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A Systematic Review and Meta-Analysis of Randomized Clinical Trials on Behavioral Interventions for Oropharyngeal Dysphagia

Tshetiz Dahal (MBBS)
General Physician, Clinical Researcher and Writer
Lugansk State Medical University, Luhansk Oblast, 93000 Luhansk, Ukraine

Avinay Basnett, Anamika Sharma
Speech Language Pathologist and Audiologist
Dr. S.R. Chandrasekhar Institute of Speech and Hearing, Bangalore, India

Andi Lama Tamang (MBBS)
Kathmandu Medical College, Purano Sinamangal, Baburam Acharya Road, Kathmandu, Nepal, 44600
Corresponding Author: Tshetiz Dahal (MBBS)

ABSTRACT
Aim : *To evaluate the outcomes of psychotherapy in oropharyngeal dysphagia patients.*
Methods : *Four separate databases were searched in a systematic manner to find randomised controlled trials (CINAHL, Embase, PsycINFO, and PubMed). The Revised Cochrane risk-of-bias tool for randomized clinical trials (RoB 2) was used to evaluate the methodological quality of the eligible publications, after which random-effects meta-analyses were then undertaken.*
Results: *There were 37 studies listed in all. Overall, it was discovered that pre-post interventions had a significant, large impact size. All behavioural therapies and the traditional dysphagia treatment comparison groups were divided into three groups: compensatory, rehabilitative, and combined compensatory and rehabilitative interventions in order to compare different types of interventions. Overall, significant treatment effects that favoured behavioural interventions were discovered. Rehabilitative treatments and no dysphagia treatment, as well as combined interventions and compensatory standard dysphagia treatment, were found to have very substantial effect sizes. The Shaker exercise, chin tuck against resistance exercise, and expiratory muscular strength training all had significant, big effect sizes when compared to the standard dysphagia treatment.*
Conclusion: *The benefits of behavioural therapies on patients with oropharyngeal dysphagia are encouraging. However, because of the significant variability within trials, generalizations from meta-analyses should be used with care.*
Keywords: *Deglutition; Swallowing disorders; RCT; Intervention; Compensation; Rehabilitation*

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I. INTRODUCTION

Dysphagia is defined as a subjective sensation of difficulty or abnormality of swallowing. Oropharyngeal or transfer dysphagia is characterized by difficulty initiating a swallow. Swallowing may be accompanied by nasopharyngeal regurgitation, aspiration, and a sensation of residual food remaining in the pharynx. Oropharyngeal dysphagia (OD), often known as swallowing abnormalities, can be caused by a variety of underlying illnesses, including stroke, degenerative neurological diseases, and acquired brain injury. They could also be the result of adverse treatment outcomes, such as radiation therapy or surgical procedures performed on individuals with head and neck cancer. Between 2.3 and 16% of the general population has OD [1]. However, estimates of prevalence can range from up to 80% in patients with stroke and Parkinson's disease, up to 30% in those who have suffered traumatic brain injuries, and over 90% in those who have contracted community-acquired pneumonia [3, 2], depending on the severity of the underlying disease and the outcome measures used (such as instrumental assessment, screening, or patient self-report) [2]. Prevalence estimates for stroke and Parkinson's disease patients can reach 80%, those for traumatic brain injury patients can reach 30%, and those for patients with community-acquired pneumonia can reach over 90% [3]. Additionally, meta-

analyses have produced estimates of the combined prevalence of swallowing issues in cerebral palsy patients as high as 50.4% [4]. A person's health may suffer greatly from OD since dysphagia can cause dehydration, starvation, and aspiration pneumonia. The high disease burden of OD, which also presents a substantial societal challenge, is accompanied by a heavy psychological and social toll that lowers both patients' and carers' quality of life [5]. Surgical, pharmaceutical, and behavioural therapies may be used to treat OD. Bolus management and modification (e.g., adjusting the viscosity, volume, temperature, and/or acidity of food and drinks), motor behavioural techniques or oromotor exercises, general body and head postural adjustments, swallowing manoeuvres (e.g., manoeuvres to improve food propulsion into the pharynx and airway protection), and sensory and neurophysiologic stimulation (e.g., neuromuscular electrical stimulation [NMES]) are examples of behavioural interventions [6]. Over the past 20 years, more and more reviews on the effects of behavioural interventions on OD therapy have been published. Although there were no limitations on subject populations or study designs, only one systematic review [7] summarized the results of swallowing therapy as administered by speech and language therapists.

Additionally, while the majority of reviews have concentrated on certain intervention types and patient demographics, relatively few reviews have used criteria for research design (e.g., [8,9] solely including randomised controlled trials [RCTs], ranked as the highest level of evidence [10]). This systematic review sought to ascertain, using only the strongest available evidence (RCTs), the effectiveness of behavioural therapies in individuals with OD. Any intervention made by a dysphagia specialist that is not surgical or pharmaceutical falls under the category of behavioural therapies. Speech therapists, occupational therapists, and physiotherapists are some of the clinicians who are referred to as dysphagia experts, while additional specialties may be included based on national healthcare and educational systems. Finally, the use of neurostimulation techniques was deemed beyond the scope of this review.

II. METHODS

The Content Validity Items for Systematic Reviews and Meta-Analyses (PRISMA) statement and checklist served as the foundation for this systematic review's methodology and reporting. To improve the crucial and transparent reporting of systematic reviews, the PRISMA 2020 declaration and checklist (Supplementary Tables S1 and S2) have been developed [11,12]. The international prospective register of systematic reviews, PROSPERO, received the protocol for this study and registered. To identify studies, literature searches were conducted on 6 March 2021, across these four databases: CINAHL, Embase, PsycINFO, and PubMed. Publications dates ranged from 1937–2021, 1902–2021, 1887–2021, and late 1700s–2021, respectively. Additional searches included checking the reference lists of eligible articles. Electronic search strategies were performed in all four databases using subheadings (e.g., MeSH and Thesaurus terms) and free text terms. Two strings of terms were combined: (1) dysphagia and (2) randomised controlled trial. The full electronic search strategies are reported in Table 1.

Table 1: Search Strategies.

Database and Search Terms	Number of Records
Cinahl: ((MH "Deglutition") OR (MH "Deglutition Disorders")) AND (MH "Randomized Controlled Trials")	**239**
Embase: (swallowing/OR dysphagia/) AND (randomization/or randomized controlled trial/OR "randomized controlled trial (topic)"/OR controlled clinical trial/)	**4550**
PsycINFO: (swallowing/OR dysphagia/) AND (RCT OR (Randomised AND Controlled AND Trial) OR (Randomized AND Clinical AND Trial) OR (Randomised AND Clinical AND Trial) OR (Controlled AND Clinical AND Trial)).af.	**231**
PubMed: ("Deglutition" [Mesh] OR "Deglutition Disorders" [Mesh]) AND ("Randomized Controlled Trial" [Publication Type] OR "Randomized Controlled Trials as Topic" [Mesh] OR "Controlled Clinical Trial" [Publication Type] OR "Pragmatic Clinical Trials as Topic" [Mesh])	**3039**

Criteria for Inclusion and Exclusion

The following requirements were used to determine whether a participant met the inclusion criteria: (1) participants had an OD diagnosis; (2) behavioural interventions were intended to reduce feeding or swallowing issues; (3) studies included a comparison group; (4) participants were assigned randomly to one of the study arms or groups; and (5) studies were written in English. Drooling, self-feeding, gastro-oesophageal reflux, and oesophageal dysphagia (such as dysphagia brought on by esophageal cancer or esophagitis) studies were not included. Studies describing drug-induced swallowing issues, transient swallowing issues brought on by oedema following surgery (such as anterior cervical discectomy), or swallowing issues linked to unfavourable outcomes of interventions like inflammation and oedema brought on by recent radiotherapy (three months after intervention) or thyroidectomy were also excluded. Studies that only discussed the removal of feeding tubes following intervention and did not provide information on issues with swallowing or feeding were also

disregarded. This review did not include any studies on behavioural eating disorders such bulimia, anorexia, or picky eating. Finally, only original research was included, leaving out things like reviews, doctorate thesis, and conference abstracts.

III. Systematic Review

Methodological Quality and Risk of Bias

The methodological calibre of the included studies was evaluated using the Revised Cochrane risk-of-bias instrument for randomised trials (RoB 2) [13]. A framework for assessing the risk of bias in the conclusions of any kind of randomised experiment is provided by the RoB 2 tool. The tool is divided into five categories that could lead to bias in study results: (1) randomization; (2) variations from intended interventions; (3) missing outcome data; (4) assessment of the outcome; and (5) choice of the reported result.

Data Collection Process

Methodological quality, participant diagnosis, inclusion criteria, sample size, age, gender, intervention goal, intervention agent/delivery/dosage, intervention condition, outcome measures, and treatment outcome were the categories from which data were extracted from the included studies using the data extraction form.

Data, items, and result synthesis

All titles and abstracts were examined for eligibility by two separate raters before original articles were considered. Consensus among raters was used to decide which studies to include. Before grading the remaining abstracts, two group meetings were held to discuss and reach consensus on the ratings of one hundred randomly chosen records. When the first two raters were unable to agree, a third person was contacted to make decisions. Two separate researchers also assessed the methodological quality, and when necessary, a third reviewer was brought in to establish an agreement. Since none of the reviewers had any official or informal relationships with any of the authors of the included research, there was no obvious bias in the selection of articles or the methodology used to rate the quality of the studies, either.Reviewers did not at this point eliminate trials depending on the type of intervention (e.g., behavioural intervention, neurostimulation). Data points from all trials were extracted during data collection utilizing thorough data extraction forms. Using RoB 2, the risk of bias was evaluated for each individual study [13]. Effect sizes and significance of findings were the primary summary metrics for evaluating treatment outcomes.

IV. META-ANALYSIS

To compare the effect sizes for the following, data were taken from pertinent studies. (1) Pre-post OD outcome measures, and (2) the mean difference in OD outcome measures between various behavioural intervention types from pre to post. All interventions were divided into four groups: combined compensatory and rehabilitative interventions, no dysphagia intervention, rehabilitative (such as oromotor exercises or Shaker exercise), and compensatory (such as body and postural changes, or bolus modification). Only studies that used an instrumental assessment (such as a fiberoptic endoscopic evaluation of swallowing [FEES] or a videofluoroscopic swallow study [VFSS]) to confirm OD were included. Meta-analyses could include outcome measures based on clinical non-instrumental assessments and visuoperceptual evaluations of instrumental examinations.

However, instrumental assessment was preferred above non-instrumental assessment outcome data if both types of data were provided. Oral intake measures, screening tools and patient self-report measures were excluded from meta-analyses. Measures other than the authors' primary outcomes may have been selected if these measures helped to reduce heterogeneity between studies. Group means, standard deviations, and sample sizes for pre- and post-measurements were input into Comprehensive Meta-Analysis Version 3.3.070 [14] in order to compare effect sizes. Data were transformed into parametric data for meta-analyses if only non-parametric data (such as medians and interquartile ranges) were available. Studies involving various intervention groups' participants were examined independently. Only one study was included in the meta-analysis where studies employed the same subjects. Studies whose data were insufficient for meta-analyses had their authors contacted by email to request more information. Using a random-effects model, Comprehensive Meta-Analysis calculated effect sizes. Studies were unlikely to have similar real effects since participant characteristics, intervention strategies, and outcome assessments varied. The spread of effect sizes around the mean was evaluated using the Q statistic, and the ratio of real variance to total variance was estimated using the I2 statistic. I2-values under 50%, between 50% and 74%, and over 75%, respectively, signify low, moderate, and high heterogeneity [15]. Using the Hedges g formula for standardized mean difference with a confidence interval of 95%, effect sizes were calculated and interpreted using Cohen's d convention: $g \leq 0.2$ as no or negligible effect; $0.2 < g \leq 0.5$ as minor effect; $0.5 < g \leq 0.8$ as moderate effect; and $g > 0.8$ as large effect [16].

Pre-post behavioural interventions produced forest plots of impact sizes for OD outcome scores. It was not possible to compare a homogenous behavioural intervention group to a comparison group without a behavioural component due to blended topologies of intervention groupings across studies. To investigate effect sizes as a function of different moderators, only a subgroup between group analysis (and not an overall between group analysis) was carried out. The effectiveness of behavioural therapies (compensatory, rehabilitative, or mixed compensatory and rehabilitative interventions) was evaluated in comparison to those of no dysphagia therapy groups or conventional dysphagia treatment (CDT). Other subgroup analyses were conducted to compare effect sizes between selected interventions (i.e., Shaker exercise, Chin Tuck Against Resistance exercise [CTAR], and Expiratory Muscle Strength Training [EMST]), medical diagnoses, and outcome measures. Only between-subgroup meta-analyses were conducted using post-intervention data, to account for possible spontaneous recovery during the period of intervention.

Publication bias was evaluated using Comprehensive Data Analysis software after passing the fail-safe N test and Begg and Muzumdar's rank correlation test. The standardised effect size and the variances of these effects are ranked in connection by the Begg and Muzumdar's rank correlation test [17]. A two-tailed p value and tau are produced by this statistical process; values of zero denote no relationship, whereas deviations from zero denote a relationship. If asymmetry is brought on by publication bias, then large effect sizes would be correlated with high standard error. If larger impacts are provided by low values, tau would be positive, whereas larger effects are portrayed by high values, tau would be negative. The fail-safe N test determines the maximum number of effect-size-zero studies that could be included in the meta-analysis before the findings become no longer statistically significant. That is, the quantity of omitted research necessary to reverse the effect [18]. There is grounds for concern if this figure is insignificant. However, if this number is high, it is possible to say with certainty that the treatment effect is present even though it may have been overstated due to the removal of some trials.

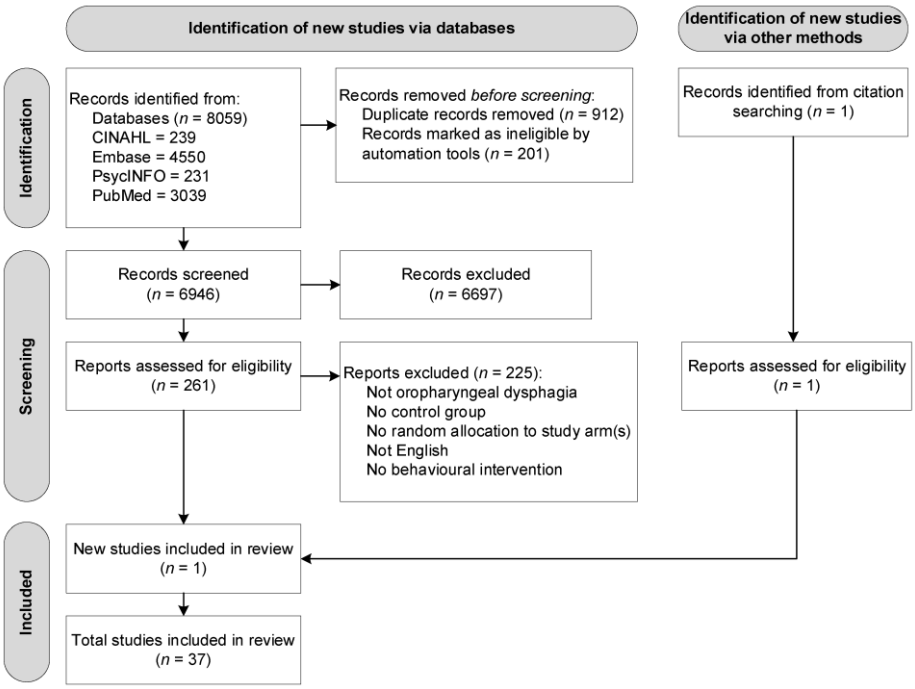
V. RESULTS

Study Selection

Four databases, CINAHL (n = 239), Embase (n = 4550), PsycINFO (n = 231), and PubMed (n = 3039), yielded a total of 8059 studies. A total of 6946 records were left after duplicate titles and abstracts were removed (n = 1113). 261 original papers were found after titles and abstracts were examined. To confirm that all inclusion requirements were met, full-text records were accessible. Since this systematic review only reports on behavioural therapies, publications were split into distinct types of interventions during full-text assessment. After 36 publications met the criteria for inclusion, one study was found by checking the references of the articles that had been included. The PRISMA-compliant flow diagram of the article selection process is shown in Figure 1.

