

The Review of Interventions to Improve the Swallowing Function in the Elderly

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Background: Swallowing function deterioration is a common problem experienced by older adults worldwide. Many studies have been conducted to improve swallowing function in older adults; however, due to differences in intervention methods and study designs, it is difficult to draw a common conclusion. This study aimed to analyze trends and intervention methods in studies of swallowing function intervention for older adults conducted from 2010 to 2022, to establish a systematic approach for developing interventions to improve swallowing function in older adults and to provide evidence for this approach.

Methods: Literature research was conducted for studies published between 2010 and 2022 that applied to swallow function interventions to adults aged 60 years or older. Databases including PubMed, Medline, RISS, Science On, KISS, and KCI were used. From a total of 1,164 articles searched using keywords, 20 articles were selected for final analysis.

Results: The number of published articles steadily increased over time, and the intervention period was most commonly 6 or 8 weeks. The types of interventions included focused exercises to improve oral muscle strength in 12 articles and programs incorporating education, practice, and expert management in 8 articles. Among the focused exercises, tongue-strengthening exercises were most common in 4 articles. The evaluation variables for intervention effects were muscle strength evaluation, oral function evaluation, quality of life, and oral health and hygiene status. Muscle strength and oral function evaluations were statistically significant in focused exercise interventions, while the quality of life and oral health and hygiene status was significant in program interventions.

Conclusion: This literature review is meaningful as a study that can be used to select the intervention period and program contents when planning an elderly swallowing intervention program.

Key Words: Aged, Deglutition, Review literature as topic

Introduction

1. Background

As the elderly population is rapidly increasing, Korea is expected to enter a super-aged society by 2025¹. Accordingly, the problem of the elderly is emerging as an important social issue, and health issues related to aging are receiving the greatest attention².

Among the various physiological changes that aging causes, decreased swallowing function is very common in

the elderly and is an important health problem that can have fatal consequences^{3,4}. Swallowing is a basic function that sustains life and is an essential component of improving the quality of life, but in the elderly, dysphagia is likely to occur due to deterioration of swallowing-related muscles due to aging³. According to the previous study, it was confirmed that 52.7% of elderly people admitted to nursing home in Korea had dysphagia⁵. Kim and Park⁶ reported 62.3% of the 260 elderly people living in the community were at risk for dysphagia.

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Dysphagia is defined as a functional disorder in which the process of getting food from the mouth to the stomach is difficult^{7,8)}. It is a type of dietary disorder that is known to interfere with basic daily life and reduce quality of life⁶⁾. Severe dysphagia is a major cause of aspiration pneumonia, the leading cause of death in the elderly, which can be life-threatening and causes physical health problems such as malnutrition, dehydration, weight loss, and suffocation^{8,9)}. These health problems can also have a negative psychological impact by secondarily causing symptoms of depression and anxiety¹⁰⁾. Kim et al.¹¹⁾ found that dysphagia slows down eating in older adults, promotes anxiety about eating, and in turn, these problems negatively affect the elderly's social activity restrictions and emotional well-being, further reducing swallowing-related quality of life⁹⁾.

It is very important to manage swallowing function in order to lead a healthy and happy life even in old age¹²⁾. However, due to the rapid entry into an aging society, awareness of the health and well-being of the elderly has not been established for some time, and active intervention or treatment for dysphagia is not actively carried out because it does not directly cause pathological conditions⁶⁾. Therefore, it is time to detect the risk of dysphagia in the elderly early and to actively intervene to improve oral function related to swallowing¹²⁾.

Swallowing function can be improved by strengthening oral function such as improving oral-facial muscle or improving saliva flow ability or reducing swallowing discomfort. Previous interventions studies for improving oral function related to swallowing were confirmed their effectiveness: Tongue muscle strengthening exercises using PEKO PANDA (PEKO PANDA[®]; JMS CO., LTD, Hiroshima, Japan)¹³⁾ or IOPI (IOPI; IOPI Medical LLC, Woodinville, WA, USA)¹⁴⁾, head and neck strengthening Exercise¹⁵⁾, singing interventions¹⁶⁾, oral health care¹⁷⁾, gum chewing exercises¹⁸⁾. Various studies on interventions for swallowing function in the elderly suggest the necessity and importance of interventions, but the study design, intervention methods, and evaluation methods between these studies are very different, making it difficult to compare the effects between interventions and to generalize. Therefore, in order to establish an effective elder

swallowing intervention program, it is important to consider the intervention studies to date, compare and analyze the effects of the intervention methods, and suggest the direction of follow-up research.

Therefore, this study examined research trends on swallowing interventions in the elderly through a literature review and conducted a comparative analysis of various interventions to prepare basic data necessary for the development of swallowing intervention programs in the future.

2. Objectives

The purpose of this study is to examine research trends and intervention measures through a review of domestic and foreign literature on swallowing intervention in the elderly.

Materials and Methods

1. Study design

This study is a literature review that attempted to present useful evidence for swallowing interventions in the elderly by analyzing research trends in studies that applied swallowing interventions to the elderly. The study was conducted according to a literature review methodology Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA).

2. Literature search

The key questions for literature search were set using Population, Intervention, Comparisons, Outcome, