Clinical Interventions in Aging

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REVIEW

Current Landscape and Prospect of Oral Frailty Intervention Strategies in Older Adults: A Scoping Review

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Abstract: The accelerated global aging process has amplified oral health challenges among older adults, emerging as a critical public health concern impacting quality of life. This study systematically reviews and synthesizes existing literature to construct a theoretical framework for oral frailty (OF) interventions in older adults. By mapping evidence clusters and gaps, we aim to inform evidence-based strategies for improving oral function to promote healthy longevity. This scoping review adhered to the methodology framework established by Arksey and O'Malley, utilizing the PRISMA-ScR guidelines to conduct a systematic search of PubMed, Web of Science, Cochrane, Embase, and PROSPERO, JBI Evidence Synthesis, Open Science Framework (up to October 2025). Eligible English-language primary studies investigating geriatric OF interventions were included for analysis. A total of 11,235 original papers were retrieved, and 14 eligible studies were finally included after deduplication and screening. Of these, 11 were cross-sectional study intervention trials, with 2 review and 1 longitudinal intervention trial. Current interventions primarily target mastication and swallowing dysfunction, focusing less on salivary secretion and oral motor skills disorders. Their effects are heterogeneous due to these differences in intervention type, implementation method, and participant characteristics. Current evidence shows that interventions hold promise for improving oral function in older adults, yet their long-term effects need systematic validation. Future research should prioritize advancements in related mechanisms, innovative technologies, and management-service models to develop universal integrated intervention programs and promote healthy aging.

Keywords: oral frailty, intervention strategies, older adults, current landscape, prospect

Introduction

The global aging process is rapidly accelerating, with individuals aged ≥ 65 years constituting 10.5% of the global population in 2024, projected to rise to 16% by 2050 and 25% by 2100.[1] With this demographic transformation, poor oral health among the elderly has become a significant public health challenge. The concept of oral frailty (OF), defined as age-related progressive decline in oral function, was first proposed by the Japanese Society of Gerodontology in 2013.[2] Despite growing scholarly attention, definitional inconsistencies persist in OF research.[3,4] To address this, international gerodontology experts have established a preliminary consensus based on current evidence, delineating eight operational criteria for OF, such as difficulty consuming hard/chewy foods, poor global swallowing function and compromised tongue mobility.[5] Based on the criteria, this study systematically analyze the types, implementation effects, and real-world challenges of OF intervention strategies in older adults.

OF serves not only as a predisposing factor for physical frailty and mortality in older adults,[6] but also demonstrates significantly associations with several geriatric syndromes including malnutrition,[7] cognitive impairment,[8] and falls.[9] Mechanistically, OF directly alters older adults' dietary intake in terms of food variety, quantity, and quality, thereby causing

Received: 3 July 2025
Accepted: 10 November 2025
Published: 14 November 2025

nutrient intake disorders and malnutrition. The development of OF in older adults involves multiple risk factors, such as denture wearing, diabetes mellitus, malnutrition, and a history of cancer.[10–13] In community and clinical settings, tools such as the OF index-6 (OFI-6), OF index-8 (OFI-8), and OF five-item checklist (OF-5) are commonly used for specialized assessment of OF in older adults.[14] Despite medical advances extending the average life expectancy for those aged ≥ 65 years, the growing prevalence of OF has created a "life expectancy-healthy life expectancy scissor gap" phenomenon.[15]

The World Health Organization has advocated effective health promotion and intervention methods for improving oral health.[16] Recently, studies on OF interventions in older adults have significantly increased. For instance, Fong et al designed a single-arm interventional study to validate the clinical effectiveness of an individualized intervention program for dysphagia in nursing home residents.[17] Steele et al observed that tongue pressure training devices with pressure sensors (eg, IOPI), significantly improved swallowing dysfunction in stroke patients.[18] Furthermore, Chua et al systematically reviewed the positive effects of oropharyngeal motor training on swallowing mechanisms in older adults.[19] Despite substantial literature and diverse study designs,[20] the evidence chain for intervention effects is not yet robust. Thus, there's an urgent need to integrate existing strategies, identify core elements of different interventions, and clarify their commonalities and differential application scopes.

As a systematic literature mapping methodology, scoping reviews have three core functions: 1) characterizing evidence distribution and volume in a research field; 2) clarifying theoretical frameworks and operational definitions of core concepts; and 3) identifying knowledge gaps to guide future research.[21] Therefore, according to PCC frameworks,[22] this study employs a scope review to address the question: What is known about interventions that address oral frailty (Concept) among community-dwelling or institutionalized adults aged ≥ 65 years (Population; as defined by the United Nations[23]) in any geographical or care setting (Context)? The aim of this scoping review was to map the types, characteristics and evidence gaps of such interventions to inform future research and practice.

Methods

This scoping review was conducted to address the above research question and its primary objectives were: 1) to identify all relevant intervention studies; 2) to chart their key features; and 3) to summarise existing evidence and gaps. This scoping review, conducted from October 2024 to October 2025, strictly adhered to the scoping review methodology framework established by Arksey and O'Malley (2005),[24] and followed the the PRISMA-ScR guidelines.[22] The primary objective was to systematically map intervention strategies for OF in older adults. The corresponding PRISMA-ScR checklist for this study has been listed as supplementary material. The protocol had been registered with Open Science Framework (OSF, https://osf.io/z47fk).

Eligibility Criteria

Inclusion criteria comprised original, peer-reviewed studies published in scholarly journals accessible globally with participants aged ≥ 65 years focusing on OF prevalence, associated risk factors, and its intervention strategies. Studies on OF prevalence and risk factors are included because some of them proposed intervention measures based on their findings. These measures, though not the focus of their respective original studies, offer vital supplements for a comprehensive OF intervention strategy in the elderly. To align research findings with the core objective, we meticulously screened and extracted intervention-related content from these studies. Exclusion criteria included non-English publications, unavailable full texts, duplicate publications, and grey literature (eg, conference abstracts, theses, guidelines, policy documents, and protocol-only studies).

Information Sources and Search Strategy

A systematic search was conducted across PubMed, Web of Science, Cochrane, Embase, and PROSPERO, JBI Evidence Synthesis, Open Science Framework from their inception to October 2025. The search strategy combined free-text and subject terms, with literature tracing method to ensure the comprehensiveness of literature coverage. Taking pubmed as an example, the English search expression is (((old people) OR (old adults) OR (old persons) OR (elderly persons) OR (the elderly)) AND ((oral frailty) OR (poor oral health) OR ((oral ill health) AND ((intervention strategies) OR (intervention measures)).

Selection Process

A standardized literature screening protocol was rigorously implemented in this study. Initially, database searches were conducted by one investigator and duplicate literature was excluded by the de-duplication tool Endnote. Subsequently, two other investigators independently performed title/abstract screening based on predefined inclusion/exclusion criteria, followed by full-text eligibility assessment. Finally, the reference lists of all included studies were manually screened (ie, reference snowballing) by two independent researchers to identify additional records. And any new citations were de-duplicated against the main search yield and assessed with the same two-stage process. Discrepancies at each stage were resolved through consensus discussion among all investigators.

Data Charting Process

This study designed a structured data extraction form (Table 1) based on the core objective of exploring OF intervention strategies in older adults. It aimed to capture key information related to intervention strategies, such as the study, publication year, country, participant, OF symptoms, interventions, assessment tools, and outcome indicators from the included studies. Since our focus was not on analyzing OF prevalence and risk factors themselves, these data were not included in Table 1. To clarify the geographic and institutional distribution of the evidence, we conducted visual summaries using R 4.4.2 with packages maps, ggplot2, and dplyr (a white-to-blue gradient indicating increasing studies).

Results

This study identified 11,235 initial records through systematic database retrieval and multi-stage screening. Subsequently, after going through steps such as deduplication (n=5433), title/abstract screening (n=5759), full-text review (n=34), and reference snowballing (n=5), 14 eligible documents were finally screened out (Figure 1). Meanwhile, 16 distinct intervention strategies were generated through structured data extraction.

Characteristics of Evidence Sources

In terms of the study design types, the 14 included studies comprised 11 cross-sectional intervention trials,[25–27,29–31,33–37] 2 review study[20,32] and 1 longitudinal trial.[28] Geographically, 6 publications originated from Japan,[25,27,28,32,34,37] 4 from the United States,[26,30,31,33] 1 from Netherlands,[35] 1 from India,[36] 1 from China[20] and 1 from Korea (Figure 2).[29] 85.7% (12 studies) originated from developed countries, whereas merely 2 studies were conducted in developing countries. Moreover, the 14 studies included in the analysis were conducted by distinct research groups. Notably, 71,4% of the literatures were published in the last decade, with the most recent article appearing in 2025. The reported interventions predominantly addressed four key domains: oral masticatory function, swallowing function, oral motor skills and salivary secretion in older adults. Detailed study characteristics are summarized in Table 1.

Synthesis of Results

Specific intervention programs for these four oral function domains and its effectiveness evaluation are shown in Table 2.

Masticatory Function Remodeling

Three studies evaluated interventions targeting masticatory function improvement and their effectiveness in older adults. A pilot trial[27] used both soft and hard chewing gums (denoted as GCE-S and GCE-H respectively) to help community-dwelling older adults with chewing training. It was found that the bite force in the GCE-H group was significantly improved (P = 0.04), while no significant change was seen in the GCE-S group (P = 0.17). A longitudinal study integrating oral health education using a leaflet based on the guidelines of Japanese Society of Gerodontology with routine dental care demonstrated enhanced bite force and masticatory performance in the intervention group, with significant between-group differences (P = 0.021).[28] Additionally, a short-term intervention utilizing masticatory muscle training improved the Mixed ability index (MAI) by 6% overall in older adults at the senior citizens center, with a 16% increase observed among those with baseline masticatory dysfunction.[29] Collectively, these interventions demonstrate that mechanically loaded exercises enhance muscle function and neuromuscular coordination, offering scalable non-pharmacological strategies for aging populations.

Table 1 The Basic Characteristics of the Included Literature (n=14)

Study	Publication Year	Country	Participant	OF Symptoms (OF Assessment Tool)	Interventions	Assessment Tools	Outcome Indicators
Iyota et al[25]	2021	Japan	49 older adults aged 68~79 years	• Oral motor dysfunction (Tongue pressure measuring instrument)	Isometric tongue supination using a tongue strength training device for 3 sets of 5 repetitions per day, at least 3 times per week for 3 months.	• Tongue pressure measuring instrument • Automatic counter (Kenkokun Handy®) • Digital grip strength meter • Multi-frequency body composition analyzer • Dietary diversity score questionnaire	Oral motor function and some body components (balance, mobility) were significantly improved, with limited effects on body components.
Rogus-Pulia et al[26]	2016	United States	56 elderly veterans with an average age of 70	• Dysphagia (Videofluoroscopic swallowing study, functional oral intake scale and Quality of Life in Swallowing Disorders Questionnaire)	I-PRO therapy was conducted using D-F for 3 days a week, 3 times a day, 10 times each time, for 8 weeks.	• Madison oral strengthening therapeutic device • Visual analog scale • Functional oral intake scale • SWAL-QOL • Penetration-aspiration scale • 3-point scoring system	Significantly improved tongue pressure, reduced dietary restrictions, optimized quality of life and subjective perception, reduced hospitalizations.
Nakagawa et al[27]	2015	Japan	12 elderly people living in the community with an average age of 77.8 years	• Weakened biting force (Dental prescale system) • Dry mouth (Oral wetness tester)	Chewing training was conducted using GCE-S for 2 weeks. After a two-week rest, the chewing training was continued using GCE-H) for another two weeks.	• Oral wetness tester • Dental prescale system • Cotton roll method	Improvement of dry mouth phenomenon and chewing function.
Onuki et al[28]	2022	Japan	273 dental outpatients aged 65 and above	• Dry mouth (Oral wetness tester) • Decreased chewing function (Gluco sensor) • Impaired swallowing function (Seirei–Shiki dysphagia questionnaire) • Oral motor dysfunction (Kenkokun Handy and tongue pressure measuring instrument)	Oral health guidance and based on a leaflet recommended by the Japanese society of gerodontology and general dental treatment were continued for approximately 6 months.	• Oral wetness tester • Chewing function test system • Seirel-Shiki dysphagia questionnaire • Pressure sensitive • Membrane system • Tongue pressure measuring instrument • Automatic pronunciation test device	Significant improvement in oral hygiene, bite force, tongue and lip motor function (/pa/), and chewing and swallowing function at the first and second assessment comparisons.
Kim et al[29]	2019	Korea	84 elderly South Koreans aged 65 or above	• Chewing dysfunction (Mixing ability index) • Dry mouth (Oral wetness tester) • Swallowing dysfunction (RSST)	Simple oral exercises, including the training of chewing, salivary secretion and swallowing functions. The intervention frequency is twice a day for one week.	• Oral wetness tester • Mixing ability index • Repeated saliva swallowing test • Modification of the questionnaire designed to assess subjective discomfort with reference to torres et al and fox et al	Significant improvement in chewing function, oral dryness phenomenon swallowing function and reduction in subjective discomfort.
Agrawal et al[30]	2018	United States	28 healthy elderly people with an average age of 75 and 10 healthy elderly people with an average age of 81	No chief complaint or medical history of dysphagia	Swallowing resistance training was conducted using the sRED for 6 weeks and the resistance gradually increased from 20 mmHg to 40 mmHg.	• Videofluoroscopy • High-resolution pharyngeal manometry • Videofluoroscopic image analysis	Swallowing function was significantly optimized in the experimental group.

Study	Publication Year	Country	Participant	OF Symptoms (OF Assessment Tool)	Interventions	Assessment Tools	Outcome Indicators
Robbins et al[31]	2005	United States	10 healthy older adults aged 70 to 89	• Dysphagia (Not mentioned in the primary study)	Progressive tongue resistance training was conducted using an inflatable balloons for 8 weeks, with 3 sessions per week, 3 sets per session, and 30 repetitions per set.	• Iowa oral performance instrument • Videofluoroscopy • Oral magnetic resonance imaging • Oral pressure transducer • Penetration-aspiration scale	Increased tongue muscle strength and volume and improved swallowing pressure without compromising swallowing safety and efficiency in healthy subjects.
Hara et al[32]	2018	Japan	• 31 healthy 74-year-olds[33] • 8 elderly individuals with an average age of 70[34] • 10 healthy elderly people[35]	• Asymptomatic healthy elderly subjects.[33,35] • Swallowing disorders (VFSS[34])	Head-raising exercise lasted for 6 weeks,[33] and JOE for 4 weeks,[34] while the duration of JOR was not explicitly stated in the article.[35]	• Jaw-Opening sthenometer[35] • Surface electromyography[33] • Videofluoroscopy[33] • Pharyngeal pressure catheters[33] • Videofluoroscopic Swallowing Study[34,35] • Microfet™[35] • SWAL-QOL[35] • Iowa oral performance instrument[35]	Increased strength of the supraglottis muscle and improved swallowing function.
Lee et al[20]	2025	China	• 48 adults aged ≥75 years[36] • 36 adults aged ≥65 years[37]	• Dry mouth symptoms[36,37] (Summated xerostomia inventory[36] and oral schirmer test[37]) • Impaired oral motor function[36,37] (Sunnybrook facial grading system[36] and oral diadochokinesis test[37]) • Decreased swallowing function[37] (RSST)	The "oral exercise" intervention encompassed exercises for expression muscles,[36,37] tongue,[36,37] salivary glands,[36,37] swallowing,[36] Oral health education (eg, brushing teeth three times daily) pronunciation and singing exercise[37]	• Summated xerostomia inventory[36] • pH meter[36] • Vernier calliper[36] • Organoleptic test[34] • Sunnybrook facial grading system[36] • Repeated saliva swallowing test[37] • Oral diadochokinesis[37] • Food swallowing test[37] • Various saliva evaluation[37] • Questionnaire for cognitive function and activities of daily living[37]	Symptoms of dry mouth[36] and halitosis significantly diminished,[36] with marked improvements in salivary secretions,[36] salivary pH,[36] mouth opening,[36] and oral motor function.[36,37] Repetitive saliva swallowing test scores showed significant improvement, while stimulated saliva secretion remained unchanged.[37]

Notes: References 35,36, 37 were identified through citation tracking during the full-text eligibility assessment of Reference 32 (a review study), while References 33 and 34 were retrieved via the same process applied to Reference 20 (another review study).

Abbreviations: I-PRO, isometric progressive resistive oropharyngeal; D-F, device-facilitated; SWAL-QOL, subscales of the dysphagia quality of life questionnaire; GCE-S, soft chewing gum; GCE-H, hard chewing gum; sRED, swallowing resistance training device; JOE, jaw opening exercises; JOR, jaw opening resistance training; VFSS, Videofluoroscopic Swallowing Study; RSST, repetitive saliva swallowing test.

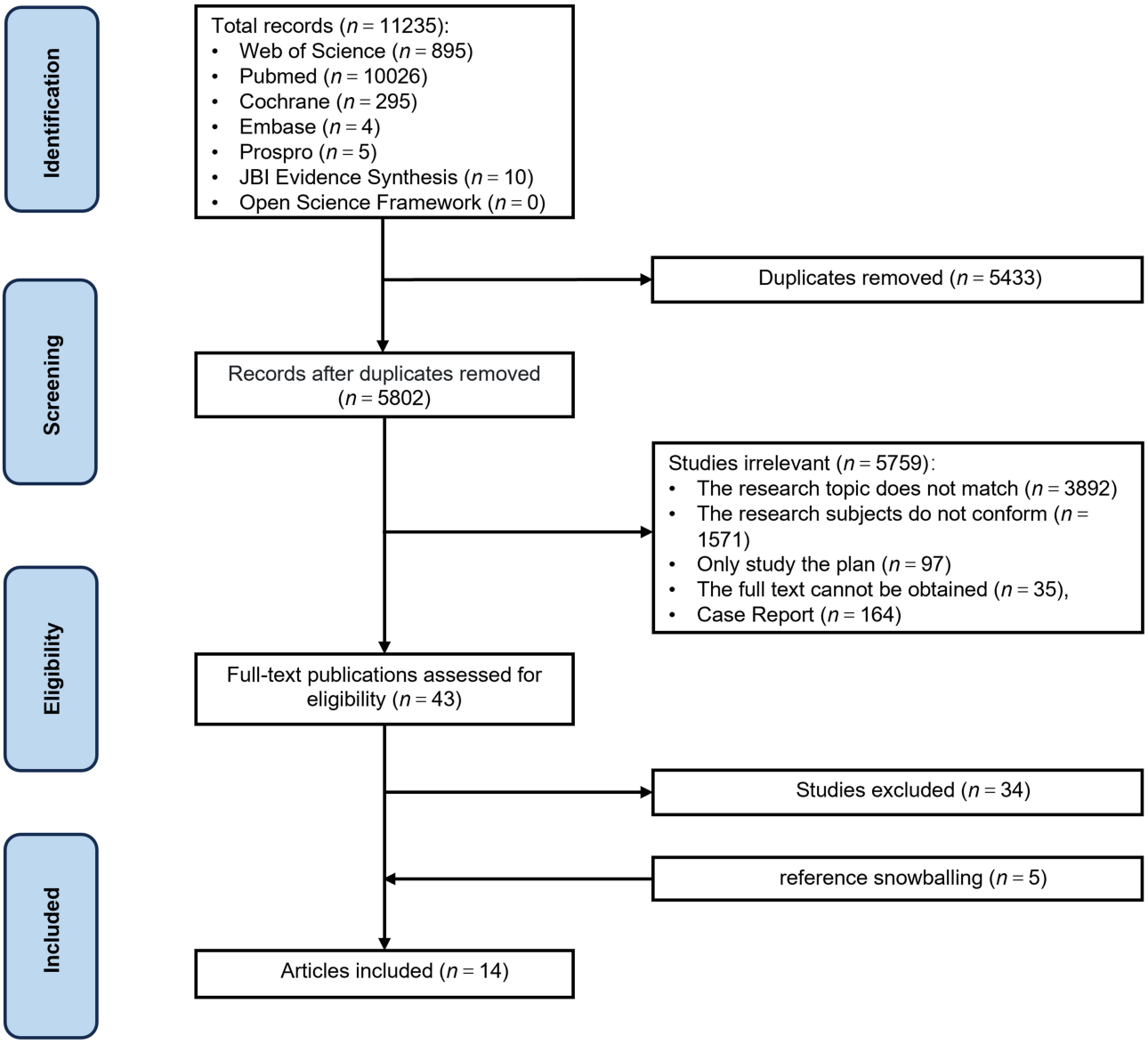

Figure 1 Literature screening process.

Swallowing Function Restoration

Eight studies implemented targeted exercises to address dysphagia in older adults. Rogus-Pulia et al demonstrated that device-facilitated (D-F) isometric progressive resistive oropharyngeal (I-PRO) therapy significantly improved swallowing-related quality of life ($P < 0.04$) and reduced subjective swallowing effort ($P = 0.001$) in elderly veterans with dysphagia.[26] Kim et al found that after implementing short-term swallowing training intervention on elderly people with swallowing dysfunction, it could effectively improve the corresponding oral function.[29] Additionally, research has demonstrated that a swallowing resistance training device (sRED) and head-raising exercise significantly increased the opening width of upper esophageal sphincter (UES) in older adults with dysphagia ($P < 0.01$), reducing bolus resistance and enhancing swallowing efficiency.[30,33] Robbins et al observed that tongue compression exercises with an air-filled bulb increased swallowing pressure, indicating enhanced lingual-masticatory coordination, though residual and aspiration improvements remained non-significant ($P > 0.05$).[31] Onuki et al significantly improved swallowing function in older adults with OF through health education using a leaflet, combined with routine dental care ($P = 0.02$).[28] Moreover, participants with a low baseline Repetitive Saliva Swallowing Test (RSST) score exhibited a significant post-intervention

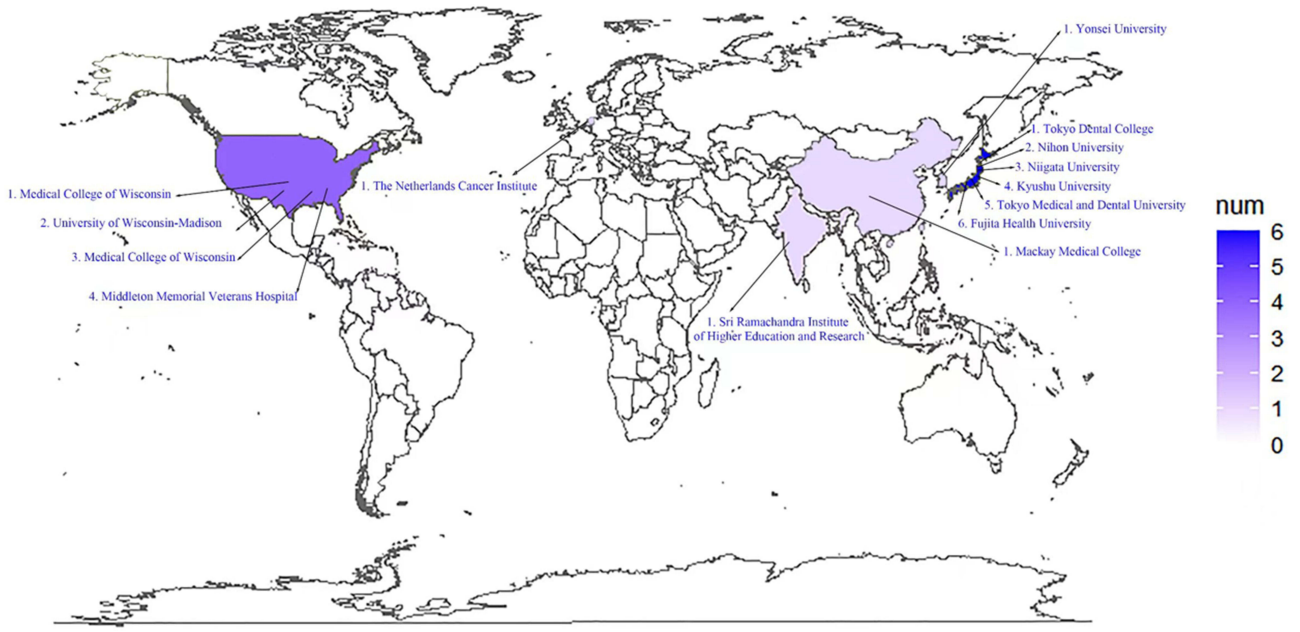

Figure 2 Visualization of the geographies and research groups of the included studies.

increase in RSST after undergoing facial-muscle training, tongue training and salivary-gland massage ($P < 0.05$).[37] In addition to the above interventions, jaw opening exercises (JOE) enhanced swallowing coordination by increasing UES mobility, while jaw opening resistance training (JOR) significantly increased supraglottic muscle volume.[34,35] Anatomical evidence indicates that augmented supraglottic muscle group improves the airway protection mechanism during swallowing by elevating the laryngeal uplift range.

Oral Motor Skill Enhancement

There are six intervention strategies targeted oral motor skills. Firstly, sustained isometric tongue elevation exercises (> 3 months) significantly improved lingual pressure and oromotor coordination (both $P < 0.001$), with collateral benefits extending to systemic function as evidenced by prolonged single-leg standing time ($P = 0.004$).[25] Secondly, device-assisted isometric progressive resistance oropharyngeal (I-PRO) treatment increased anterior and posterior tongue pressure by 92.5 and 85.4 units respectively (both $P < 0.001$).[26] This data demonstrates that instrument-assisted approaches enable precise reinforcement of specific tongue muscle groups, with pressure gradient changes serving as objective biomarkers for swallowing function improvement. Furthermore, eight weeks of lingual resistance exercise with an air-filled bulb increased isometric tongue pressure, especially peaking at six weeks ($P = 0.001$).[31] Similarly, after six months of combined oral health guidance and routine dental care intervention, showed significantly improved oral motor function in older adults with OF ($P = 0.091$).[28] The mechanism of the effect may stem from the reinforcement of oral self-care behaviors by regular professional guidance and the maintenance of oral health status by prophylactic treatment. After 16 consecutive days of oral exercise intervention (including facial expression, tongue, and swallowing training), the mean oral motor function score, assessed by the Sunnybrook Facial Grading System, of 48 elderly residents in a nursing home increased from 89 to 93, with a statistically significant difference ($P < 0.001$).[36] Implementing Chiba Model Exercises for Clear Speech on elderly individuals at high oral health risk revealed a significant post-intervention increase in the repetition rate of syllables (/pa/, /ta/, /ka/) ($P < 0.01$).[37]

Salivary Secretion Management

Five other intervention studies were conducted on salivary secretion and oral wetness. The dual-texture chewing gum scheme designed by Nakagawa et al showed texture-specific effects, that is, the GCE-S group significantly increased saliva secretion ($P = 0.03$), while the GCE-H group improved mucosal moisture ($P = 0.04$).[27] This suggests that food texture variations may modulate salivary feedback mechanisms and mucosal contact efficiency. After one-week oral

Table 2 Specific Interventions and Measures and Effects

Manifestations of OF	Intervention Strategies	Intervention Effect	Ref.
Chewing (difficulty eating hard or tough foods, inability to chew all types of food)	**IS1: Chewing exercise protocol**. Chewing exercises were performed with two different hardnesses of gum (GCE-S and GCE-H), each lasting 2 weeks with a 2-week rest period during which no chewing exercises were performed. Chewing was performed twice a day for 5 minutes each time, with the first 2 minutes of chewing following a fixed rhythm and the second 3 minutes of free chewing.	• Occlusal force: there was a significant increase in occlusal force after GCE-H (P = 0.04), whereas occlusal force increased slightly but not significantly after GCE-S (P = 0.17). • Occlusal contact area: there was no significant change in occlusal contact area throughout the test period.	[27]
	IS2: Oral health protocol. Oral health guidance and general dental treatment based on a leaflet recommended by the Japanese society of gerodontology.	• Bite force increased significantly in the oral hypofunction group improvement group, and the difference in the change in bite force between the improvement group and the re-diagnosis group of older adults was significant (P = 0.021). • Significant improvement in masticatory function.	[28]
	IS3: Chewing muscle exercise schedule. Chewing muscle exercises, performed twice a day for 1 week.	• Mean mixed ability index increased by 6% immediately after the intervention and by 16% in the group with poorer mastication.	[29]
Swallowing (decreased ability to swallow solid foods, decreased ability to swallow liquids, overall poor swallowing function)	**IS4: D-F I-PRO with madison device therapy**. Participants perform isometric tongue pressure training by pressing specific parts of the tongue against a customized occluder with multiple pressure sensors. The training program consisted of 10 repetitions 3 times per week for 8 weeks. Training goals were reset weekly based on maximal pressure (60% of maximal value in week 1 and 80% in weeks 2–8).	• Quality of life significantly improved: 8 of 11 SWAL-QOL significantly improved (effect estimates = 6.5–19.5, P < 0.04). • Self-reported feelings of swallowing effort were significantly reduced (effect estimate = −18.1, P = 0.001). • Significant improvement in eating: significant improvement in functional oral intake scale (FOSI) scores (effect estimate = 0.4, P = 0.02).	[26]
	IS5: Swallowing exercises schedule. Swallowing exercises, performed 2 times a day for 1 week.	• In the group with poorer swallowing function, 25% of the subjects improved immediately after the intervention and 40% after 1 week.	[29]
	IS6: sRED training protocol for laryngeal movement. A sRED was used to limit anterosuperior laryngeal movement by applying external resistance at the neck. The training regimen consisted of 30 swallows 3 times a day for 6 weeks, with resistance gradually increasing from 20 mmHg to 40 mmHg.	• Maximal UES opening was significantly increased (P < 0.01). • Anterior and superior movements of the larynx and hyoid bone were significantly increased (P < 0.01). • The thickness of the posterior pharyngeal wall was significantly increased during swallowing (P < 0.01). • Pharyngeal constriction integral was significantly increased during swallowing (P < 0.01).	[30]
	IS7: Head-raising exercise. Three repetitive 1-min sustained head raisings in the supine position, interrupted by a 1-min rest period. Do it three times a day for six weeks.	• The maximum anterior excursion of the larynx significantly increased (P < 0.05). • The anteroposterior diameter and cross-sectional area of the maximum UES opening significantly increased (P < 0.05). • The average hypopharyngeal intrabolus pressure decreased significantly (P < 0.05).	[33]
	IS8: Tongue compression exercise protocol. Apply pressure between the tongue and hard palate using an inflatable sphere. 30 tongue compression exercises 3 days per day, targeting 60% of baseline maximum pressure (week 1) and 80% (weeks 2 through 8).	• Swallowing pressure was significantly increased in the 10 mL liquid, 3 mL semi-solid, and 3 mL effort swallowing conditions (all P < 0.05). • No significant changes in post-swallow residue, penetration/misaspiration, or swallow duration were observed as assessed by video fluoroscopic swallowing studies.	[31]
	IS2: Oral health protocol. Oral health guidance and general dental treatment based on a leaflet recommended by the Japanese society of gerodontology.	• Swallowing function was significantly improved in the rediagnosis group (P = 0.035).	[28]
	IS9: JOE and JOR. The patient performs a maximal jaw opening and closing exercise in the sitting position and holds it for 10 seconds, repeating it 5 times, twice a day for 4 weeks. An assistive device is used to apply resistance to the jaw in order to strengthen the maxillary muscles.	• Mandibular opening and closing exercise training (JOE) improved upward movement of the maxilla and increased the opening width of the UES, but failed to improve forward movement. • Mandibular opening resistance training (JOR) improves mandibular opening force and volume of maxillary muscle groups in healthy older adults.	[34,35]
	IS10: Facial, tongue and gland training. It will be carried out every 2 to 3 weeks for a total of 5 to 6 times, each session lasting 120 minutes. The entire intervention plan will last for 3 months	• The RSST scores of the subjects with lower baseline RSST scores improved significantly (P < 0.05). • Although the average score increased, the difference was not statistically significant (P = 0.084).	[37]

Oral motor skills (impaired tongue movement, speech or vocalization)	**IS11: Isometric tongue lift exercise**. Using a tongue strength training device for 3 months. Participants performed 3 sets of 5 repetitions per day, at least 3 times per week. The appropriate stiffness of the training device was selected based on the participant's tongue pressure and adjusted monthly.	• Oral function: tongue pressure and oral rapid alternating movements significantly improved ($P < 0.001$). • Physical function: significant improvement in eyes-open single-leg stand time, sit-up-stand time (both $P < 0.01$), and significant reduction in 3-meter timed get-up-and-walk test time ($P = 0.019$). • Body composition: visceral fat levels and basal metabolic rate were significantly lower ($P = 0.001$). • Group comparison: Participants were categorized into a frail/pre-frail group and a healthy group based on the Japanese frailty scale. The healthy group showed significant improvements in several measures, whereas the frail/pre-frail group showed significant improvements in sit-up-stand time, but no significant changes were observed in body composition.	[25]
	IS4: D-F I-PRO with madison device therapy. Participants perform isometric tongue pressure training by pressing specific parts of the tongue against a customized occluder with multiple pressure sensors. The training program consisted of 10 repetitions 3 times per week for 8 weeks. Training goals were reset weekly based on maximal pressure (60% of maximal value in week 1 and 80% in weeks 2–8).	• Significant increase in lingual pressure: anterior lingual maximal isometric pressure increased significantly from baseline to 8 weeks (effect estimate = 92.5, $P < 0.001$), as did posterior lingual maximal isometric pressure (effect estimate = 85.4, $P < 0.001$).	[26]
	IS8: Tongue compression exercise protocol. Apply pressure between the tongue and hard palate using an inflatable sphere. 30 tongue compression exercises 3 days per day, targeting pressures of 60% (week 1) and 80% (weeks 2 through 8) of baseline maximum pressure.	• All participants had a significant increase in lingual isometric pressure at week 4 ($P = 0.002$) and week 6 ($P = 0.001$).	[31]
	IS2: Oral health protocol. Oral health guidance and general dental treatment based on a leaflet recommended by the Japanese society of gerodontology.	• Significant improvement.	[28]
	IS12: Facial, tongue and swallow training. Once a day, 30 minutes each time, for 15 consecutive days, under the supervision of the researcher, to ensure the correct execution of each training movement.	• The average score of oral motor function evaluated by the Sunnybrook Facial Grading System increased from 89 to 93 ($P < 0.001$).	[36]
	IS13: Chiba model exercise for clear speech. It will be carried out every 2 to 3 weeks for a total of 5 to 6 times, each session lasting 120 minutes. The entire intervention plan will last for 3 months.	• The repetition speed of syllables (/pa/, /ta/, /ka/) significantly increased after the intervention ($P < 0.01$).	[37]
Salivation (decreased salivation or dry mouth)	**IS1: Chewing exercise protocol**. Chewing exercises were performed using two gums of different hardness (GCE-S and GCE-H), each lasting 2 weeks with a 2-week rest period in between. Twice a day for 5 minutes each time, the first 2 minutes of chewing in a fixed rhythm and the last 3 minutes of free chewing.	• Salivary secretion: salivary secretion increased significantly after GCE-S ($P = 0.03$), returned to baseline levels after 2 weeks of rest, and increased significantly again after GCE-H ($P = 0.02$). • Mucosal humidity: mucosal humidity increased significantly after GCE-H ($P = 0.04$).	[27]
	IS14: Secretion stimulation protocol. Salivary secretion stimulation, performed twice daily for 1 week.	• Salivation: unstimulated salivation increased by 0.1 mL/min immediately after the intervention and by 29% in the group with poorer salivation. • Oral humidity: tongue humidity increased by 3% immediately after the intervention and remained at this level.	[29]
	IS2: Oral health protocol. Oral health guidance and general dental treatment based on a leaflet recommended by the Japanese society of gerodontology.	• The improvement in oral humidity was more significant in the oral hypofunction group improvement group ($P = 0.031$).	[28]
	IS15: Gland massage and oral stimulation. Once a day, 30 minutes each time, for 15 consecutive days, under the supervision of the researcher, to ensure the correct execution of each training movement.	• The average salivary secretion of the subjects increased from 0.29 mL/min to 0.40 mL/min ($P < 0.001$).	[36]
	IS16: Gland massage and oral education. Through acupoint massage and electrical stimulation, perform once a day for 30 minutes each time. Six sessions make up one course of treatment, and continue for three consecutive courses.	• The amount of stimulated saliva secretion did not change significantly before and after the intervention ($P = 0.432$).	[37]

Note: IS stands for 16 distinct intervention strategies.

Abbreviations: GCE-S, soft chewing gum; GCE-H, D-F, device-facilitated; I-PRO, isometric progressive resistive oropharyngeal; SWAL-QOL, subscales of the dysphagia quality of life questionnaire; UES, upper esophageal sphincter; sRED, swallowing resistance training device; JOE, jaw opening exercises; JOR, jaw opening resistance training.

exercise program conducted by Kim et al,[29] non-stimulated salivary secretion of those with low salivary secretion function increased by 29%. This data indicates that even short-term interventions are effective in activating salivary gland function and have certain therapeutic value for patients with Sjogren's syndrome. Moreover, longitudinal oral health management revealed gradual improvement in participants' mucosal moisture is positively correlated with increased saliva secretion,[28] highlighting periodic professional intervention's long-term benefits for saliva function maintenance. The massage and motor stimulation protocol for salivary glands designed by Raj et al significantly increased the mean salivary flow rate of subjects from 0.29 mL/min to 0.40 mL/min post-intervention ($P < 0.001$).[36] Additionally, the combined intervention of salivary gland massage and oral health education induced a trend of increased stimulated saliva secretion, yet without statistical significance ($P = 0.432$).[37] This might be due to limited sample size, short intervention duration, and insufficient massage intensity/frequency.

Discussion

This study systematically screened 14 relevant studies, including 16 interventions. These interventions mainly target four aspects: masticatory function, swallowing function, oral motor skills, and salivary secretion ability. While these interventions demonstrated significant functional improvements in respective outcomes, marked heterogeneity in efficacy was observed across studies. This variability was significantly associated with differences in intervention type, implementation protocols, and participant population characteristics.

Studies from Japan account for half of the studies in this field, closely related to its unique demographic structure. In 2023, MHLW reported in "The simple life table of reiwa 5th year" that the average life expectancy reached 81.09 years for males (+0.04 years) and 87.14 years for females (+0.05 years).[38] This demographic shift underscores accelerating population aging dynamics. According to a statistical report released by Japanese Ministry of Internal Affairs and Communications, as of the third quarter of 2024, 29.3% of the national population was aged ≥ 65 years. This is not only a new historical peak since the establishment of the statistical system in 1950, but also continues to rank among the world's top aging countries with a 5.2 percentage point lead over Italy (24.1%), which has the second highest level of aging in the world. Consequently, Japanese severe aging issue has driven extensive research by their scholars into OF in older adults. Amid ongoing demographic shifts, Japanese national health promotion program designate oral function maintenance as a pillar strategy for aging society challenges.[39] The document highlights that oral health is crucial for older adults' nutrition and communication, and is positively linked to preventing systemic diseases and improving quality of life. Notably, the "8020 oral health promotion project" implemented in Japan since 1989 has achieved significant social benefits.[40] By establishing a community-based oral healthcare service network, the program successfully increased the proportion of elderly participants meeting oral health targets from <15% initially to 48.6% by 2023. This approach of combining public health policy with primary-care practice has reshaped research paradigms in oral health promotion. It also offers a practical model for oral health governance in aging societies globally, and has established Japanese leading position in geriatric dentistry research.

In selecting interventions for OF in older adults, the international community has shown significant divergence. East Asia, represented by Japan, focuses on community-driven, low-cost prevention (eg, chewing gum[27]), while North America, led by the United States, concentrates on technology-oriented development of smart medical devices (eg, sRED occlusal detection system[27] and the I-PRO oral function evaluator[26]). This strategic difference originates from distinct socio-economic resource allocation and cultural cognitive frameworks. In terms of resource allocation, Japan has about 68,000 dental clinics nationwide, with an average of one clinic per 1800 people, and most of them are located in the community.[41] In contrast, oral health system of the United States exhibits "technology-intensive" characteristics, emphasizing a technology-driven intervention orientation. This difference in resource allocation deeply reflects the fundamental difference between the two types of public health systems. Japan prioritizes universal accessibility, while the United States emphasizes precision-driven efficiency. Additionally, cultural cognitive dimensions further amplify this divergence, as Japanese collectivist perception of aging fosters a proactive intervention logic epitomized by the "8020 oral health promotion project".[40] This non-invasive and continuous intervention is institutionally complementary to the Japanese cultural tradition that emphasizes group responsibility for health. Conversely, individualism in the United States leads to a preference for quantified, precise clinical solutions in its medical culture. For example, the sRED employs 32 pressure

sensors for real-time occlusal force monitoring and incorporates machine learning algorithms to dynamically optimize chewing efficiency.[30] This high-technology intervention aligns with values of individual health autonomy while potentially exacerbating structural imbalances in medical resource allocation.

In the geographical distribution of the 14 included studies, 85.7% (12 studies) originated from developed countries,[25–35,37] with only two from developing nations.20,33 This disparity may stem from several factors. Developed countries often have more robust healthcare infrastructures, greater research funding, and a higher emphasis on geriatric care.[42] In contrast, developing countries may face resource constraints, competing public health priorities, and limited awareness of OF as a distinct clinical entity.[43] This imbalance suggests a critical need to address OF in low-resource settings, where aging populations are rapidly growing but research and interventions remain scarce. Moreover, another notable finding is that all 14 studies originated from distinct research teams, with no group pursuing longitudinal or follow-up research. This fragmentation may reflect the nascent stage of OF intervention research, where interdisciplinary collaboration or sustained funding are lacking. This discontinuity may hinder the translation of preliminary findings into evidence-based guidelines. Thus, future efforts should prioritize long-term funding mechanisms and multi-center consortia to ensure research continuity, validate intervention efficacy across diverse populations, and address unmet needs in developing regions.

Among the four core aspects of current geriatric OF interventions, despite the predominant use of mechanical exercises and device-assisted resistive training, evidence-based efficacy demonstrates significant heterogeneity, necessitating refined exploration of their optimal application boundaries. In the field of masticatory function interventions, interventions such as the graded gum-chewing program[27] and short-term muscle exercise[29] show differential efficacy. While hard chewing gum significantly enhanced bite force, they failed to effectively improve occlusal contact area. This suggests that mechanical loading alone may not be sufficient to address functional coordination. In contrast, a composite approach integrating health education and dental care[28] yield more comprehensive functional improvement, highlighting the synergistic effect of biomechanical training and behavioral correction. Moreover, dysphagia interventions exhibit technology-dependent characteristics. Device-assisted therapies (eg, I-PRO[26] and sRED[30]) demonstrated positive outcomes in pharyngeal muscle strengthening and dysphagia reduction, yet failed to concurrently mitigate aspiration risk.[31] This implies that localized muscle strengthening alone may be insufficient for restoring the corresponding neuromuscular coordination. Similarly, while the tongue-lifting device effectively enhanced tongue pressure and physical function in robust older adults, their efficacy was limited in the frail group.[25] This shows that interventions need to be tailored to individual frailty levels. Compared to the first three intervention strategies, saliva regulation research is still in its early stages. Chewing-gum interventions only provided short-term stimulation, and conventional saliva-secretion stimulation lacked sustained efficacy in relieving xerostomia.[27] Thus, it is necessary to develop a sustained maintenance mechanisms to ensure long-term therapeutic outcomes and functional stability. Notably, current evaluation frameworks rely predominantly on assessment scales such as subscales of the dysphagia quality of life questionnaire (SWAL-QOL) or short-term physiological indicators, limiting their capacity to capture functional dynamics and predict long-term intervention outcomes. This assessment gap significantly impedes the clinical translation of research findings into practical applications.

To transcend current intervention limitations, future research on OF in older adults must build an integrated "mechanism-technology-service" prevention system. Firstly, at the mechanistic research level, it is imperative to elucidate the molecular mechanisms regulating salivary secretion and the pathological features of oral motor neuromuscular degeneration, establishing the biomarker-based precision risk prediction models. Based on this, further objective assessment tools can be further developed to complement the self-reporting deficiencies. Secondly, future research should prioritize innovative interventions like targeted therapeutics (eg, novel salivary gland-targeted agonists) and non-invasive rehabilitation technologies (eg, neuroelectric stimulation modulation therapies, and VR-driven oral motor training protocols). Concurrently, strategic integration of 3D printing technology should be pursued to optimize customization of personalized auxiliary aids. Moreover, the service model should restructure the care chain by establishing a tiered linkage mechanism among geriatric dentistry, rehabilitation, and community care stations. Relying on wearable devices and telemedicine platforms can realize the continuous care loop of "hospital-community- family". Additionally, cost-effectiveness evaluations from the perspective of health economics are essential to provide evidence support for the formulation of medical insurance policies. Notably, longitudinal cohort studies are needed to validate the long-term benefits of oral function exercises in healthy aging. Through the synergistic promotion of mechanism exploration,

technological innovation and model integration, a full-cycle prevention network for oral debility can be established, ultimately achieving substantial improvement in oral health and quality of life among older adults.

Besides the above advantages, this study has the following limitations. Firstly, the included studies focused on a few countries, especially Japan, which might weaken the generalizability of findings. Additionally, while aligning with international academic norms, the English-language publication restriction risked omitting culturally specific interventions and introducing cultural adaptability bias through exclusion of non-English studies. Similarly, the exclusion of gray literature might have missed innovative intervention programs in the field of practice that have not been formally published, which may also affect the study's conclusion.

Conclusion

In summary, current research predominantly addresses rehabilitating mastication and swallowing dysfunction, yet notable gaps exist in exploring interventions for salivation, xerostomia, and oral motor dysfunction. Most interventions lack standardized assessment tools and evidence-based validation, with efficacy further constrained by individual factors. Future research should deeply explore intervention mechanisms, develop low-cost technologies and embed OF screening in primary-care workflows to establish a function-centered comprehensive prevention model. These findings can offer valuable insights for guideline updates, community oral-health programs and medical resource allocation for high-risk older adults.

Data Sharing Statement

Data sharing is not applicable to this scoping review as no new research data are reported.

Funding

This work was funded by the Natural Science Foundation of Shandong Province (ZR2021QH294) and Research Fund for Academician Lin He New Medicine (JYHL2022MS02).

Disclosure

The authors report no conflicts of interest in this work.

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