Description of Studies

All 37 included studies are described in detail in Table 2 and Table 3. Table 2 reports on study characteristics, definitions and methods of diagnosing oropharyngeal dysphagia, and details on participant groups. Information such as medical diagnosis, sample size, age and gender, is provided on all study groups. Table 3 presents intervention goals, intervention components, outcome measures and treatment outcome of each included study.



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Study : Country	**OD (Definition/Terminology; Diagnostic Measure/Method) Diagnosis Main Inclusion/Exclusion Criteria**	**Sample (N) Groups (*n*) a**	**Group Descriptive (Mean ± SD) (Age, Gender, Relevant Medical Diagnoses)**
Ayres, et al. [19] **: Brazil**	**OD:** Oropharyngeal dysphagia determined by FEES **Diagnosis:** PD **Inclusion:** PD and oro-pharyngeal dysphagia. **Exclusion:** Presenting language and/or hearing disorders that could complicate the understanding of intervention; diagnosis of dementia, or other neurological illnesses.	**n = 32:** **Experimental group:** Chin-down manoeuvre and swallowing orientation (*n* = 11) **Orientation group:** Swallowing orientation only (*n* = 7) **Control group:** No intervention (*n* = 14)	**Experimental group/Orientation group/control group** **Age years:** 62 (11.5)/64.5 (5.6)/62.8 (6.2) **Male:** 80%/66.7%/75% **Schooling:** 5.9 (4.1)/12 (9.1)/10.3 (8.4) **Time of disease:** 10.7 (4.7)/11.8 (8)/8.8 (6) **H & Y disability score:** 2.8 (0.8)/2.5 (0.7)/2.5 (0.8) **MOCA:** 21.9 (4.9)/20.5 (7.7)/21.2 (8.4) **PDQ-***39:* 41.4 (13.8)/38.7 (16.7)/36.5 (17.1) **BDI:** 13.8 (7.7)/17.1 (9.2)/14.7 (9.3) *FOIS:* 5.9 (1.3)/6.8 (0.5)/6.8 (0.4)

Table 2 : Study characteristics of studies on behavioural interventions for people with oropharyngeal dysphagia.

Carnaby, et al. [20] **: USA**	**OD:** Diagnosis of swallowing difficulty by speech pathologist, <85 on Hospital's dysphagia assessment **Diagnosis:** Clinician diagnosed Stroke, WHO definition **Inclusion:** Stroke < 7 days **Exclusion:** NR	**n = 306:** **UC** (n = 102) **Low intensity** (n = 102) **High intensity** (n = 102)	**High intensity/low intensity/UC: mean (SD)** **Age yr:** 69.8 (12.5)/72 (12.4)/71.4 (12.7) **Male:** 59%/58%/58% **Severity Barthel index** <15: 78%/78%/79% **Rankin score**>3: 85%/79%/83%

			Length hospital stay, days: 19.1/19.2/21.4
Carnaby, et al. [21] **: USA**	**OD:** Dysphagia on admission- score < 178 on MASA, no history of swallowing disability, head/neck surgery. **Diagnosis:** Sub-acute stroke confirmed by attending neurologist according to the WHO definition **Inclusion:** Able to adhere to behavioural treatment regimens **Exclusion:** NR	**n = 53:** **MDTP + NMES** (NMES; n = 18), **MDTP + sham NMES** (MDTP; n = 18) [Denoted as 'Carnaby et al. (2020a)' in Figure 4.] **UC** (n = 17) [Denoted as 'Carnaby et al. (2020b)' in Figure 4.]	**NMES/MDTP/UC: mean (SD)** **Age yr:** 62.7 (12.2)/70.6 (11.8)/64.3 (14.7) **Male:** 55%/44%/41% **Modified Rankin:** 4.5 (0.6)/4.46 (0.5)/4.56 (0.5) **Modified Barthel:** 5.3 (3.4)/5.5 (2.8)/5.6 (2.6) **Days post stroke:** 7.83 (3.9)/8.47 (7.17)/6.7 (5.1) **MASA score:** 157.8 (16.5)/154.62 (18.87)/158.4 **FOIS score:** 3.72 (1.44)/3.25 (1.61)/4.35 (1.8)
Choi, et al. [22] **: Korea**	**OD**: Dysphagia after stroke confirmed by VFSS **Diagnosis:** Stroke (method NR) **Inclusion:** No major cognitive deficit (MMSE >20), >fair grade on neck muscle testing, symmetric neck posture **Exclusion:** neck pain or neck surgery, poor general condition, severe communication problem, unstable medical condition, presence of a tracheostomy tube	**n = 32:** **Experimental–Shaker exercise (SE) and conventional dysphagia therapy** (CDT; n = 16) [Denoted as 'Choi et al. (2017a)' in Figure 4.] **Control–CDT** (n = 16) [Denoted as 'Choi et al. (2017b)' in Figure 4.]	**Experimental SE + CDT/control (CDT):** mean (SD) **Age yr:** 60.8 (10.9)/60.4 (10.5) **Gender** (male/female): 10/6/9/6 **Time since stroke onset months:** 3.4 (1.6)/4.1 (1.0) **PAS:** 4.6 (0.8)/4.9 (0.1) **FOIS:** 3.1 (1.0)/3.2 (0.68)
DePippo, et al. [23] **: USA**	**OD:** MBS, BDST, VFSS, speech pathologists determined dysphagia **Diagnosis:** Stroke by clinical history, neurologic examination CT/MRI **Inclusion:** 20–90 yrs, no history of oral or pharyngeal anomaly **Exclusion:** aspirated >50% of all consistencies,	**n = 115**, allocated to graded therapist treatment levels: **Group A** (n = 38) **Group B** (n = 38) **Group C** (n = 39)	Group A/Group B/Group C **Age yr:** 76/74.5/73 **Male/Female:** 22/16/19/19/27/12 **Mini-Mental State score:** 16 (12)/17 (10)/18 (10) **Barthel-ADL Mobility**: 37 (23)/48 (20)/46 (38) **Weeks post** stroke: 4.6/4.5/4.9
Eom, et al. [24] **: Korea**	**OD:** Dysphagia caused by a stroke, confirmed by VFSS **Diagnosis:** Stroke **Inclusion:** Age > 65, onset duration < 3 months, score ≥ 24 on MMSE. **Exclusion:** Presence of severe orofacial pain, significant malocclusion or facial asymmetry, unstable breathing or pulse, tracheostomy, aphasia or apraxia, inadequate lip closure	**n = 30:** Experimental- resistance expiratory muscle strength training (n = 15) Placebo group (n = 15).	**Experimental/Placebo** **Age yr:** 69.2 (4.1)/70.2 (3.6) **Male/Female:** 5/8/6/7 **PAS baseline:** 5.1 (0.8)/4.9 (0.6)
Gao and Zhang [25] **: China**	**OD:** VFSS evaluation **Diagnosis:** Chinese diagnosis guidelines for acute ischemic stroke, CT or MRI **Inclusion:** >60 yrs, positive Neill screening test, first-time cerebral infraction. **Exclusion:** unstable conditions, previous abnormality in mouth, throat or neck, multiple organ dysfunction syndromes, uncooperative patients, severe mental illness, complete or sensory aphasia	**n = 90:** **Control** (n = 30) [Denoted as 'Goa & Zhang (2017c)' in Figure 4.] **Shaker exercise** (n = 30 [Denoted as 'Goa & Zhang (2017a)' in Figure 4.] **Chin tuck against resistance** (CTAR; n = 30) [Denoted as 'Goa & Zhang (2017b)' in Figure 4.] [Figure 5: **Shaker–Control** denoted as 'Goa & Zhang (2017b)'; CTAR–Control: denoted as 'Goa & Zhang (2017a)]	**Control/Shaker/CTAR** **Age yr:** 71.1 (6.4)/71.1 (7.1)/70.9 (6.6) **Male:** 14/15/13 **Therapeutic course (day):** 12.2 (1.4)/13.0 (1.4)/ 13.0 (1.6)

Guillén-Solà, et al. [26] **: Spain**	**OD:** Dysphagia confirmed by VFSS score ⩾3 in 8-point PAS **Diagnosis:** Subacute ischemic stroke **Inclusion:** Stroke within 1–3 wks. **Exclusion:** Cognitive impairment and/or history of previous neurological diseases associated with dysphagia	**n = 62:** **Group 1:** control standard swallow therapy (SST) (n= 21), **Group 2:** SST + IEMT (n = 21) **Group 3:** SST + sham IEMT+ NMES (n = 20).	**Control/IEMT/NMES** **Age yr:** 68.9 (7.0)/67.9 (10.6)/70.3 (8.4) **Male:** 12 (57.1%)/16 (76.2%)/10 (47.6%) **Modified Rankin:** 3.7 (0.8)/3.9 (0.5)/3.6 (0.8) **Barthel Index:** 44.0 (18.5)/42.7 (14.6)/41.8 (12.2) **Stroke onset** (days): 9.3 (5.1)/10.8 (8.7)/11.0 (5.5) **FOIS:** 4.3 (0.6)/4.5 (0.5)/4.4 (1.0) **PAS:** 5.4 (2.3)/5 (2.7)/5.5 (2.2)
Hägglund, et al. [27] **: Sweden**	**OD:** Swallowing function assessed with timed water swallow test; diagnosed dysfunction when swallowing rate did not exceed 10 mL/s. **Diagnosis:** NR **Inclusion:** ≥65 yrs, No cognitive impairment, ≥3 days intermediate care. **Exclusion:** Patients receiving end of life care, moderate or severe cognitive impairment	**n = 116:** **Intervention:** Oral neuromuscular training (n = 49) **Control:** Usual care (n = 67)	**Control/Intervention** **Age yr:** 85/83 **Male:** 29 (43.3)/27 (55.1) **Dysphagia risk condition**: 32 (47.8)/25 (52.1) **Care moderate dependence:** 27 (40.9)/18 (36.7) **Swallowing rate** (mL/s): 4.10/5.31
Hägglund, et al. [28] **: Sweden**	**OD:** Swallowing dysfunction (pathological TWST test 4-weeks post-stroke) **Diagnosis:** Stroke **Inclusion:** First-time stroke and a pathological timed water swallow test. **Exclusion:** Inability to cooperate; neurological diseases other than stroke, known history of dysphagia prior to the stroke, prominent horizontal overbite (contra-indication due to the oral device's design), or hypersensitivity to the acrylate	**n= 40:** **Control group:** 5 weeks of continued of oro-facial sensory stimulation (n = 20) [Denoted as 'Hägglund et al. (2020b)' in Figure 4.] **Intervention group:** Oral neuromuscular training using oral device (Muppy®) for 5 weeks + oro-facial sensory vibration stimulation (n = 20) [Denoted as 'Hägglund et al. (2020a)' in Figure 4.]	**Control/Intervention** **Age years:** 75 (56–90) yrs/75 (60–85) **Male** = 14/11; Female: 6/9. **Stroke type:** Ischemic (16 16); ICH= 3/4; ischemic and ICH = 1/0; left hemisphere = −6/7; right hemisphere = 10/10; supratentorial = 15/16; infratentorial = 3/4; supra- and infratentorial = 1/0. **Lowered consciousness at hospital admission:** 6/6

Hwang, et al. [29] **: Korea**	**OD**: OD confirmed by VFSS **Diagnosis:** Stroke **Inclusion:** Dysphagia <3 months, swallow voluntarily. **Exclusion:** trigeminal neuropathy, tongue deviation, facial asymmetry, communication disorders.	**n = 25:** **Experimental, tongue stretching exercises** (TSE) (n = 13) [Denoted as 'Hwang et al. (2019a)' in Figure 4.] **Control group** (n = 12) [Denoted as 'Hwang et al. (2019b)' in Figure 4.]	- **Experimental/Control** **Age (yrs):** 60.5 (12.5)/62.2 (10.3) **Male**: 6/5 **Time since stroke, weeks**: 8.2 (2.9)/9.1 (2.7) **Type of stroke** (n) **Haemorrhage**: 7/6 **Type of stroke** (n) **Infarction:** 4/4
Jakobsen, et al. [30] **: Denmark**	**OD:** Clinical signs of dysphagia; score ≥3 on PAS, FEES. **Diagnosis:** Severe ABI, non-sedated GCS <9, <24 hrs of injury **Inclusion:** 18–65 yrs **Exclusion:** formerly acquired or congenital brain damage, psychiatric diagnosis, history of treatment for head and neck cancer, need for a tracheostomy tube, agitated behaviour	**n = 10:** **Intervention facilitation of swallowing** (n = 5) [Denoted as 'Jakobsen et al. (2019a)' in Figure 4.] **Control basic care + usual treatment** (n = 5) [Denoted as 'Jakobsen et al. (2019b)' in Figure 4.]	**Control/Intervention** **Age yrs:** 45.6 (37.5–57.8)/53.8 (41.8–61.4) **Male:** 4/2 **Days from injury:** 70.4 (43.0)/76.4 (21.8) **GCS at injury** (3–15 points): 6.8 (4.4)/6.0 (5.2)
Jang, et al. [31] **: Korea**	**OD:** Swallowing difficulty VFSS-patients who showed velopharyngeal incompetence (VPI) on VFSS were enrolled **Diagnosis:** Subacute stroke **Inclusion:** Diagnosis of subacute stroke **Exclusion:** Previous stroke, pharyngeal structural abnormalities, unable to cooperate	**n = 36:** **Study-conventional therapy + mechanical inspiration, expiration exercise** (n = 18) [Denoted as 'Jang et al. (2019a)' in Figure 4.] **Control-conventional therapy only** (n = 18) [Denoted as 'Jang et al. (2019b)' in Figure 4.]	**Study/Control** **Age yrs:** 67.3 (9.5)/71.15 (8.6) **Male,** n: 10/9 **Stroke type,** n **Haemorrhage**: 8/6 **Days from stroke onset**: 20.5 (13.6)/18.4 (12.5)
Jeon, et al. [32] **: Korea**	**OD:** Swallowing dysfunction/dysphagia as determined by VDS and PAS scores on VFSS **Diagnosis:** Stroke disease **Inclusion:** MMSE-K score ≥19 points; stroke disease duration ≥6 mths and <2 years **Exclusion:** Altered neck posture. VitalStim contraindications or cardiopulmonary disease.	**n= 34:** **Experimental group:** NMES + upper cervical spine mobilization (n = 17) **Control group:** NMES and sham mobilization (n = 17)	**Experimental/Control** **Age yrs:** 63.12 (13.5)/64.47 (8.43) **Male:** 11/6; 11/6 **Side of stroke (left/right):** 6/11; 7/10 **Haemorrhage/infarction:** 14/3/12/5 **Weight:** 69.11 (11.95); 65.55 (12.66) **K-MMSE (point):** 24.53 (2.62)/24.2 (2.91) **K-NIHSS (point):** 10.41 (3.06)/10.76 (3.75)
Kim, et al. [33] **: Korea**	**OD:** Dysphagia defined as a disorder that causes difficulty with chewing and swallowing food **Diagnosis:** Stroke **Inclusion:** Diagnosed with dysphagia between May and July 2014; Symptoms of dysphagia for 6 months prior to treatment; 24 points or higher on MMSE- K; fair grade of manual muscle testing of neck flexors. **Exclusion:** Heart/internal/musculoskeletal disease	**n= 26:** **Experimental group:** PNF short-flexion neck exercises (n= 13) **Control group:** Shaker exercise (n= 13)	**Experimental/Control** **Age yrs:** 63.2 (10.2)/63.6 (8.1) **Male:** 8/5; 7/8 **Side of stroke (right/left):** 7/6/7/6
Kim and Park [34] **: Korea**	**OD**: Dysphagia confirmed by VFSS **Diagnosis:** Diagnosed as having had stroke within 6 months post-onset **Inclusion:** Liquid aspiration or penetration on VFSS, nasogastric tube able to communicate, no cognitive deficit **Exclusion:** Secondary stroke, gastronomy tube, tracheostomy, neck or shoulder pain,	**n = 30:** **Experimental group**, mCTAR exercise and traditional dysphagia treatment (n = 12) **Control group**, only traditional (n = 13)	**Experimental/Control** **Age yrs:** 63.5 (5.5)/65.2 (6.2) **Male:** 6/6 **Type of stroke–haemorrhage:** 5/7 **Side of stroke (right/left):** 5/7/4/9 **Facial palsy:** 1/1 **Dysarthria:** 1/0

	cervical herniated nucleus, cervical spine orthosis or brainstem stroke		
Koyama, et al. [35] **: Japan**	**OD:** Stroke related dysphagia, hypopharyngeal residue found by VFSS **Diagnosis:** Stroke **Inclusion:** able to perform real or sham exercise **Exclusion**: Level 1 to 4 on FOIS, pulmonary aspiration with 2 mL of barium water in VFSS, past or present temporomandibular joint disease and/or tumor in head or neck, past or present progressive disease	**n = 12:** **Intervention, modified jaw opening exercise** (MJOE; n = 6) **Control, isometric jaw closing exercise** (n = 6)	**Intervention/control** **Age yrs:** 66.0 (9.3)/71.8 (7.6) **Male:** 5/5 **Post-onset weeks, mean (SD)**: 6.7 (2.1)/9.2 (4.0) **FOIS**, n, Level 5/Level 6: 3/3/4/2
Krajczy, et al. [36] **: Poland**	**OD:** Level 1–3 or 5–7 on SRS **Diagnosis:** Ischaemic stroke- using the National Institutes of Health Stroke Scale **Inclusion:** Early post-stroke (first stroke) period (<30 days) **Exclusion:** 2nd or 3rd stroke, level 1–3 dysphagia or level 5–7 dysphagia according to SRS, cognitive function disorders, total aphasia, anarthria, bilateral facial nerve paralysis, tracheostomy	**n = 60:** **Study, original dysphagia treatment** (n = 30) **Control** (n = 30)	**Study/Control** **Age yrs**: 55–65 (3.3)/55–65 (1.5) **Male**: 12/14 **Paresis, right side**: 15/12
Kyodo, et al. [37] **: Japan**	**OD:** Dysphagia determined by endoscopic swallowing evaluation **Diagnosis:** Elderly patients with moderate-to-severe dysphagia. Diagnosis: NR **Inclusion:** Patients hospitalized between May 2017 and Sept 2018 who underwent endoscopic swallowing evaluation **Exclusion**: Patients ≥65 years old; the presence of an acute infection; patients who developed cerebrovascular disease, myocardial infarction, aspiration pneumonia within 2 weeks	**n= 62** (randomized crossover trial): **Control group:** Pureed diet without gelling agent **Intervention group:** Pureed diet with gelling agent	**Total sample** **Age years:** 83 (9) **Male/female**: 36/26 **Height (cm):** 153.4 (6) **Weight (kg):** 51.8 (5) Concurrent medical conditions: **Aspiration pneumonia:** 22 (35%) **CVA:** 19 (31%) **Other:** 21 (34%) **Hyodo-Komagane Score** **Mild** 0–3: 8 (13%) **Moderate** 4–7: 35 (56%) **Severe** 8–9: 19 (31%)
Logemann, et al. [38] **: USA**	**OD:** Speech pathologist referral after swallow screening, patient aspirating thin liquids. **Diagnosis:** Physician's diagnosis of dementia or PD. Bedford Alzheimer Nursing Severity Scale; neurologist rated PD using Hoehn and Yahr scale. **Inclusion:** 50–95 yrs **Exclusion:** Inability to perform chin down intervention	**n = 742** All patients received all 3 interventions (random order): Chin-down intervention Nectar Honey-thickened liquids	**Age range:** 50–79, 41% **Age range**: 80–95, 59% **Male:** 70% **PD–No dementia**: 32% **PD–Dementia:** 19% **Dementia–Other**: 19% **Dementia–Single or multistroke:** 15% **Dementia–Alzheimer's**: 15%
Manor, et al. [39] **: UK**	**OD:** Referred to speech pathologist for evaluation of swallowing disturbances, confirmed via FEES. **Diagnosis:** PD had been diagnosed according to the UK Brain Bank criteria **Inclusion:** Diagnosis as above **Exclusion:** History of other uncontrolled neurological or medical disorders interfering with swallowing	**n = 42:** **Experimental group** - received video-assisted swallowing therapy (VAST; n = 21) **Control group-conventional therapy** (n =21)	**Vast/Conventional therapy** **Age yrs:** 67.7 (8.3)/69.9 (9.7) **Disease duration (years)** 7.4 (4.7)/8.8 (5.7) **Disease severity** (H&Y-1–5) 2.2 (0.8)/2.2 (0.8) **MMSE score** (range 0–30) 28.1 (1.6)/27.8 (1.5) **Swallowing disturbances questionnaire**: 14.7 (5.8)/14.3 (7.2) **Fiberoptic endoscopic evaluation of swallowing:** 0.7 (0.4)/0.6 (0.4)
Mepani, et al. [40] **: USA**	**OD:** Post deglutitive dysphagia, pharyngeal phase dysphagia, VFSS to confirm **Diagnosis:** Stroke or chemoradiation for head and neck cancer	**n = 11:** **Traditional swallowing therapy** (n = 6) [Denoted as	**Traditional/Shaker** **Age years:** 70.5 (9.5)/64 (22.8) **Males:** 5 (83%)/3 (60%) **Etiology of dysphagia:**

	Inclusion: Pharyngeal phase dysphagia, incomplete UES opening and post-deglutitive aspiration, hypopharyngeal residue, able to comply with protocol, dysphagia with aspiration of at least 3 month duration **Exclusion:** History of pharyngeal surgical procedures excluded.	'Mepani et al. (2009a)' in Figure 4] **Shaker Exercise** (n = 5) [Denoted as 'Mepani et al. (2009b)' in Figure 4.]	**CVA**: 4 (67%) 2 (40%) **Cancer:** 2 (33%) 3 (60%)
Moon, et al. [41] **: Korea**	**OD:** Aspiration or penetration, oropharyngeal residue, confirmed VFSS. **Diagnosis:** Subacute stage 3–12 weeks after the onset of stroke **Inclusion:** Diagnosis as above, could follow instructions provided, score of > 21 on Mini Mental State Exam, decreased lingual pressures with either anterior or posterior tongue as 40 kPa **Exclusion**: Non-stroke patients with dysphagia.	**n = 16:** **TPSAT plus traditional dysphagia therapy** (n = 8) [Denoted as 'Moon et al. (2018a)' in Figure 4.] **Control, traditional dysphagia therapy** (n = 8). [Denoted as 'Moon et al. (2018b)' in Figure 4.]	**TPSAT/Control** **Age years:** 62.0 (4.2)/63.5 (6.1) **Male:** 3/4 **Stroke type (ischemic/hemorrhagic)**: 6/2/6/2 **Poststroke duration days:** 56.0 (17.4)/59.9 (20.0) **MMSE:** 22.87 ± 2.47 23.50 ± 2.00
Park, et al. [42] **: Korea**	**OD**: Dysphagia confirmed by VFSS Diagnosis: Stroke **Inclusion:** Onset within 6 months; score ≥24 on the MMSE **Exclusion**: Stroke prior to that resulting in dysphagia, severe orofacial pain, significant malocclusion or facial asymmetry, unstable breathing or pulse, tracheostomy, severe communication disorder, inadequate lip closure	**n = 27:** **Experimental group, Expiratory muscle strength training (EMST)** (n = 14) **Placebo sham** (n = 13)	**Experimental/Placebo** **Age years:** 64.3 (10.7)/65,8 (11.3) **Male n:** 6/6 **Time since onset weeks:** 27. 4 (6.3)/26.6 (6.8)
Park, et al. [43] **: Korea**	**OD:** Dysphagia following stroke was confirmed by VFSS **Diagnosis:** Stroke **Inclusion:** Onset duration was <12 months, swallow voluntarily, MMSE score ≥20 **Exclusion**: Secondary stroke, severe communication disorder, pain in the neck region, unstable medical conditions, head and neck cancer	**n = 22:** **Experimental, chin tuck against resistance exercise** (CTAR; n = 11) [Denoted as 'Park et al. (2018a)' in Figure 4.] **Control group, only conventional dysphagia treatment** (n = 11). [Denoted as 'Park et al. (2018b)' in Figure 4.]	**Experimental/Control** **Age years:** 62.2 (17.3)/58.4 (12.5) **Male**: 6/4 **Infarction:** 7/6 **Time after stroke** (weeks): 37.2 (54 3)/14 (14.4) **Oral feeding:** 4/5 **Tube feeding:** 7/6
Park, et al. [44] : Korea	**OD:** OD after stroke by VFSS **Diagnosis:** Stroke based on computed tomography or MRI **Inclusion:** Inpatient, no significant cognitive problems (MMSE score > 24) **Exclusion**: Secondary stroke, trigeminal neuropathy, significant malocclusion or facial symmetry, para-functional oral habits, tongue strength could not be measured, severe communication disorders, neck pain or neck surgery, presence of tracheostomy tube	**n = 24:** **Experimental, effortful swallowing training** (EST; n = 12) [Denoted as 'Park, Oh et al. (2019a)' in Figure 4.] **Control, saliva swallowing** (n = 12). [Denoted as 'Park, Oh et al. (2019b)' in Figure 4.]	**Experimental/Control** **Age years:** 66.5 (9.5)/64.8 (11.2) **Male:** 6/5 **Stroke lesion middle cerebral artery:** 6/6 **Time since stroke onset, wks**: 24.4 (8.6)/25.7 (6.3)
Park, et al. [45] **: Korea**	**OD:** pharyngeal dysphagia confirmed through VFSS **Diagnosis**: Diagnosed as having stroke **Inclusion:** Within 6 months post-onset, nasogastric tube; absence of cognitive deficits. **Exclusion:** Secondary stroke, presence of other neurological, pain in the disc and cervical spine, cervical spine orthosis, presence of gastronomy tube, problems with the oesophageal phase of Dysphagia	**n = 37 patients**: **Experimental, game-based chin tuck against resistance exercise** (n = 19) [Denoted as 'Park, Lee et al. (2019a)' in Figure 4.] **Control, traditional head-lift exercise** (n = 18) [Denoted as 'Park, Lee et al. (2019b)' in Figure 4.]	**Experimental/Control** **Age years:** 60.9 (11.2)/59.5 (9.3) **Male** n: 13/10 **Type of stroke, haemorrhage**, n: 12/14 **Paretic side, right, n:** 11/13 **Time since stroke, months:** 3.60 (1.19)/3.85 (1.18)

Park, et al. [46] **: Korea**	**OD:** Dysphagia after stroke, by VFSS **Diagnosis:** Stroke due to hemorrhage or infarction **Inclusion**: <6 months of onset, liquid aspiration or penetration on VFSS; nasogastric tube; voluntary swallowing; coughing after water swallow test. **Exclusion:** Secondary stroke, difficulty in using both upper limbs, significant malocclusion or facial asymmetry, pain in the disc and cervical spine, limitations in opening jaw, use of cervical spine orthosis, tracheostomy, severe communication difficulties associated with dementia or aphasia, presence of gastronomy tube, problems with the oesophageal phase of dysphagia	**n = 40:** **Experimental, resistive jaw opening exercise** (RJOE (n = 20) [Denoted as 'Park et al. (2020a)' in Figure 4.] **Placebo group** (n = 20) [Denoted as 'Park et al. (2020a)' in Figure 4.]	**Experimental/Placebo** **Age years:** 62.1 (10.1)/61.8 (12.1) **Male:** 9/8 **Infarction:** 7/8
Ploumis, et al. [47] **: Greece**	**OD:** Dysphagia screening-at least one severe symptom, validated in Greek Ohkuma questionnaire **Diagnosis:** Hemiparesis following stroke **Inclusion:** Hemiparesis following stroke, at least one severe symptom of the validated Greek Ohkuma questionnaire **Exclusion**: Exclusion-Barthel Index >20, Motor Function Hemispheric Stroke Scale <25, history of OD.	**n = 70:** **Experimental group cervical isometric exercises** (n = 37) **Control** (n = 33)	**Experimental/Control** **Age years (all participants):** 52 (15) **Barthel Index:** 22.8 (2.4)/23.4 (2.7) **Motor function, Stroke Scale:** 22.8 (2.4)/23.4 (2.7) **Sagittal** C2-C7 Cobb **angle:** 16.9 (18.5)/14.0 (16.2) **Coronal C2-C7 Cobb angle:** 6.9 ± 5.3/6.2 ± 5.0 **VFSS Score:** 1.0 (0)/1.0 (1.0)
Sayaca, et al. [48] **: Turkey**	**OD:** 'Swallowing difficulties' determined with Turkish version of the eating assessment tool (T-EAT-10) **Diagnosis:** No neurological problems after neurologist's examination **Inclusion:** Over 65 yrs, adequate cognitive status. **Exclusion:** Head/neck conditions affecting swallowing	**n = 50:** **Proprioceptive neuromuscular facilitation** (PNF; n = 25) **Shaker exercises** (n = 25)	**Shaker/PNF** **Age years**: 69 (4.9)/67(2.1) **Male:** 10/10 **T-EAT**-10 scores: 3.5 (1.8)/3.6 (1.3) **Peak amplitude (μV):** 425.1 (170.7)/417.9 (143.0) **Swallow speed (secs):** 1.3 (0.3)/1.3 (0.3) **Swallow capacity (mL/sec):** 1.2 (0.1)/1.2(0.1) **Swallow volume (mL/sec)**: 1.3 (0.1)/1.3(0.1)
Steele, et al. [49] **: Canada**	**OD:** Dysphagia post stroke (VFSS) **Diagnosis**: Recent stroke (4–20 wks) **Inclusion:** Recent stroke, one repetition maximum posterior maximum isometric tongue-palate pressure measure <40 kPa at intake, stage transition duration if < 350 ms on at least one liquid barium swallow at intake VFSS **Exclusion**: Severe dysphagia with no functional opening of upper esophageal sphincter; pre-existing dysphagia or diagnoses of head and neck.	**n = 14:** **Experimental TPPT treatment arm** (n = 7) [Denoted as 'Steele et al. (2016a)' in Figure 4 .] **Comparison TPSAT treatment arm** (n = 7) [Denoted as 'Steele et al. (2016b)' in Figure 4 .]	**TPPT/TPSAT** **Age years, range:** 56–84/49–89 **Male:** 4/5 **Days post onset, range**: 28–126/33–150
Tang, et al. [50] **: China**	**OD:** Radiation-induced dysphagia and trismus by non-instrumental clinical assessment **Diagnosis:** Nasopharyngeal carcinoma (NPC) patients after radiotherapy **Inclusion:** Diagnosed as above **Exclusion:** Dysphagia or trismus as initial symptoms of NPC excluded	**n = 43:** **Rehabilitation group, routine treatment + 3 months rehabilitation therapy** (n = 22) **Control group, routine treatment** (n = 21)	**Rehabilitation group/Control group** **Age years (total sample):** 49.3 (11) **Male (total sample**), n: 32 **Postradiotherapy, years:** 4.6 (1.8)/4.8 (1.6) **Interincisor distance (IID), cm:** 1.9 (0.7)/1.8 (0.6)

Tarameshlu, et al. [51] **: Iran**	**OD:** Dysphagia based on DYMUS questionnaire (patient self-report) **Diagnosis:** Established diagnosis of MS according to McDonald's criteria **Inclusion:** 20–60 years, lack of acute relapse in past two months, no other conditions such as stroke **Exclusion**: severe reflux, dysphagia due to drug toxicity, pregnancy	**n = 20:** **Experimental (TDT), sensorimotor exercises and swallowing manoeuvres** (n = 10) [Denoted as 'Tarameshlu et al. (2019a)' in Figure 4.] **Usual Care (UC), diet prescription and postural changes** (n = 10) [Denoted as 'Tarameshlu et al. (2019b)' in Figure 4.]	-	**TDT/UC** **Age years:** 47.5 (12.9)/39.9 (9.7) **Male:** 2/5 **Disease Duration (years):** 6.8 (2.9)/6.1 (2.7) **Expanded Disability Status Scale:** 3.6(2.1)/3.2(2.5) **MS Type-Relapse-Remitting**: 4/7 **MS Type-Primary Progressive**: 4/1 **MS Type-Secondary Progressive:** 2/2
Troche, et al. [52] **: USA**	**OD:** Swallowing disturbance (screening followed by VFSS) **Diagnosis:** PD-diagnostic criteria of the UK Brain Bank **Inclusion:** 55–85 yrs, same PD medication, >24 MMSE. **Exclusion:** other neurologic disorders; head/neck cancer	**n = 60:** **Expiratory muscle strength training** (EMST; n = 30) **Sham** (n = 30)	- -	**EMST/Sham** **Age years:** 66.7 (8.9)/68.5 (10.3) **Male:** 25/22 **Hoehn & Yahr stage** 2.5: 8/13, stage 3: 14/8 **Unified Parkinson's Disease Rating Scale III motor total:** 39.4 (9.2)/40.0 (8.5)
Wakabayashi, et al. [53] **: Japan**	**OD:** Dysphagia, Eating Assessment Tool (EAT-10) score ≥3 points **Diagnosis:** NR (Community-dwelling, ≥65 yrs) **Inclusion:** Receiving long-term care via day-service or day-care program, mild cognitive impairment/dementia **Exclusion:** Severe or moderate dementia, inability to perform training	**n = 91:** **Intervention group, resistance training of swallowing muscles** (n = 43) **Control group** (n = 48)	- -	**Intervention/Control** **Age years:** 80 (7)/79 (7) **Male:** 19/28 **Tongue pressure(kPa)**: 23.3 (8.3)/23.3 (10.0) **EAT-10, median (IQR):** 7 (5–13)/8 (4–11) **Barthel Index:** 81 (9)/81 (21)
Woisard, et al. [54] **: France**	**OD:** Dysphagia- by Deglutition Handicap Index (DHI) **Diagnosis:** NR. (Sitting abnormality- by seated postural control measure, SPCM). **Inclusion** >18 years; DHI score >11, score >0 on 1 item SPCM, chronic dysphagia. **Exclusion**: NR	**n = 56:** **Group without device (D−) (n = 30)** [Denoted as 'Woisard et al. (2020b)' in Figure 4.] **Group with the device (D+)** (n = 26) [Denoted as 'Woisard et al. (2020a)' in Figure 4.]		**D-/D+** **Age years (total sample):** 61.5 (11.8) **Male,** n (total sample): 35 **Degenerative dysphagia, N (total sample)**: 24 **NIHSS**: 1.3 (1.4)/1.3 (1.6) **PAS:** 1.7 (1.3)/1.9 (1.9) **FOIS**: 6.0 (0.9)/5.8 (1.1)
Zhang and Ju [55] **: China**	**OD**: Swallowing dysfunction (water swallow test upon inclusion) **Diagnosis:** Stroke **Inclusion**: Swallowing dysfunction E**xclusion:** NR (admitted patients with dysphagia)	**n = 120:** **Intervention, nursing intervention** (n = 60) **Control, conventional nursing servic**e (n = 60)		**Control/intervention** **Age years:** 70.6 (7.4)/70.3 (7.4) **Males:** 33/32

A Terminology as used by author(s).

Notes. ABI = Acquired brain injury; BDI = Beck Depression Inventory; BDST = Burke Dysphagia Screening Test; CVA = cerebrovascular accident; DOSS = Dysphagia Outcome and Severity scale; FEES = Fiberoptic Endoscopic Evaluation of Swallowing; FOIS = Functional Oral Intake Scale; GCS = Glasgow Coma Scale; H&Y disability score = Hoehn and Yahr disability score; K-MMSE or MMSE-K = Mini-mental examination

Korean version; K- NIHSS = Korean version of National Institute of Health Stroke Scale; MASA = Mann Assessment of Swallowing Ability; MBS = Modified Barium Swallow; MIE = Minimally Invasive Oesophagectomy; MDTP = McNeill Dysphagia Therapy Program; MMSE = Mini-Mental State Examination; MOCA = Montreal Cognitive Assessment; NIHSS = National Institute of Health Stroke Scale; NMES = Neuromuscular Electrical stimulation; NR = Not reported; OD = Oropharyngeal dysphagia; PAS = Penetration-Aspiration Scale; PD = Parkinson's disease; P-DHI = Persian Dysphagia Handicap Index; PDQ-39: Parkinson's Disease Questionnaire-39; PNF = proprioceptive neuromuscular facilitation; RCT = Randomised Controlled Trial; SLP: Speech-Language Pathology; SRS = Swallowing Rating Scale; SSA = Standardized Swallowing Assessment; SIS-6 = Swallowing Impairment Score; SWAL-QOL = Swallow Quality-of-Life Questionnaire; tDCS = transcranial Direct Current Stimulation; UC = Usual Care; VDS = Video-fluoroscopic Dysphagia Scale; VFSS = Video-Fluoroscopic Swallowing Study; WHO = World Health Organisation; WST = Water Swallow Test; TWST = Timed Water-Swallow Test.

Table 3: Outcome of behavioural interventions for people with oropharyngeal dysphagia.

Study	Intervention Goal	Intervention Agent, Delivery and Dosage a	Materials and Procedures a	Outcome Measures	Treatment Outcome a
Ayres et al. [19]	To verify the effectiveness of a manoeuvre application in swallowing therapy in patients with PD.	Intervention agent: NR Dosage: Experimental group: chin-down manoeuvre and swallowing orientation: 4 sessions per week (30 min each). Orientation group: Swallowing orientation only: 4 sessions per week (30 min each).	Three groups: Experimental group: Chin-down posture manoeuvre (patient instructed to 'swallow lowering the head until chin touches in the neck'). Patients performed manoeuvre twice a day, swallowing saliva, during meals, throughout the week, at home. Patients were given a form to record the number of times the manoeuvre was performed at home. Patients also given instructions for optimal feeding and swallowing related to 'swallowing orientations': (1) environment during feeding (2) posture (3) meal-time (4) oral hygiene. Written instructions given. Orientation group: Patients also given instructions for optimal feeding and swallowing related to 'swallowing orientations': (1) environment during feeding (2) posture (3) meal-time (4) oral hygiene. Written instructions given. Control group: No intervention received during 4-week period. Written instructions given.	Primary outcomes: FEES; Clinical evaluation (checking 21 signs and symptoms of oropharyngeal dysphagia and rating these as present or absent); FOIS; SWAL-QOL.	Experimental group showed significant improvement in clinical evaluation of dysphagia compared to two other groups regarding solid ($p = < 0.001$) and liquid ($p = 0.022$). Analysis of FEES did not show differences between groups. Experimental group presented with significant improvement in scores of domains frequency of symptoms ($p = 0.029$) and mental health ($p = 0.004$) on the SWAL-QOL when compared with the groups that did not receive intervention.
Carnaby et al. [20]	Compare standard low-intensity and high-intensity behavioural interventions with usual care (UC) for dysphagia	Intervention agent: Speech pathologist (Low/high intensity); physician and speech pathologist when referred (UC) Dosage (average): Swallowing sessions = 8.1, treatment days = 15.3, duration of session = 21.6 min	UC (control): Physician management. Patient referred to hospital speech pathology if needed. Treatment- feeding supervision, safe swallowing. If prescribed–VFSS. Standard low-intensity: Swallowing techniques, environmental modifications (upright for feeding); safe swallowing advice (eating rate); dietary modification (speech pathologist, 3 times per wk for 1 month. Strategies VFSS. Standard high-intensity: Direct swallowing exercises (effortful swallow, supraglottic swallow technique), dietary modification (from speech pathologist, daily for 1 month. Swallowing exercises established by examination and VFSS.	Primary outcomes: retur n to pre stroke diet < 6 months Secondary outcomes: time to return to normal diet, proportion recovered, functional swallowing, dysphagia-related complications, died, were institutionalise d, or dependent in daily living 6 months post stroke.	Compared with usual care and low-intensity therapy, high-intensity therapy was associated with an increased proportion of patients who returned to a normal diet ($p = 0.04$) and recovered swallowing ($p = 0.02$) by 6 months.

Carnaby et al. [21]	Effectiveness and safety of exercise based swallowing therapy and neuromuscular electrical stimulation for dysphagia	Intervention agent: NMES & MDTP-Speech pathologists, >5 years dysphagia experience. UC-experienced therapist Dosage: 1 h/day × 3 wks (15 sessions)	McNeill Dysphagia Therapy Program (MDTP): Exercise-based swallowing-criteria for initial oral bolus materials for therapy and advancement on 11-step "food hierarchy". Simple swallowing. Clinicians monitor each swallow. Neuromuscular Electrical stimulation (NMES): VitalStim®-Active NMES/sham, common single electrode placement-midline above hyoid bone to superior to cricoid cartilage)-ascending amplitude until amplitude reached. Usual care treatment control (UC): Behavioural swallowing treatment strategies common in dysphagia treatment.	Primary outcomes: Ability to swallow (MASA), oral intake (FOIS). Secondary outcomes: Barium swallow outcomes, self-perceived swallowing, weight, time to pre-stroke diet, complications.	Post treatment dysphagia severity significant between groups ($p \leq 0.01$). MDTP greater change vs. NMES or UC for increased oral intake ($p \leq 0.02$), functional outcomes at 3-mnths (RR = 1.7, 1.0–2.8), earlier time for "return to pre-stroke diet" ($p < 03$).
Choi et al. [22]	Effects of Shaker exercise on aspiration and oral diet	Intervention agent: Caregiver (SE), occupational therapist (CDT) Dosage: 30 min/day, 5 days/wk × 4 wks	Shaker Exercise (SE): Isometric and isokinetic movements. 3 head lifts held for 60 s in supine; 60 s rest. 30 reps head lifts observe toes without raising shoulders-without hold. Conventional Dysphagia Therapy (CDT): Orofacial muscle exercises, thermal tactile stimulation, therapeutic/compensatory manoeuvres.	Primary outcomes: PAS from VFSS. Oral diet level by FOIS.	Experimental group greater improvement on PAS ($p < 0.05$) and FOIS ($p < 0.05$) vs. control group.
DePippo et al. [23]	Effect of graded intervention on occurrence of dysphagia related complications	Intervention agent: Dysphagia therapist (SLP?) Dosage: Bi-weekly session monitoring for all groups	Group A–Patient-managed diet. One session-therapist recommended diet based on MBS results and compensatory swallowing techniques. Patient chose diet (regular vs. graded). Group B–Therapist-prescribed diet (MBS) and swallowing techniques, evaluated every other week. Group C-Therapist prescribed diet and daily reinforcement of swallowing techniques through mealtime dysphagia group.	Primary outcomes: Dys phagia related complications: Pneumonia, dehydration, calorie-nitrogen deficit, recurrent upper airway obstruction, and death.	No significance between groups for time until end inpatient stay or to 1-year post. Only significance was patients in group B developed pneumonia sooner than group A.
Eom et al. [24]	Effect of resistance Expiratory Muscle Strength Training (EMST) on swallowing function	Intervention agent: NR Dosage: 5 days p/wk × 4 wks, 5 sets of 5 breaths on device × 25 p/day. Both groups treatment 30 min × 5 days/wk × 4 wk	Experimental group (EMST + Conventional treatment): Portal Expiratory Muscle Strength Trainer (EMST150). Patients opened mouth after inhalation, EMST mouthpiece between lips. Blew strongly and rapidly until pressure release valve within EMST device opens. Pressure release set to open if pressure target exceeded. < 1-min break after each session, for muscle fatigue and dizziness. Placebo group (Sham EMST + Conventional treatment): Trained using a sham non-functional EMST device with no loading device. Conventional treatment.	Primary outcomes: VDS and PAS based on a VFSS to analyse oropharyngeal swallowing function.	Experimental significant in VDS pharyngeal phase ($p = 0.02$ and 0.01) and PAS vs. placebo ($p = 0.01$). Both significant VDS all phases (all $p < 0.05$). Experimental only significant in PAS ($p = 0.01$ vs. 0.102).
Gao and Zhang [25]	Effects of rehabilitation training on dysphagia and psychological state	Intervention agent: NR Dosage: 3 sessions/actions performed morning, midday and evening. 7 days p/wk × 42 days	All patients received routine treatment including internal medicine, traditional rehabilitation and routine nursing. Control: Traditional tongue and mouth exercises. Each movement repeated 10 times as one session. Shaker exercise: Supine position, single action raised head to look at feet. 30 reps = set of actions.	Primary outcomes: Dysphagia: VF SS at baseline, 2, 4, 6 wks post. Swallowing function, PAS Psychological state: Self-	Degrees of dysphagia improvement, between 2–4 wks in CTAR and Shaker. Significantly higher in CTAR (87%) and Shaker (77%) vs. control (43%) (all $p < 0.05$). Significantly lower SDS in CTAR vs. Shaker/control 6 wks post (all $p < 0.05$).

			Perform 3 sets of actions-continuously or with 1-min relaxation until complete. (Denoted as 'Goa & Zhang, 2017a' in Figure 5.) Chin Tuck Against Resistance (CTAR) exercise: Patients seated tucking chin to compress inflatable rubber ball for 30 reps = set of actions. Perform 3 sets, continuously or with relaxation. (Denoted as 'Goa & Zhang, 2017b' in Figure 5.)	Rating Depression Scale (SDS) baseline, 6 wks post.	
Guillén-Solà et al. [26]	Effectiveness of inspiratory/expiratory muscle training (IEMT) and neuromuscular electrical stimulation (NMES)	Intervention agent: Occupational, speech, physical therapist Dosage: Control- 3 hrs p/day × 5 days wk × 3 wks. Group 2-2 × p/day, 5 days × 3 wks. Group 3–40-min daily sessions (5 days per wk × 3 wks)	Control/SST: Multidisciplinary inpatient rehabilitation for mobility, activities of daily living, swallowing and communication. Education self-management of dysphagia, oral exercises and compensatory techniques based on VFSS. EMST + SST: Inspiratory/Expiratory Muscle Training (EMST)-respiratory training, 5 sets of 10 respirations, 1 min unloaded recovery breathing, with therapist. Pressure 30% of maximal expiratory pressures increased weekly. NMES + Sham EMST + SST: Sham respiratory muscle training, fixed at 10 cmH2O. Neuromuscular electrical stimulation using VitalStim device. Supervision by speech therapist, electrodes on suprahyoid muscles 80 Hz of transcutaneous electrical stimulus, patients to swallow when felt muscle contraction.	Primary outcomes: Dysphagia severity by PAS. Respiratory muscle strength (maximal inspiratory and expiratory pressures). Post- and 3-month follow-up.	Maximal respiratory pressures most improved Group 2: treatment effect 12.9 (CI 4.5–21.2) and 19.3 (CI 8.5–30.3) for maximal inspiratory and expiratory pressures. Swallowing security improved in Groups 2 and 3. PAS and complications -no between group difference 3-months.
Hägglund et al. [27]	Effect of oral neuromuscular training among older people in intermediate care with impaired swallowing	Intervention agent: Dental hygienists and speech pathologist Dosage: NR	Intervention (IQoro® + Usual care): The device IQoro® was used for oral neuromuscular training. The device is designed to stimulate sensory input and strengthen the facial, oral, and pharyngeal muscles. Professionals provided training instructions. If participants had difficulties performing training, staff or family members were instructed on how to assist. Control (Usual care): Usual care with adjustments in food consistencies and posture instructions.	Primary outcomes: Swallowing rate (timed water swallow test) Secondary outcomes: Signs of aspiration during water swallow, swallowing related quality of life (QOL).	Swallowing rate significant improvement, intervention vs. controls post ($p = 0.01$), 6 months following ($p = 0.03$). Aspiration significantly reduced in intervention vs. controls ($p = 0.01$). QoL no between-group differences
Hägglund et al. [28]	To determine the effects of neuromuscular training on swallowing function in patients with stroke and dysphagia.	Intervention agent: Discipline NR Dosage: Neuromuscular training = 3 times per session and 3 times daily before eating Orofacial sensory vibration stimulation was performed 3 times daily before meals. 5 weeks of training in total.	Group A-Orofacial sensory-vibration stimulation: Patients received 5 weeks of continued oro-facial sensory vibration stimulation using an Oral B® electric toothbrush. Instructions given on how to stimulate the buccinator mechanism, lips, external floor, tongue. Group B-Orofacial sensory-vibration stimulation + oral neuromuscular training (Muppy®): Patients received oral neuromuscular training for 5 weeks + oro-facial sensory vibration stimulation 1) Oral device (Muppy®) was used for oral	Primary outcome: Changes in swallowing rate measured by the Timed Water Swallow Test (TWST). Secondary outcomes: changes in lip force measured by lip-force test + swallowing dysfunction as measured by VFS (in lateral	Swallowing rate: After intervention, both groups had improved significantly (Group B, $p< 0.001$; Group A, $p = 0.0001$) in TWST, but no significant between-group difference in swallowing rate. At 12 month follow-up, Group2 had improved significantly in swallowing rate compared to Group A ($p = < 0.032$) Lip force: Significant improvement in lip force in Group 2 ($p < 0.001$) compared to non-significant improvement in Group 1 ($p =$

			neuromuscular training that aims to stimulate sensory input and strengthen facial, oral, pharyngeal muscles. Muppy® is placed pre-dentally behind closed lips and pt sits in upright position. Patients hold device against a gradually increasing horizontal pulling force for 5–10 s whilst trying to resist the force by tightening the lips (2) oro-facial sensory stimulation of buccinator using electric toothbrush. Verbal, practical and written instructions about training given. Patient/caregiver reported training in a log-book. All patients in both groups self-administered or were assisted by relatives or ward staff in oro-facial sensory vibratory stim.	projection).	0.079). Improvement in Group 2 maintained at 12 month follow up.
Hwang et al. [29]	Effect of tongue stretching exercises (TSE) on tongue motility and oromotor function in patients with dysphagia after stroke.	Intervention agent: TDT/TSE by occupational therapists. Dosage: TSE–5 × p/wk × 4 wks. Stretching 20 × p/ day.	Control group: Traditional Dysphagia Treatment (TDT)- oral facial massage, thermal-tactile stimulation, compensatory skill straining. Both groups received TDT. Experimental group: +Tongue Stretching Exercise (TSE); dynamic/static stretching exercises (20 reps each). Dynamic-therapist pulled patient's tongue to end feel point of ROM and held for 2–3 s before guiding back to mouth. Static-therapist pulled tongue to end feel point, held 20 s.	Primary outcomes: Oro motor function-Oral phase events of VDS, VFSS Tongue motility-Distance from lower lip to tip of tongue during maximum protrusion of the tongue.	Experimental significant differences in tongue motility, bolus formation, tongue to palate, bolus loss, oral transit time-oral VDS phase ($p < 0.05$ for all). Control significant for lip closure only ($p < 0.05$).
Jakobsen et al. [30]	Effect of the intensification of the nonverbal facilitation of swallowing on dysphagia.	Intervention agent: Occupational therapist Dosage: 30 sessions (10-min rest, 20-min session, 10-min rest), 3 wks (2 × day).	Experimental treatment: Facial Oral Tract Therapy (F.O.T.T.) concept-rehabilitation intervention using structured tactile input and nonverbal facilitation techniques (to allow for effective function in meaningful daily life activities). Control group: Treatment comprised stimulating activities in the facial oral tract similar to those of the intervention group but without facilitation of swallowing or verbal request to swallow.	Primary outcomes: FOIS, PAS, and electrophysiological swallowing specific parameters (EMBI).	Intervention feasible. PAS and FOIS improved in both groups, no group differences. Swallowing specific parameters reflected clinically observed changes.
Jang et al. [31]	Effects of Mechanical Inspiration and Expiration (MIE) exercise using mechanical cough assist on velopharyngeal incompetence	Intervention agent: NR Dosage: 20 sessions Both groups, 30 min 2 × day, 5 × wk × 2 wks.	Study group MIE exercise: CNS-100 Cough Assist® and conventional swallowing rehabilitation. Inspiration- positive pressure 15–20 cm H2O, increased to 40 cm H2O for 2 s. Expiration–similar pressure 10–20 cm H2O above positive pressure; held 3–6 s, simulating airflow during cough. Patient coordinated respiratory rhythm to cough assist machine. Control: Conventional dysphagia rehabilitation of oral motor and sensory stimulation, NMES, oral exercises for safe swallow.	Primary outcomes: Swallowing function American Speech-Language-Hearing association scale, functional dysphagia score, and PAS, VFSS. Coughing function-peak cough flow.	Study group significant improvement in functional dysphagia score- nasal penetration degree. Nasal penetration degree and peak cough flow showed greater improvement in study vs. control group.
Jeon et al. [32]	To investigate the effects of NMES plus upper spine cervical mobilization on	Intervention agent: Joint mobilization was performed by a physical therapist (with over 160 h of	All interventions were performed in sitting position. NMES: Intervention group received upper cervical spine (C1–2) mobilization with	Primary outcome: Forward head posture measured by CCFT	The intervention group showed significantly better scores in CCFT ($p = 0.05$) and in CVA ($p = 0.05$) than in control group. PAS scores were

	forward head posture, and swallowing in stroke patients with dysphagia.	manual therapy education. NMES was delivered by 3 experienced OTs. Dosage: once a day, 3 × times a week, for 4 weeks; both groups received NMES for 30 min; experimental group received 10 min of upper cervical spine mobilization; control group received 10 min of sham mobilization.	NMES. Mobilization: Therapist used one hand to hold the subject's C1(atlas); other hand placed on subject's occiput. Mobilization force could not be standardised. NMES was applied to the suprahyoid using VitalStim®. Electrodes attached to the motor point of the suprahyoid muscles (digastric) to induce anterior excursion and vertical elevation movements of hyoid bone during normal swallowing. Stimulation was applied by gradually increasing the intensity to the level that patients felt a grabbing sensation in the neck without pain or laryngospasm. Control group: Patients received upper cervical spine sham mobilization combined with NMES.	(Stabilizer TM Pressure Biofeedback) and craniovertebral angle (CVA). Swallowing function measured by VFS and PAS.	significantly better in the intervention group compared to control group ($p = <0.05$). Significant increase in VFS total score and PAS than in the control group ($p = <0.05$)
Kim et al. [33]	The effects of Proprioceptive Neuromuscular Facilitation (PNF) on swallowing function of stroke pts with dysphagia	Intervention agent: NR Dosage: PNF-based short neck exercises 3 times a week for 30 min each time for 6 weeks	Experimental group: PNF Patients started by lying on a bed with head and neck positioned off the bed (tester supported left laryngeal region with his right hand and placed left fingertips below patient's jaw) Patient instructed to look at target object in a direction 15 degrees diagonally to the right side Tester then initiated given exercises by moving the patient's neck in a diagonal direction opposite to the direction specified Patient instructed to 'draw your jaw inward' and tester applied a level of resistance to the patients jaw to fully activate neck flexor below jaw (rotation to the right) Same exercises applied in opposite direction. Control group: Shaker exercise 1. Isometric exercises: Patients lay on bed and raised their heads without moving shoulders off the bed, looked at ends of their feet for 60 s, and then lowered heads back on the bed. If patient had difficulty raising his/her head, they were asked to perform same exercise for 3 times for as long as they could. Isotonic exercises: Patients raised their head in same posture and looked at the ends of their feet 30 consecutive times.	Primary outcome: New VFSS and ASHA NOMS Scales.	Statistically significant improvements in: premature bolus loss, residue in the valleculae, laryngeal evaluation, epiglottic closure, residue in pyriform sinuses, coating of pharyngeal wall after swallowing, pharyngeal transit time and aspiration on both new VFSS scale and ASHA NOMS scale ($p < 0.05$). Control group also demonstrated statistically significant improvements in premature bolus loss, residue in the valleculae, laryngeal evaluation, epiglottic closure, residue in pyriform sinuses, pharyngeal transit time and aspiration ($p < 0.05$). No statistically significant differences between the groups were found in new VFSS scale and ASHA NOMS scale.
Kim and Park [34]	Effect of modified chin tuck against resistance (mCTAR) exercise on patients with post-stroke dysphagia.	Intervention agent: Occupational therapist Dosage: 30 min × 5 days a week, for 6 weeks	Experimental group mCTAR exercise: PhagiaFLEX-HF device. Subject seated, fixed part of device to desk, firmly attach chin surface under chin. Exercise performed in isotonic/isometric. Isometric-holding chin down for 10 s against resistance (10 s, 3 times). Isotonic-30 × reps chin-down against resistance.	Primary outcomes: Aspiration and oral diet -PAS and FOIS. Secondary outcomes: Rate of nasogastric tube removal	Experimental statistically significant improvement in PAS and FOIS vs. control ($p < 0.001$). Rates of nasogastric tube removal were 25% (experimental) vs. 15% (control).

			Traditional dysphagia treatment (TDT): Oral facial massage, thermal-tactile stimulation and compensatory training.	was analyzed.	
Koyama et al. [35]	Feasibility and effectiveness newly developed Modified Jaw Opening Exercise (MJOE) in poststroke patients with pharyngeal residue.	Intervention agent: Speech pathologist/physician Dosage: 4 × sets daily, 5 × p/wk × 6 wks. (6 s × 5 reps = 1 set)	Intervention MJOE: Surface electrodes mandibular midline. Participants closed mouth, sitting position, pressed tongue against hard palate. Trainer hand under participant's chin and applied upward vertical resistance. Visual feedback given. Maintained 80% Maximum Voluntary Contraction (MVC). Control sham exercise isometric jaw closing exercise: Surface electrodes to masseter, visual feedback, 20% MVC.	Primary outcomes: VFSS was performed before and after exercise. The distance between the mental spine and the hyoid bone (DMH) and hyoid displacement (HD) were measured.	No temporomandibular joint or neck pain. Intervention group, DMH decrease where anterior HD ended and an increase in anterior HD were seen. Control, no changes.
Krajczy et al. [36]	Effects of dysphagia therapy in patients in the early post-stroke period.	Intervention agent: Physiotherapist Dosage: Physiotherapy program average 60 min × day, × 15 days	Control/both groups: Safe food education and neurological physiotherapy depending on patient dysfunction. Therapy included passive, assisted, supported and respiration exercises, erect posture, walking re-education, and training on NDT Bobath and PNF methods. Study group: +original dysphagia treatment, restoring chewing and swallowing functionality– Strengthening and breathing exercises and thermal stimulation.	Primary outcomes: Swallowing function - Timed test of swallowing Swallowing reflux – Controlled swallowing after swallowing blended food. Reflex categorized as good or delayed.	Swallowing reflux, Cough and voice quality and swallowing time, number of swallows and SpO2 All Statistically significant differences between groups after therapy (p = <0.01).
Kyodo et al. [37]	To evaluate the effectiveness of puree diets containing a gelling agent for the prevention of aspiration pneumonia in elderly patients with moderate to severe dysphagia.	Intervention agent: Gastroenterologists experienced in transnasal endoscopy along with a speech therapist evaluated swallowing. Discipline who created gelling agent (intervention) NR. Dosage (average): NR	Patients underwent endoscopic swallowing evaluation while sitting in a chair/sitting up in bed. Images of oropharynx and larynx were displayed on a monitor and recorded on digital video recorder. Pureed diet without gelling agent was made by mixing 100 g of white rice and 50 mL of water with a blender for one minute. Texture characteristics (IDDSI Level 4) were: hardness, 1760 ± 125 N/m2; cohesiveness, 0.59 ± 0.03; adhesiveness, 224 ± 56 J/m3. Pureed diet with gelling agent was made by mixing 100 g of rice porridge at > 70 degrees with 0.5 g of the gelling agent with a blender for one minute. Texture characteristics (IDDSI Level 4) were: hardness, 312 ± 11.3 N/m2; cohesiveness, 0.81 ± 0.02; adhesiveness, 108 ± 5.8 J/m3.	Primary outcome: Presence of material in throat using endoscopic cyclic ingestion score (0 to 4) Secondary outcomes: Sense of material remaining in the throat after swallowing of pureed rice and/or test jelly; degree of dysphagia using Hyodo-Komagane score (0 to 12: mild 0–3; moderate 4–7; severe 8–9)	Residuals in throat were significantly less likely with pureed rice with than without the gelling agent (median cyclic ingestion score (range); 1 (0–4) vs. 2 (0–4); p = 0.001. Irrespective of presence or absence of the gelling agent, the sense of materials in the throat was significantly less frequent in older patients (p = <0.01). No adverse events occurred.
Logemann et al. [38]	3 treatments for aspiration on thin liquids—chin-down posture, nectar-thickened liquids, or honey-thickened	Intervention agent: Speech pathologist Dosage: NR	Chin-down intervention: chin to the front of the neck, three swallows of 3 mL of thin liquid from a spoon and three swallows of the same liquid from an 8-oz cup filled with 6 oz of liquid. Nectar or Honey-thickened liquids: on the two thickened liquid interventions, three	Primary outcomes: Swallowing function-VFSS	49% aspirated all interventions, 25% not any. More on thin liquids despite chin-down posturing vs. using nectar-(p < 0.01) or honey-thickened (p < 0.01). More on nectar- vs. honey thickened (p <

	Liquids.		swallows of 3 mL of thickened liquid from a spoon and three self-regulated swallows, performed as separate swallows, each from an 8-oz cup filled with 6 oz of the thickened liquid.		0.01).
Manor et al. [39]	Effectiveness of visual information while treating swallowing disturbances in patients with PD.	Intervention agent: Speech and swallowing therapist Dosage: Each group 5 × 30 min sessions, during 2-wk period and a 6th session 4 wks after the 5th one	Control–conventional therapy: Both interventions swallowing exercises and compensatory therapy based on FEES. Compensatory strategies carried out with different food and liquid consistencies in clinic, patient practiced at home. VAST: video-assisted tool during each session, for educating and assisting understanding structure of swallowing. Patients observed a normal swallowing process and their distorted one. After learning compensatory technique, patient practiced it during drinking and eating in the clinic after observing video then at home. During next four sessions patients observed video with suitable compensatory swallowing technique while eating and drinking focusing on the new swallowing behaviour.	Primary outcomes: Swallowing function-by fiberoptic endoscopic evaluation of swallowing (FEES). Quality of life-quality of care and degree of pleasure from eating assessed by questioners	Significant improvement in swallowing functions both groups. FEES significantly greater reduction in food residues in pharynx in VAST vs. conventional treatment group. SWAL-QOL scores significant between groups favour of VAST: burden, eating desire, social functioning, mental health, symptom frequency ($p < 0.01$).
Mepani et al. [40]	Effect of the Shaker exercise on thyrohyoid muscle Shortening improve pharyngeal dysphagia	Intervention agent: Speech pathologist Dosage: Biweekly 45-min therapy sessions for 6 weeks.	Traditional therapy: 5 times daily. Laryngeal and tongue ROM exercises and swallowing manoeuvres (Super-Supraglottic Swallow, Mendelsohn Manoeuvre, Effortful Swallow). Shaker Exercise: 3 times per day for 6 weeks. Isometric and isokinetic head-lift in supine position. Patients raised head high and forward to observe toes. Isometric–3 times head lifts held 60 s, 60-s rest period. Isokinetic-30 head lifts at constant velocity, performed without holding or rest periods.	Primary outcomes: Change in thyrohyoid muscle shortening by Videofluoroscopy	After therapy, the percent change in thyrohyoid distance in the Shaker Exercise group was significantly greater vs. traditional therapy ($p = 0.034$).
Moon et al. [41]	Effects of Tongue pressure strength and accuracy training (TPSAT) on tongue pressure strength, swallowing function, and quality of life in stroke patients with dysphagia.	Intervention agent: Occupational therapist Dosage: TPSAT and traditional dysphagia therapy 30 min × day; Only traditional therapy performed 30 min × twice daily. Both groups, daily 5× times wk × 8 wks.	Both groups received standardized physical/occupational therapies. Traditional dysphagia therapy: thermal tactile stimulation, Mendelsohn manoeuvre, effortful swallow, diet modification. TPSAT with traditional dysphagia treatment: TPSAT consisted of an anterior and posterior isometric tongue strength exercise and an isometric tongue accuracy exercise. The protocol involved five sets of tongue-to-palate presses, 6 reps per set for each session. Isometric tongue accuracy exercise, amplitudes were set at 50, 75, 100% of maximum pressure from first isometric strength. Participants generated precise pressures within 10 kPa error for each amplitude.	Primary outcomes: Tongue pressure strength - maximum isometric tongue pressures (MIPs) of anterior, posterior tongue using Iowa Oral Performance Instrument. Swallowing function-MASA; QoL-SWAL-QOL	TPSAT with traditional dysphagia significantly improved MASA, SWAL-QOL, and MIPs. Traditional dysphagia significantly increased MASA, SWAL-QOL, and MIPs anteriorly ($p < 0.05$). TPSAT significant in anterior, posterior MIPs, tongue movement MASA, vs. controls ($p < 0.05$).
Park et al. [42]	Effects of EMST on the activity of suprahyoid muscles, aspiration and	Intervention agent: Occupational therapist Dosage: 5 days × wk × 4 wks. 5 sets × 5 breaths on device, 25	Experimental group: resistance set at 70% range of MEP (Maximal Expiratory Pressure). Subjects open mouth following maximum inhalation, EMST mouthpiece between lips, close mouth. Blow	Primary outcomes: Activity in the suprahyoid muscle group - using surface	Experimental significantly more in suprahyoid muscle activity ($p = 0.01$), liquid PAS ($p = 0.03$) and FOIS ($p = 0.06$), but not

	dietary stages in stroke patients with dysphagia.	breaths per day.	strong and fast until pressure release valve in EMST device opens-expiratory pressure exceeded set target. Placebo group: training using sham device-non-functional device, little effect of physiologic load on targeted muscles.	electromyography (sEMG). PAS used to assess VFSS results. Dietary stages-FOIS.	semisolid type PAS (p = 0.32), vs. placebo.
Park et al. [43]	Effect of chin tuck against resistance exercise (CTAR) on the swallowing function in patients with dysphagia following subacute stroke.	Intervention agent: Occupational therapist Dosage: 30 min × day, × 5/wk, × 4 wks	CTAR: Isometric CTAR, patients chin tuck against device 3 × 60 s no repetition. Isotonic CTAR, patient 30 reps by strongly pressing against resistance of the device and releasing it. Therapist demonstrated exercise methods. Conventional dysphagia treatment: Both groups -orofacial muscle exercises, thermal tactile stimulation, and therapeutic or compensatory manoeuvres.	Primary outcomes: Swallowing function - Functional Dysphagia Scale (FDS) and PAS, based on VFSS	Experimental more improvement in oral cavity, laryngeal elevation/epiglottic closure, residue in valleculae, and residue in pyriform sinuses of FDS and PAS compared vs. controls (p < 0.05, all).
Park et al. [44]	Effects of Effortful Swallowing Training (EST) on tongue strength and swallowing function in patients with stroke.	Intervention agent: Occupational therapist Dosage: Training 30 min, 5× days per wk × 4 wks. Both groups conventional dysphagia treatment 30 min/day, 5 days/wk × 4 wks.	Experimental EST: Patients pushed tongue onto palate, squeezing neck muscles, swallow forcefully. Performed 10 times p/session, 3 sessions p/day. Effortful swallowing confirmed by therapist through visual observation and palpation. Control group: Swallow naturally without intentional force. Patients given small spray of water to induce swallowing, and rest. Both groups received conventional dysphagia therapy (compensatory techniques -chin tuck, head tilting, rotation; therapeutic techniques - orofacial muscle exercises, thermal tactile stimulation using ice sticks, expiratory training).	Primary outcomes: Tongue strength-Iowa Oral Performance Instrument. Oropharyngeal swallowing function VDS, based on VFSS.	Experimental group greater improvements in anterior and posterior tongue strength vs. control (p = 0.05 and 0.04), and greater improvement in oral phases of VDS (p = 0.02).
Park et al. [45]	Effects of game-based Chin Tuck against resistance exercise (gbCTAR) and head-lift exercise on swallowing function and compliance in dysphagia post-stroke	Intervention agent: Occupational therapist Dosage: 5 × wk × 4 weeks. Traditional dysphagia treatment (TDT) 30 min per day	Experimental group: performed gbCTAR exercise LES 100 device. Before gbCTAR exercise, 1-RM measured for resistance values. 1-RM, resistance bar placed directly beneath jaw, and chin tuck directed against resistance. gbCTAR exercise at threshold of 70% 1-RM, divided into isometric and isotonic exercises, combined with the game. Control group: head lift exercises in supine (isometric and isotonic). Both groups TDT- oral facial massage, thermal-tactile stimulation and compensatory training.	Primary outcomes: Swallowing function-VDS and PAS. Dietary assessment-FOIS Compliance with the 2 exercises-(motivation, interest, physical effort, fatigue), numerical rating self-report scale.	No significant between group difference in VDS, PAS, FOIS. Compliance, motivation and interest Scores significantly higher, and scores for physical effort needed and fatigue significantly lower, in experimental vs. control.
Park et al. [46]	Effect of Resistive Jaw Opening Exercise (RJOE) on hyoid bone movement, aspiration, and oral intake level in stroke patients.	Intervention agent: Occupational therapist Dosage: 30 min × 5 times wk × 4 wks.	Experimental group: RJOE device to provide resistance to suprahyoid muscles. Isometric exercise, 30 s with device resistors pressed downward (3 times, 30–60 s of rest). Isotonic exercise repeatedly depressed by RJOE by holding device resistance down for 2–3 s then returned to original state (10 reps, 3 sets) with 30 s rest. Placebo group: RJOE using 1-mm thick device with almost no resistance to suprahyoid muscles. Exercise type and frequency of	Primary outcomes: Hyoid bone movement -by two-dimensional analysis of anterior and superior motion on VFSS. Aspiration-PAS Oral intake level-FOIS.	Both groups significant differences in hyoid movement, PAS, FOIS (p< 0.05). No significant difference between groups except for liquid type, PAS. Effect sizes (Cohen's d) 0.6–1.1 for anterior, superior movement of hyoid bone, semisolid and liquid type of PAS, and FOIS respectively.

			RJOE same as experimental group. Both groups received conventional dysphagia therapy after intervention, which involved orofacial muscle exercises, thermal tactile stimulation and therapeutic or compensatory manoeuvres.		
Ploumis et al. [47]	Evaluate cervical isometric exercises in dysphagic patients with cervical spine alignment disorders due to hemiparesis after stroke.	Intervention agent: Allied health Dosage: inpatient 12 wks, speech 30 min daily. Experimental- 4× reps 10 min, 3× day, 12 wks.	All patients -inpatient program including physiotherapy, occupational and speech therapy. Speech included deglutition muscle strengthening, compensatory techniques. Experimental group: +plus cervical isometric strengthening exercises contract neck muscles under resistance forward-backward-sidewards). Control group: Regular speech therapy plus sitting balance.	Primary outcomes: Cervical spine radiographs in erect (sitting/standing) position coronal, sagittal C2-C7 Cobb angle, VFSS to evaluate deglutition.	Experimental group- more pronounced correction ($p < 0.01$) of cervical alignment in both planes and greater improvement ($p < 0.05$) of deglutition too, than control group.
Sayaca et al. [48]	Whether combined isotonic technique of Proprioceptive Neuromuscular Facilitation (PNF) is superior to Shaker exercises in improving function of swallowing muscles.	Intervention agent: Shaker 'CS' (?). PNF physiotherapist Dosage: Each exercise set 1 x per day, 3x wk x 6 wks.	Shaker exercises: isometric (3 reps) and isotonic contractions (30 reps) neck flexor muscles. Patients raised head to observe toes without raising shoulders. Isometric- lifted head, held for 1-min 3 times, 1-min rest. Isotonic- lifted head 30 reps, no holding. PNF: Combined isotonic technique- concentric, stabilizing and eccentric contraction without relaxation. Stabilizing contractions to improve control, force, coordination, and eccentric contraction. Moved head against resistance with open mouth- kept position for 6 s against resistance in seated position; kept position while physiotherapist moved back to initial position. 30 reps per day.	Primary outcomes: Swallowing difficulties Turkish Eating Assessment Tool (T-EAT-10). Capacity, volume, and speed of swallowing-100 mL-water swallow test. Contraction amplitude changes-motor unit activity, by superficial electromyography.	T-EAT-10 decreased both groups ($p < 0.001$). Water swallowing capacity and volume improved both groups ($p < 0.001$). No change in swallowing speed both groups ($p > 0.05$). Maximal voluntary contraction of suprahyoid muscles higher in PNF vs. Shaker ($p < 0.05$).
Steele et al. [49]	Compare outcomes of two tongue resistance training protocols	Intervention agent: Speech pathologist Dosage: 24 sessions (TPPT or TPSAT), 2–3× wk, 8–12 wks. 60 tongue-pressure tasks per session.	Tongue-pressure profile training (TPPT): emphasized pressure-timing patterns that are typically seen in healthy swallows by focusing on gradual pressure release and saliva swallowing tasks. Tongue- pressure strength and accuracy training (TPSAT): emphasized strength and accuracy in tongue-palate pressure generation and did not include swallowing tasks.	Primary outcomes: Posterior tongue strength, oral bolus control, penetration–aspiration and vallecular residue- VFS, PAS	Both groups significant tongue strength and post-swallow vallecular residue with thin liquids. Stage transition duration (bolus control), PAS no significant differences.
Tang et al. [50]	Effect of rehabilitation therapy on radiation-induced dysphagia and trismus in nasopharyngeal carcinoma (NPC) patients after radiotherapy.	Intervention agent: Therapists, assistants Dosage: Rehabilitation group, exercises 3× per day, each 15 cycles, 45 cycles per day.	Both groups routine treatment. Rehabilitation group: training by therapists at hospital, continued at home post-discharge by exercise booklet, guardian oversight and calendar Exercises: Tongue-range of motion exercises included passive and active movement exercises. Pharynx and Larynx- exercises changing body position to maximize swallow function and minimize aspiration. Swallow manoeuvres included effortful swallow and Mendelsohn manoeuvre. Sensory procedures utilizing pharyngeal cold stimulation performed by	Primary outcomes: Severity of dysphagia- water swallow test Trismus- LENT/SOMA score and the interincisor distance (IID).	Rehabilitation group only significant improvement in swallowing function. Percentage of patients with effective results in rehabilitation higher than control ($p = 0.02$). Control IID significantly decreased at Post ($p = 0.001$), both groups decreased at 3 months, rehabilitation group less than controls ($p = 0.004$). Trismus in rehabilitation higher vs. control ($p = 0.02$).

			therapists. Exercise for Trismus- Active jaw movements- opening/closing mouth repeatedly, opening mouth slightly, moving lower mandible to left and right, stretched chin downward and forward and a range of passive jaw movements. Control group: No rehabilitation exercises Both groups received routine treatment (e.g., anti inflammatory treatment for aspiration pneumonia)		
Tarameshlu et al. [51]	Effects of Traditional Dysphagia Therapy (TDT) on swallowing function in Multiple Sclerosis (MS) patients with dysphagia.	Intervention agent: Therapist Dosage: both groups 6 weeks, 18 sessions, 3 × per week, every other day.	Traditional Dysphagia Therapy (TDT): Includes oral motor control, range of motion exercises, swallowing manoeuvres, strategies to heighten sensory input. Usual care (UC): postural changes, modifying volume and speed of food presentation, changing food consistency and viscosity, and improving sensory oral awareness.	Primary outcomes: Swallowing ability- Mann Assessment of Swallowing Ability (MASA) Secondary outcomes: PAS and PRRS.	Groups improved MASA, PAS and PRRS ($p < 0.001$). All significantly greater in TDT vs. UC group. Large effect size MASA in TDT ($d = 3.9$) and UC ($d = 1.1$).
Troche et al. [52]	Treatment outcome of device-driven EMST on swallow safety, physiologic mechanisms through measures of swallow timing and hyoid displacement.	Intervention agent: Clinician Dosage: EMST, 4 weeks, 5 days per week, for 20 min per day, using a calibrated or sham, handheld device.	Expiratory muscle strength training (EMST): device set to 75% of participant's average MEP. Visited weekly by clinician-instructed to wear nose clips, deep breath, hold cheeks lightly, blow hard into device, identify air was flowing freely through device (once reached threshold pressure). Sham: Sham device identical to EMST device, pressure release valve non-functional and to 75% of participants' average MEP-no physiologic load to muscles.	Primary outcomes: Swallow function- judgments of swallow safety, PAS scores, swallow timing, and hyoid movement from VFS images.	EMST improved swallow safety, PA scores vs. sham. EMST improvement of hyolaryngeal function during swallowing, findings not evident for sham group.
Wakabayashi et al. [53]	Effects of resistance training of swallowing muscles in community dwelling older individuals with dysphagia.	Intervention agent: Research co-workers Dosage: intervention exercises for 10 s; 1 set = 10 reps. 2 sets per day 3× per wk × 3 months	Control/both groups: dysphagia brochure (about oral hygiene, tongue resistance exercise, head flexion exercise against manual resistance, nutrition, and food modifications). Intervention: resistance exercises for swallowing muscles involving tongue resistance exercise and head flexion against manual resistance. Research co-workers instructed participants once how to perform resistance training.	Primary outcomes: Improvement in dysphagia -Eating Assessment Tool (EAT-10) score. Secondary outcomes: Tongue pressure	Percentage of participants with EAT-10 scores <3 not statistically significantly different between groups $p = 0.6$). Post intervention EAT-10 ($p = 0.7$) and mean tongue pressure ($p = 0.4$).
Woisard et al. [54]	Effect of a personalized transportable folding device for seating on dysphagia	Intervention agent: Occupational therapy Dosage: 1 x training session with device (D+ group) and without device (D- group).	D-/All groups: All patients training session: evaluation of needs, impact of head positioning on swallowing, adapted position of head through body positioning, practice using occupational therapy cushions or personalized transportable folding device for seating (DATP) according to randomization. D+ group: in charge to determine characteristics of the device required so they could have them during the training session. Instruction for patients was to put the personalized instructions into practice by using the device.	Primary outcomes:quality of swallowing Secondary outcomes:posture, device acceptability, QoL. Measurement of hyoid bone movement during swallowing. VFSE and questionnaire.	Significantly better posture both groups ($p < 0.001$), more hyoid bone motion in D+ group. Significant mean difference for D+ group vs. D− group, for horizontal and vertical movement. Other swallowing markers not significant.
Zhang and Ju [55]	Clinical improvement of	Intervention agent: Nursing staff	Control group: conventional nursing service that strictly conforms to the	Primary outcomes:	Improved swallowing dysfunction higher in

nursing intervention in swallowing dysfunction of elderly stroke patients.	Dosage: NR	doctor's advice. Nursing intervention: (1) Psychological intervention, nurses communication with patients/family, evaluates psychological state, encourages and comforts. (2) Health education, nurse introduces knowledge about swallowing dysfunction and effects through videos and images. (3) Rehabilitation exercises, pronunciation training, muscle training, mouth opening exercises, ingestion training. (4) Diet intervention, appropriate foods should be chosen according to specific conditions.	Swallowing dysfunction–30 mL water drink test Living quality-assessment questionnaire of living quality (GQOL-74), includes physical, psychological and social functions, and material life. Pulmonary infection–rate Nursing satisfaction–self-made questionnaire.	intervention vs. control ($p < 0.05$). Scores of physical, psychological and social functions, and material life and nursing satisfaction higher in intervention vs. control ($p < 0.05$). Pulmonary infection lower in intervention vs. control $p < 0.05$).

A Terminology as by authors.
Notes. CVA = cerebrovascular accident; EMST = Expiratory Muscle Strength Training; FEES = Fiberoptic Endoscopic Evaluation of Swallowing; FOIS = Functional Oral Intake Scale; MASA = Mann Assessment of Swallowing Ability; MBS = Modified Barium Swallow; MIE= Minimally Invasive Oesophagectomy; MDTP = McNeill Dysphagia Therapy Program; MEP = Maximum Expiratory Pressure; NMES = Neuromuscular Electrical stimulation; NR = Not reported; OD = Oropharyngeal dysphagia; PAS = Penetration-Aspiration Scale; PD = Parkinson's disease; P-DHI = Persian Dysphagia Handicap Index; PNF= Proprioceptive Neuromuscular Facilitation; PRRS = Pharyngeal Residue Rating Scale; QoL = Quality of life; RCT = Randomised Controlled Trial; SIS-6 = Swallowing Impairment Score; SWAL-QOL= Swallow Quality-of-Life Questionnaire; VDS= Video-fluoroscopic dysphagia scale; VFSS = Video-Fluoroscopic Swallowing Study; TWST= Timed Water-Swallow Test; VDS = Videofluoroscopic Dysphagia Scale; VFSE = Videofluoroscopic Examination.

Participants (Table 2) : The 37 studies included a total of 2656 participants (mean = 72; SD = 124.5), with the sample sizes across studies ranging from 10 [30] to 742 participants [38]. All but two studies reported the mean age of participants [38,49], which was 65.6 years (SD = 8.8). Participant age range was only reported in five studies, ranging between 55 [36] and 95 [38] years. The mean percentage of male participants across all studies was 55.8% (SD = 13.7).

Most studies included stroke patients (n = 24). Other diagnoses included: patients with Parkinson's disease [19,39,52], acquired brain injury [30], multiple sclerosis [51] and nasopharyngeal cancer [50]. Two studies included a mixed patient population with Parkinson's disease or dementia [38], and stroke or head and neck cancer patients after chemoradiation [40]. Five studies did not provide further details on diagnoses [28,38,49,54,55]. The most frequent method for confirming OD was VFSS (n = 17), with only four studies using FEES (n = 4) [20,31,38,40]. Seven studies used non-instrumental clinical assessments, five studies used a screening tool [28,29,39,48,56], and four studies used patient self-reported dysphagia [49,52,54,55]. The included studies were conducted across fifteen countries, with studies most frequently conducted in Korea (n = 13), USA (n = 6), China (n = 3) and Japan (n = 3).

Measures of results (Table 3)
The included research targeted numerous distinct OD domains with numerous different outcome metrics. The Penetration Aspiration Scale (PAS; 15 studies), the Functional Oral Intake Scale (FOIS; 8 studies), various water swallow tests (4 studies), and the Mann Assessment of Swallowing Ability were the most commonly utilised measurements (MASA; 3 studies). Only one or two studies used any of the other outcome measures, which supports their significant heterogeneity.

Interventions (Table 3)
The 37 studies that were considered covered a spectrum of behavioural therapies that were given by different health care providers. Single allied health disciplines handled the majority of the intervention implementation: occupational therapists in ten trials, speech pathologists in eight studies, physical therapists in two studies [36,48], and nursing personnel in one research [55]. Five research [23,27,28,33,48] involved more than one field,

and two studies [24,22] reported carers as the intervention agent either alone [24] or alongside occupational therapists [22]. Nine studies lacked details about the interventions' delivery fields. The amount of the intervention varied widely, from one training session [54] to three workouts per day, seven days a week, for 42 days [25].

Groups for behavioural interventions (Table 3)

Seven research out of the 37 included studies [19,20,21,23,25,26,38] contained three participant groups; all other studies used two groups. All intervention groups were divided into three categories: compensatory, rehabilitative, and mixed compensatory and rehabilitative interventions based on the authors' descriptions of the therapy's contents. There were various intervention groups (compensatory, rehabilitative, or combination compensatory and rehabilitative intervention groups) in ten investigations. Thirteen research only included groups integrating compensatory and rehabilitative therapies, 10 studies only included rehabilitative groups, and five studies only included compensatory groups [20,24,38,39,55]. Most studies (n = 23) included a comparison group that received a type of dysphagia treatment often referred to as traditional therapy, standard swallow therapy, or conventional dysphagia treatment (CDT). Some studies also used the term usual care for CDT groups. CDT treatment could include counselling and the provision of information about swallowing and dysphagia, compensatory strategies (e.g., bolus modification and adjusted head positioning), rehabilitation, oromotor exercises and/or thermal stimulation. Three studies included a comparison group receiving medical standard care without dysphagia treatment [20,51,56]. In three studies, patients underwent sham dysphagia training [36,43,53]. Several studies compared two or three behavioural interventions without having a CDT or medical standard care group included [33,34,46,49,50,55].

Risk of Bias Assessment

According to the results of the Begg and Mazumdar rank correlation process, there is no evidence of publication bias, with a tau value of 0.305 (two-tailed p = 0.113). The data from 15 studies used in this meta-analysis produce a z-value of 7.528 (two-tailed p 0.001) and were combined. N that can fail is 207. This indicates that for the aggregate two-tailed p-value to reach 0.050, 207 "null" studies must be found and included. In order for the effect to be eliminated, there would need to be 13.8 missing studies for every research that was observed. Begg and Mazumdar rank correlation and fail-safe N both demonstrate that there is no publication bias.

Methodological Quality

Using the RoB 2 technique, the included RCTs' risk of bias was evaluated. The risk of bias summary for each domain for individual research and for all included studies is shown in Figures 2 and 3. However, more than half of the available research (19/37) scored overall as having some issues, with three studies classified as being at high risk. Most studies demonstrated modest risk of bias for each domain.

Figure 2 : Risk of bias summary for all included studies (n = 37) in accordance with RoB2.

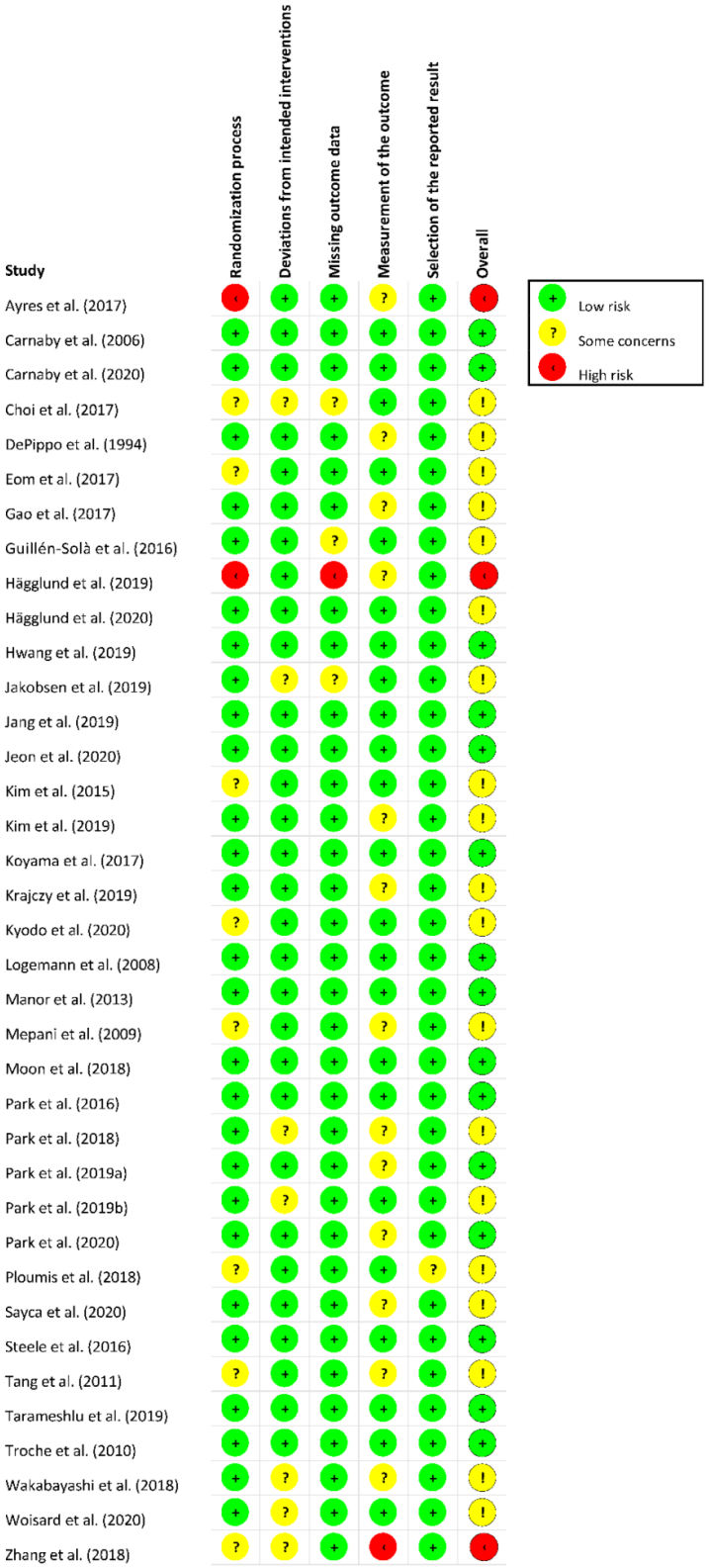

Figure 3 : Risk of bias summary for individual studies (n = 37) in accordance with RoB2 [19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55]. Note. If one or more yellow or red circles (domains) have been identified for a particular study, the Overall score (last column) shows an exclamation mark, indicating that either the study shows some concerns (yellow circle with exclamation mark) or is at high risk (red circle with exclamation mark).

Meta—Analysis: Effect of Interventions

The meta analyses [21,22,24,25,28,29,30,31,34,35,40,41,42,43,44,45,46,49,51,52,54] included twenty one studies. All study groups were divided into four categories: no dysphagia intervention, mixed compensatory and rehabilitative interventions, and combination compensatory and rehabilitative interventions. One study included patients with self-reported swallowing difficulties without a confirmed OD diagnosis by instrumental assessment (VFSS or FEES) [48], four studies did not report on clinical non-instrumental outcome data [20,28,37,40], ten studies did not provide enough data for meta-analysis [21,24,27,34,38,39,48,51,56,57], and two studies were excluded to reduce heterogeneity between studies [32,53]. Seventeen studies were excluded. Overall, within group analysis. (Figure 4).

A significant, large pre-post intervention effect size was calculated using a random-effects model ($z(35) = 8.047$, $p < 0.001$, Hedges' $g = 1.139$, and 95% CI = 0.862–1.416). Pre-post intervention effects varied greatly between studies, ranging from 0.058 to 5.732. Of the 36 intervention groups included in the meta-analysis, 19 groups showed large effect sizes (Hedges' $g > 0.8$), six groups showed moderate effects sizes ($0.5 <$ Hedges' $g \leq 0.8$), seven groups showed minor effect sizes ($0.2 <$ Hedges' $g \leq 0.5$), and four groups showed negligible effect sizes (Hedges' $g \leq 0.2$). Between-study heterogeneity was significant ($Q(35) = 152.938$, and $p < 0.001$), with I2 showing heterogeneity accounted for 77.115% of variation in effect sizes across studies.

Study name	Subgroup within study	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Carnaby et al. (2020a)	Rehabilitation	1.052	0.359	0.129	0.349	1.756	2.932	0.003
Carnaby et al. (2020b)	Combination	0.784	0.353	0.125	0.092	1.476	2.219	0.026
Choi et al. (2017a)	Combination	2.057	0.430	0.185	1.214	2.899	4.783	0.000
Choi et al. (2017b)	Compensation	0.652	0.365	0.133	-0.063	1.368	1.786	0.074
Eom et al. (2017)	Rehabilitation	1.516	0.414	0.171	0.705	2.327	3.663	0.000
Gao & Zhang (2017a)	Rehabilitation	1.335	0.282	0.080	0.782	1.889	4.727	0.000
Gao & Zhang (2017b)	Rehabilitation	1.326	0.282	0.080	0.773	1.879	4.701	0.000
Gao & Zhang (2017c)	Rehabilitation	0.446	0.258	0.067	-0.060	0.952	1.727	0.084
Hägglund et al. (2020a)	Rehabilitation	0.058	0.326	0.106	-0.581	0.697	0.177	0.859
Hägglund et al. (2020b)	Rehabilitation	0.278	0.382	0.146	-0.471	1.026	0.727	0.467
Hwang et al. (2019a)	Combination	0.464	0.416	0.173	-0.352	1.280	1.115	0.265
Hwang et al. (2019b)	Compensation	0.109	0.429	0.184	-0.731	0.949	0.255	0.799
Jakobsen et al. (2019a)	Rehabilitation	4.189	1.097	1.204	2.039	6.340	3.818	0.000
Jakobsen et al. (2019b)	Rehabilitation	0.635	0.589	0.346	-0.519	1.789	1.079	0.281
Jang et al. (2019a)	Combination	2.102	0.409	0.168	1.299	2.904	5.134	0.000
Jang et al. (2019b)	Combination	1.197	0.355	0.126	0.501	1.893	3.370	0.001
Mepani et al. (2009a)	Combination	0.378	0.538	0.290	-0.678	1.433	0.702	0.483
Mepani et al. (2009b)	Rehabilitation	1.077	0.620	0.384	-0.138	2.292	1.737	0.082
Moon et al. (2018a)	Combination	5.732	1.118	1.250	3.541	7.924	5.126	0.000
Moon et al. (2018b)	Combination	4.079	0.862	0.743	2.389	5.769	4.731	0.000
Park et al. (2016)	Rehabilitation	1.934	0.449	0.201	1.054	2.813	4.309	0.000
Park et al. (2018a)	Combination	1.690	0.483	0.233	0.743	2.636	3.500	0.000
Park et al. (2018b)	Combination	0.300	0.413	0.170	-0.509	1.109	0.726	0.468
Park, Oh et al. (2019a)	Combination	1.317	0.438	0.192	0.460	2.175	3.010	0.003
Park, Oh et al. (2019b)	Combination	0.647	0.405	0.164	-0.147	1.441	1.598	0.110
Park, Lee et al. (2019a)	Combination	1.574	0.365	0.133	0.858	2.290	4.308	0.000
Park, Lee et al. (2019b)	Combination	0.970	0.345	0.119	0.293	1.647	2.809	0.005
Park et al. (2020a)	Combination	2.364	0.468	0.219	1.446	3.282	5.047	0.000
Park et al. (2020b)	Combination	0.632	0.377	0.142	-0.106	1.370	1.678	0.093
Steele et al. (2016a)	Rehabilitation	0.306	0.521	0.271	-0.715	1.327	0.587	0.557
Steele et al. (2016b)	Rehabilitation	0.578	0.553	0.306	-0.506	1.663	1.045	0.296
Tarameshlu et al. (2019a)	Combination	3.281	0.673	0.453	1.963	4.600	4.877	0.000
Tarameshlu et al. (2019b)	Compensation	2.767	0.612	0.375	1.567	3.967	4.519	0.000
Troche et al. (2010)	Rehabilitation	0.351	0.257	0.066	-0.152	0.855	1.367	0.172
Woisard et al. (2020a)	Compensation	0.148	0.274	0.075	-0.389	0.684	0.539	0.590
Woisard et al. (2020b)	Compensation	0.146	0.255	0.065	-0.354	0.646	0.573	0.567
		1.139	0.142	0.020	0.862	1.416	8.047	0.000

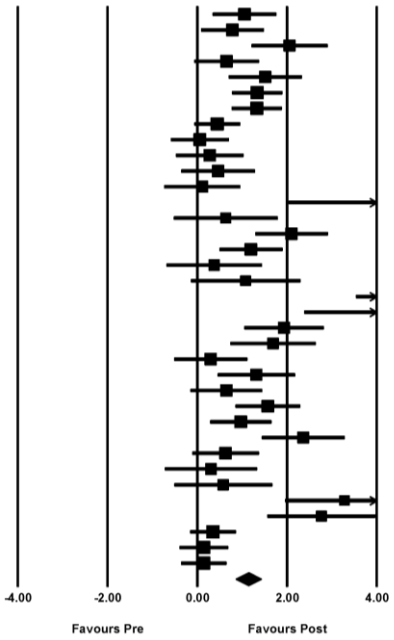

Figure 4 : Within intervention group pre-post meta-analysis : [21,22,24,25,28,29,30,31,40,41,42,43,44,45,46,49,51,52,54,56]. Note. Refer to Table 2 for explanation of the subgroups.

Between analysis of subgroups. Behavioral therapies were compared with no interventions, conventional dysphagia treatment (CDT), or no dysphagia therapy groups in subgroup analyses (Table 4). (Figure 5). Both behavioural treatments and CDT were divided into three groups: those that were primarily compensatory, rehabilitative, and those that were both. Overall, significant treatment effects that favoured behavioural interventions were discovered. Large impact sizes were identified, in particular, when contrasting combination treatments with compensatory CDT with rehabilitative programmes with no CDT. Shaker exercise, chin tuck against resistance exercise (CTAR), and expiratory muscular strength training all had substantial, big effect sizes as compared to CDT based on similarities between trials (EMST). The majority of trials, which had significant, modest effect sizes, involved populations with strokes. Comparisons between outcome measures indicated at significant effects for PAS only.

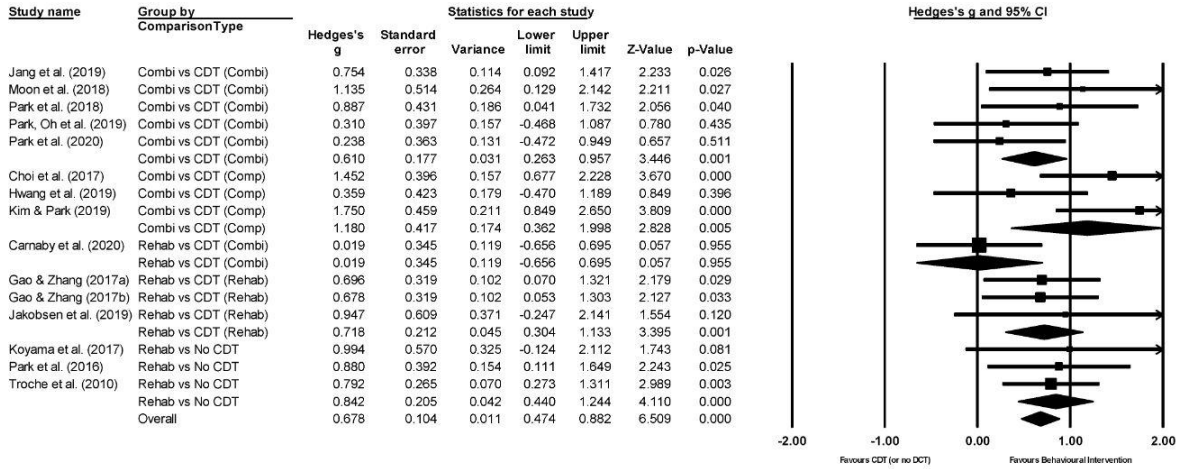

Figure 5 : Between subgroup meta-analysis for different types of interventions: behavioural interventions compared with conventional dysphagia treatment (CDT) or no dysphagia therapy [21,22,25,29,30,31,34,35,41,42,43,44,46,52]. Note. Refer to Table 2 for explanation of the subgroups.

Subgroup	Hedge's g	Lower Limit CI	Upper Limit CI	Z-Value	p-Value
Intervention type					
Combined vs. CDT (Combined) (n = 5)	0.610	0.263	0.957	3.446	0.001 *
Combined vs. CDT (Compensation) (n = 3)	1.180	0.362	1.998	2.828	0.005 *
Rehabilitation vs. CDT (Combined) (n = 1)	0.019	−0.656	0.659	0.057	0.955
Rehabilitation vs. CDT (Rehabilitation) (n = 3)	0.178	0.304	1.133	3.395	0.001 *
Rehabilitation vs. No CDT (n = 3)	0.842	0.440	1.244	4.110	<0.001 *
Selected interventions					
Shaker vs. CDT (n = 2)	1.038	0.300	1.776	2.756	0.006 *
CTAR vs. CDT (n = 3)	1.045	0.427	1.663	3.316	0.001 *
EMST vs. no CDT (n = 2)	0.819	0.389	1.250	3.733	<0.001 *
Diagnostic groups					
Acquired Brain Injury (n = 1)	0.947	−0.247	2.141	1.554	0.120
Parkinson's disease (n = 1)	0.792	0.273	1.311	2.898	0.003 *
Stroke (n = 13)	0.731	0.474	0.988	5.573	<0.001 *
Outcome measures					
Superior hyoid displacement (n = 1)	0.994	−0.124	2.112	1.743	0.081
MASA (n = 2)	0.512	−0.574	1.599	0.925	0.355
PAS (n = 11)	0.804	0.572	1.036	6.789	<0.001 *

Tongue motility oromotor function (n = 1)	0.359	−0.470	1.189	0.849	0.396

Notes. * Significant.

Table 4: Between subgroup meta-analyses comparing intervention groups of included studies.

VI. Discussion

This systematic review sought to ascertain, using only the strongest available evidence (RCTs), the effectiveness of behavioural therapies in individuals with OD. Utilizing PRISMA and meta-analysis techniques, findings from the literature were provided.

Systematic Review Findings

There were found to be 37 behavioural RCTs in OD. The small number of high-level evidence studies is alarming given the high prevalence [3] and negative effects of OD on health [57], quality of life [5,58], and health-economics [59]. RCTs are expensive and typically call for significant funding [60]. Funding requests in this field of study may be at a disadvantage when competing with well-known, life-threatening conditions like cancer or stroke due to the widespread lack of awareness of OD [61]. Although OD is a sign of these illnesses as well as many other underlying problems, there is still a lack of public awareness that causes practitioners in both the medical and non-medical fields to have a diminished grasp of and awareness of the disastrous effects of OD [61]. Further, although RCTs are characterized by random allocation and allocation concealment, few of the included studies included sufficient reporting on the processes of randomization and blinding. These finding are in line with current literature on quality assessments of RCTs [62,63], confirming that the risk of selection bias [63] and the success of blinding methods in RCTs [62] can often not be ascertained due to frequent poor reporting. There are a number of methodological issues that come up when comparing behavioural RCTs in OD. When reporting on the swallowing issues of the covered patient populations, authors may utilize conflicting definitions for OD or not offer enough information. Additionally, a number of research used non-instrumental evaluations (such as patient self-report or a screening tool) to detect or confirm OD, making it difficult to compare the results of different investigations. The use of a screening instrument is particularly troublesome because it cannot validate the presence of OD. The only goal of a screening tool is to identify patients who are at risk for OD; subsequent testing can either confirm or disprove the diagnosis [2].

Furthermore, despite the fact that instrumental assessment is thought to be the best method for verifying an OD diagnosis, VFSS and FEES methods may vary (e.g., using different numbers of swallow trials, viscosities, and volumes). Studies evaluated the effects of treatment using a wide variety of outcome indicators. Various OD qualities may lead to different therapeutic outcomes since OD is a complex phenomena [64]. For instance, changes in oral intake or the quality of life associated with dysphagia may not always be correlated with the results of instrumental assessment. Therefore, oral consumption metrics and patient self-reports were disregarded in meta-analyses to lessen heterogeneity. Additionally, several studies used outcome measures with questionable or undefined psychometric qualities, which makes it difficult to assess treatment outcomes because the data may not be accurate or reliable. Measures with inadequate responsiveness traits should also be avoided as outcome measures intending to assess the effectiveness of interventions since they are not sensitive to changes in treatment [2]. Only a few research included only compensatory groups; the majority of studies either featured a mixed rehabilitative and compensatory intervention group or a rehabilitative intervention group. In order to categorize CDT comparison groups into similar group types (compensatory and/or rehabilitative CDT), which also displayed significant diversity in their interventions, Overall, the nomenclature used to refer to CDT comparative groups in the research was complex and varied. This was particularly important when interventions were not well articulated, and when phrases like "normal care" or "conventional therapy" failed to adequately convey the kind or scope of CDT offered. Despite employing categories to categorize various intervention kinds, variability was unavoidable to some extent. Different health care providers applied the interventions, which included a variety of activities and dosages of care. Because most studies included the use of various treatment modalities, it is difficult to pinpoint the "active" components of specific interventions.

Meta-Analysis Findings

When considering meta-analyses for behavioural interventions, overall significant treatment effects were identified as favouring behavioural interventions over CDT and withholding dysphagia therapy. Most promising intervention approaches were rehabilitative interventions, which were associated with large effect sizes. Additionally, rehabilitative interventions such as Shaker exercise, CTAR exercise, and EMST showed significant, large effect sizes. However, since most studies included in the meta-analysis provided data on stroke patients only, future research still needs to confirm these findings in other diagnostic populations such as

Parkinson's disease, acquired brain injury or patients with head and neck oncology. As stated above, patient self-report and oral intake measures were excluded from meta-analyses to increase homogeneity between studies. Though self-report and oral intake data might be interesting for future meta-analyses, this would require additional RCTs to be published, as currently there is limited data available in the literature. Finally, future studies should report on treatment dosage and duration in more detail. Due to high heterogeneity between studies and incomplete reporting, no subgroup meta-analyses could be conducted for these variables.

Limitations

Although reporting of this review followed the PRISMA guidelines to reduce bias, some limitations are inherent to this study. As only RCTs published in English were included, some RCTs may have been excluded based on language criteria. In addition, meta-analyses were restricted because of heterogeneity of the included studies. As such, comparisons across studies are challenging and, generalization and meta-analyses results should be interpreted with caution.

VII. Conclusion

Oropharyngeal dysphagia behavioural meta-analyses revealed a large, overall, meaningful pre-post intervention effect size. Behavioral approaches were found to have significant treatment effects against traditional dysphagia treatment. The comparison of rehabilitative therapies with no treatment for dysphagia and combination interventions with compensatory standard dysphagia treatment revealed notable significant effect sizes. Shaker exercise, CTAR, and EMST all demonstrated substantial, large effect sizes when compared to standard dysphagia treatment. The benefits of behavioural therapies on patients with oropharyngeal dysphagia are encouraging. However, given the significant degree of heterogeneity between trials, generalizations from this meta-analysis need to be interpreted with caution.

Conflicts of Interest

The authors declare no conflict of interest.

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