observation sample.

Enjoyment

In contrast to the other clusters, enjoyment outcomes were more commonly carer outcomes ($n=9$ studies) than child ones ($n=7$). These were measured in carer training, behavioural intervention and two assessment and recommendation studies. The child outcomes used carer report typically ($n=5$) or observation ($n=5$) but never child self-report. The studies found multiple different statistically significant improved child mood measures (e.g. general mood, eating resistance, other mealtime behaviours) ($p=0.04$ -

<0.001) (Adams et al., 2012; Zuurmond et al., 2018), typically with medium–large effect sizes (Acar et al., 2022; Panerai et al., 2018; Seiverling et al., 2017, 2020; Taylor et al., 2017).

Seven studies, using all three intervention approaches, reported statistically significant improvements in parental mood using different outcomes and tools. Two studies examined general parent/carer mood. Ayça et al. (2021) found statistical significance demonstrated in all the WHOQoL-BREF subscales with medium–large effects for physical and psychological functioning, environment, and social relationship. Zuurmond et al. (2018) reported statistically significant changes on all the PedsQL-FIM sections, matched within interview findings. Others focussed on the mealtime itself (e.g. parental mealtime anxiety/stress reduced on self-developed tools; $p<0.001$ - $p<0.0001$) (Adams et al., 2012; Hettiarachchi & Kitnasamy, 2013). The AYCE measure gave small–large effect size outcomes for ‘aversion to mealtimes’ and ‘positive mealtime environment’ ratings (Seiverling et al., 2017; 2020). Three studies identified improved skills following carer training that could benefit child mealtime enjoyment (e.g. verbal communication) two significantly so ($p<0.008$ - $p<0.01$) (Colodny et al., 2015; Harding & Halai, 2009).

Summary

Across studies child and carer outcomes were consistent with the desired effect except for rare occasions. Only two results (1%) were unable to be determined, four (2%) results were in the opposite direction of aimed effect, and five (2%) were mixed results. Carer outcomes were less reported (safety $n=5$, efficiency $n=3$, enjoyment $n=9$) but indicated improvements with statistical significance and/or a small–large effect size (66–100% of studies), except for carer skill efficiency outcomes (33%, $n=3$ studies). Child outcome results were strong for the small number of studies ($n=7$) reporting child enjoyment (100% of results at statistical significance and/or small–large effect size). Safety and efficiency child outcome results again mainly followed the desired effect, but fewer results reported at levels of statistical significance and/or suitable effect sizes (safety $n=48\%$, enjoyment $n=44\%$). Within efficiency although an increase in intake was evident (50% with small–large effect size, $n=10$ studies) the time results showed a mixed picture (e.g. slower mealtime; 43% $n=7$ studies).

Robustness of synthesis

Adherence to PRISMA guidance ensured the review followed a published framework with a search strategy targeting all available evidence. The heterogeneity of studies, outcomes, and quality limitations meant that limited data were available for synthesis.

Discussion

This PRISMA informed systematic review aimed to identify and evaluate mealtime interventions provided to carers; to change carer mealtime assistance behaviours, to improve child and carer outcomes. Encouragingly, 29 studies met criteria for inclusion and after quality rating 24 were included in the narrative synthesis. Studies ranged from a RCT to single case designs. Participants were variably described, particularly in relation to child impairment including oropharyngeal skill. The interventions provided varied considerably in multi/uni-disciplinary profession(s), approach (recommendations, carer training, or behavioural intervention), and amount; with limited intervention description such that replication would be unlikely. There was great heterogeneity in outcomes targeted and measures. Therefore, generalisability is to be considered with caution.

The small number of RCT ($n = 1$) and non-RCTs ($n = 4$) means the strength of the evidence is limited. This reflects historic findings including a Cochrane review (Morgan et al., 2012), identifying insufficient evidence from high-quality RCTs or non-RCTs, with NICE (2017) and Parr et al. (2021) coming to the same conclusion. It mirrors the limited research-evidence base for other childhood dysphagia interventions (e.g. gastrostomy feeding; Gantasala et al., 2013). However, by evaluating additional study designs alongside RCTs and non-RCTs we identified some evidence of intervention effectiveness for mealtime safety, efficiency, and enjoyment.

Encouragingly this review found a trend that intervention is better than none and all approaches can have positive outcomes. Interestingly Ayça et al. 2021 demonstrated differences in first vs. ongoing intervention, Katseni et al. (2021) suggested an improvement plateau after 6 months and seven other studies reported on participants' first ever intervention. Ideally school-aged children and their carers will have previously received effective intervention. Therefore these studies may not necessarily inform clinical practice for school-aged children requiring ongoing management (Morgan et al., 2024) (e.g. during puberty; with head and neck anatomical changes potentially increasing aspiration risk; Arvedson, 2013).

The child health safety improvements results are positive but were less frequently reported ($n = 5$ studies). For efficiency, oro-motor or oro-sensory skill outcomes had some positive results, mainly within single case design studies. The most consistent results were carer and child enjoyment outcomes with improved carers' safety (knowledge, skills, and confidence to support child). Positively, in relation to school-aged children, Harding and Halai (2009) demonstrated significant improvements despite some good baseline participant knowledge. Interventions did improve intake (efficiency) and nutrition (safety) with the best nutrition outcomes when studies provided additional medical and non-oral nutritional

support. This reflects that comprehensive MDT intervention is recommended (NICE, 2017; West, 2024), however the impact of each element is unknown. Notably sometimes targeting one outcome affected others (e.g. participants experienced increased nutrition but reduced efficiency with meal-times; Korabek et al. 1981) above the recommended 30 minutes maximum (Arvedson, 2013). To ensure interventions are truly effective; safety, efficiency, and enjoyment outcomes must all be considered.

Interventions also varied considerably in content. Dosage, intensity, and frequency were described either related to carer advice/training or child mealtime, but rarely both. Different levels all led to positive safety, efficiency, and enjoyment outcomes. Recently reported interventions delivered by health professionals, indicate positive oro-motor skill results but have also had different intensity levels, 5 times per day to once per week (Banzato et al., 2022; Khamis et al., 2023; Min et al., 2022). The considerable variability within our review prevented us determining which approach or dosage was most effective. With high dosage having child and carer burden and cost-effectiveness implications, this issue needs to be considered carefully with the right approach and dosage individualised by child and carer need.

Variability was also evident in the carer mealtime behaviours targeted. Some studies addressed one variable (e.g. food texture) with others targeting multiple variables, often individualised (e.g. positioning, communication, etc). Target direction also varied with the same carer behaviour (e.g. provide modified texture, used in both ways, i.e. compensation vs. habilitation, or not specified). Volkert et al. (2013) found offering larger food particles improved chewing ability as effectively as their behavioural prompts. This indicates the importance of considering and identifying the key targets to change and the right direction. Parr et al. (2021) found that parents and professionals were unaware of some carer behaviour target options and suggested a toolkit to help identification. The diversity of interventions and targets identified can be seen positively reflecting the wide variety of needs that children with oropharyngeal dysphagia have. Target selection and direction require individual, clinician-carer decision-making; based on comprehensive, holistic assessment. The positive outcomes from the studies identified could guide clinicians as they create practice-based evidence.

TIDieR framework (Hoffmann et al., 2014) mapping highlighted theoretical basis differences in studies using medical/child development or psychological/behavioural approaches, with a combination only twice (Bailey & Angell, 2005; Petersen & Ottenbacher, 1986). Studies providing carer training or with a behavioural theoretical basis, tended to report a higher behaviour change technique number (Michie et al., 2013). Across the studies, behaviour change technique use was low (1–17) despite 93

techniques available in the v1 taxonomy (Michie et al., 2013). The behaviour change techniques used were mainly advising and demonstrating how to perform mealtime assistance behaviours and restructuring the mealtime environment (e.g. providing oro-motor equipment). Interestingly, some potentially suitable behaviour change techniques (e.g. problem solving; i.e. help identify and overcome barriers to optimal mealtime assistance), reducing negative emotions (e.g. help manage the mealtime stress) were rarely or not used and could be considered in future.

Fidelity monitoring of the mealtime intervention provided and/or carer adherence was limited. Encouragingly, carer training intervention studies all evaluated maintenance, changed behaviour in hypothetical scenarios or generalisation to practice/impact on child/carers outcomes with positive findings (Adams et al., 2012; Carvalho et al., 2013; Colodny et al., 2015; Harding & Halai, 2009; Hettiarachchi & Kitnasamy, 2013; Zuurmond et al., 2018). This evaluation step has been reported absent within adult and child disability clinical practice (Chadwick et al., 2014; Charpentier et al., 2020).

Review evidence limitations

This review's included studies were very heterogeneous in relation to study design, intervention approach, and dosage (one to multiple sessions per day), participants (child, family/paid carer-child(ren), carer), and participant diagnostic/oropharyngeal impairment. High variability in the participant characteristics description including neurodisability type (e.g. historic terminology such as 'handicapped' (Sobsey & Orelve, 1984), limited reporting of impairment or functional level, co-occurring conditions, and variable oropharyngeal dysphagia description (e.g. feeding and eating disorder), makes it difficult to be confident that studies have comparable children. The studies using intensive behavioural approaches tended to have less participant diagnostic or impairment level description, making it unclear whether their oro-motor difficulties were associated with reduced experience/opportunity and/or neurogenic oropharyngeal dysphagia. Additionally, the wide-ranging participant outcomes alongside multiple measures for one outcome (e.g. weight) made data comparisons and synthesis difficult.

Generally, sample sizes were small making it difficult to complete statistical analysis, with insufficient power. Frequently included studies just met the criteria of >25% school-aged children or included additional interventions. Although 24 studies met quality rating for synthesis, quality could be improved in the delivery and reporting of these studies.

Review method limitations

The lack of funding for translation means that two potentially relevant articles were excluded from this

review. Double screening for records was used but for quality rating and data extraction only a sample was double coded. This may have reduced rigour but is common practice and suitable for time-constrained studies. This review did not extract all potential diversity characteristics, however, typically un-extracted items (e.g. socioeconomic status) were not reported. It was frequently difficult to code intervention carer behaviours targeted, due to the wide-ranging terminology used and no single framework available. Peer reviewed literature (Morgan et al., 2012; Parr et al., 2021; West, 2024) and textbooks all use different approaches to categorise oropharyngeal dysphagia interventions and/or targets. The FEEDS toolkit list (Parr et al., 2021) and a Cochrane review framework (Morgan et al., 2012), were both initially trialled, however without category definitions they were not easy to implement. Therefore, a bespoke framework was developed that had face validity with the authors and a small speech-language pathology stakeholder group. The TiDieR (Hoffmann et al., 2014) rating was likely impacted by solely using the peer-reviewed records, not manuals if in existence, but still revealed study details.

Clinical implications

Mealtime interventions appeared better than no intervention and can be delivered to a carer to support child eating and drinking skills at mealtimes. Providing family/paid-carers with recommendations and training can impact child and carer outcomes positively. However, healthcare professionals need to be aware of complexity when providing mealtime interventions (e.g. focusing on multiple carer behaviour targets). Considerations include: How are health professionals selecting and prioritising carer behaviour mealtime targets (e.g. environmental vs texture change) and in what direction (e.g. compensation or habilitation) and how do they include other interventions (e.g. tube feeding, activities separate from the mealtime, psychological support; Parr et al., 2021)? In addition, if delivering intervention to family/paid-carers, have they considered which behaviour change techniques (Michie et al., 2013) they use (e.g. credible source), information on how to perform the behaviour, and whether additional ones could be effective? Are they considering delivery modality (e.g. accessible written information; Morgan et al., 2018), on-site vs. online (Morgan et al., 2024; Tamura et al., 2023)? Furthermore, high income context professionals could consider adapting low-resource setting interventions (Harris et al., 2020) (e.g. the most common carer training study location).

Future research

This review has highlighted the need for well designed, well described, and reproducible intervention studies into carer directed mealtime

interventions when supporting school-aged children with oropharyngeal dysphagia. Thorough descriptors for participant characteristics and classification scales usage to describe child participant impairments (e.g. GMFCS (Palisano et al., 1997), EDACS (Sellers et al., 2014), and/or others should be incorporated. Despite the availability of multiple frameworks describing the intervention behaviour targets, a functional one is needed to inform practice and research going forward. Identifying the barriers and enablers carers experience in providing mealtime assistance would support behavioural change technique selection to optimise interventions. Additionally, the development of a child and carer core outcome set for mealtime interventions with an integrated core measure set is required to ensure study comparability. The importance of both child and carer outcomes is evident, including child self-report. In the context of heterogeneous participants and interventions (e.g. personalised targets) n-of-1 designs (Tate et al., 2015) continue to have merit but require study and intervention reporting rigour.

Conclusion

This systematic literature review aimed to identify, describe, and synthesise the evidence on mealtime interventions provided to carers of school-aged children with oropharyngeal dysphagia, including their effectiveness. The review found three types of interventions (assessment and recommendations, carer training, and intensive behavioural intervention) with multiple intervention targets. All provided positive outcomes for mealtime safety, efficiency, and enjoyment for children and carers. The level of study designs included suggests that evidence is low, but encouraging. This synthesis should enable clinicians to consider which intervention approach and targets they could select for children within their own caseload and highlights the need for future research that uses consistent participant descriptions and a core outcome set.

Notes

1. Family/paid-carers deliver the intervention but are not necessarily a participant within the study.
2. Rated using NIH B-A because although planned at NRCT results combined groups due to attrition.
3. Additional information in additional study report Cross-McClintic et al. 1994
4. Additional information in additional study report Donkor et al.(2019)
5. Additional information in additional study report Gisel et al. (1995)
6. Group 1 (Pre, mid, post), Group 2 & 3: Pre, pre2, post).
7. Started intervention at mid-point measures.
8. Additional information in additional study reports Pinnington and Hegarty (1999) Pinnington and Hegarty (1994)
9. Age for participants with complete data only reported.
10. Sex for participants with complete data only reported.

11. IG: 25M, 20F CG: 26M, 20F.
12. Epileptic Encephalopathy term used in report.
13. Muscle Diseases term used in report.
14. IG: Mean = 29.6y SD = 8.0 CG: Mean = 31.9y SD = 4.6.
15. IG: 15F CG: 2M, 13F.
16. Chronic non-progressive encephalopathy term used in report.
17. Post2 n = 19, (n = 8-10 for videos) with numbers of video clips: Pre: n = 35, post n = 32, post2 n = 30).
18. Down's syndrome term used in report.
19. Convulsive syndrome term used in report.
20. Hydrocephalus and psychomotor delay used in report, N of each diagnosis not reported.
21. Number of participants eligible for inclusion & able to be extracted separately, total participants n = 10 in study.
22. Neurodisability diagnosis unable to extracted separately based on n = 10 in study.
23. Number of participants eligible for inclusion & able to be extracted separately, total participants n = 14 in study.
24. Rett syndrome term used in report.
25. Additional information in additional study report Cross-McClintic et al. (1994)
26. N = 24 orally fed.
27. Chromosomal disorder & Down Syndrome terms used in report.
28. Developmental delay & Spina bifida terms used in report.
29. Mental retardation term used in report.
30. Learning disabilities term used in report.
31. Number of participants eligible for inclusion & able to be extracted separately, total participants n = 56 in study.
32. Age reported for all participants (n = 52).
33. Sex reported for all participants (n = 52).
34. Intellectual disability term used in report.
35. Neurological problems, Obsessive compulsive disorder, Spina Bifida Traumatic brain injury.
36. Additional information in additional study report Donkor et al. (2019).
37. >40y n = 19, 30-40y n = 29, >40y n = 16.
38. IG: Mean = 32.0y SD = 0.76 CG: Mean = 2.97 SD = 0.91.
39. Number of participants eligible for inclusion & able to be extracted separately, total participants n = 9 in study.
40. Additional information in additional study report Gisel et al. (1995).
41. Aspiring group (Group 3), Non-aspiring (NA) group n = 20 (Group 1: n = 10, Group 2 n = 10).
42. Group 3: 5.4y SD = 2.7.
43. Group 1 4.8y SD = 1.4, Group 2: 5.0y SD = 1.9.
44. Group 1: 3M, 7F Group 2: 4M, 7F.
45. Results also reported for pre2-post intervention (after wait list).
46. 0-2y n = 10, 2-5y n = 15, 5-12y n = 32, 12-18y n = 11.
47. Congenital hyper/hypotonia (n = 8), Guillain-Barre (n = 1).
48. Number of participants eligible for inclusion & able to be extracted separately, total participants n = 18 in study.
49. Additional information in additional study reports Pinnington and Hegarty (1994), Pinnington & Hegarty (1999).
50. Of n = 16 SD = 2.75 of n = 20.
51. Acquired brain injury (n = 2), Metabolic condition (n = 1).
52. N = 17 received feeding therapy & oral dietary supplements, n = received feeding therapy.
53. Central nervous system abnormality (n = 8), Congenital infection (n = 6), Foetal alcohol syndrome (n = 2), Prematurity with/out intraventricular haemorrhage (n = 11), Perinatal asphyxia (n = 3), Pervasive developmental delay (n = 4).
54. n = 21 Oro-motor or pharyngeal dysfunction, n = 14 aversive feeding behaviour.
55. Number of participants eligible for inclusion & able to be extracted separately, total participants n = 4 in study.
56. CHARGE syndrome used in report.

57. Spastic quadriplegia term used.
58. Number of participants eligible for inclusion & able to be extracted separately, total participants n = 4 in study.
59. IG n = 36 telehealth, n = 36 CG face to face intervention.
60. IG Mean = 4.0y SD = 2.9 CG Mean = 4.7y SD = 3.5.
61. Intellectual dysfunction term used.
62. Encephalitis, Muscular Dystrophy.
63. Number of participants eligible for inclusion and able to be extracted separately, total participants n = 2 in this study.
64. Developmental delay & prematurity.
65. Profound & multiple disability.
66. N = 19 school aged.
67. N = 9 subgroup interviewed for some results reported.
68. 4.2–15.3 Mean = 8.2y school aged <4y n = 5 > 18y n = 1.
69. 14M 5F school-aged.
70. Follow-up session amount not specified.
71. Four main sessions with regular group and individual feedback sessions.
72. 2.3 = Average/staff member.
73. However was experiential – role played feeding each other.
74. Michie et al. (2013).
75. See Supplemental Material 6 for list of all Behaviour Change Techniques.
76. Unable to specify a behaviour. See Supplemental Material 6 for description/further information.
77. Others included as ‘treatment as usual’. See Supplemental material 6 for more details.
78. Mean gain reported only.
79. Increase in protein but not fruit & vegetables.
80. Some longer, some shorter than 30 minutes.
81. Reported for both groups unless specified.
82. Greater increase in pre-pre2 than pre2-post.
83. Different results for subgroups.
84. Some participants changed from gelatin to raisins in trials (Increased texture takes longer).
85. Group C only pre-post (intervention after wait list control period).
86. Group B IG & C pre-post (intervention after wait list control period).
87. Group B IG pre-mid & pre-post.
88. Group C only pre-pre2 & pre-post.
89. Group A IG only (Group time increased).
90. All groups (Group C CG time increased).
91. Groups A IG & C (intervention after wait list control period).
92. Group B IG.
93. Group A IG (Group C time increased).
94. Group B IG.
95. Groups B IG & C (intervention after wait list control period).
96. Group A IG time increased.
97. Group A IG.
98. Group C CG pre2-post (intervention after wait list control period).
99. Increase, significant at mid NS at post.
100. Increase, significant at mid NS at post.
101. Participants did not receive textured food to demonstrate skill.
102. Did increase n in >90th centile band also.
103. Pre-intervention not reported.
104. Correct at pre-intervention.
105. Correct at pre-intervention.

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Data availability statement

Supplemental material is available including: Search terms used (1: EBSCO and 2: Ovid), 3: Table of the outcome clusters, outcomes and subcategories, 4: Table of excluded studies and reasons, 5: Table of intervention description using the TIDieR framework, 6: Table of intervention content (carer behaviours targeted and behaviour change techniques used), 7: Table of studies results, 8: Table of quality rating for single case designs rated using the RoBiNT, 9: Table of quality rating for RCTs and non-RCTs rated using the PEDro, 10: Table of quality rating for before-after studies with no control group rated using the NIH quality assessment tool. The data extraction table for this review will be available through FigShare following PhD thesis completion.

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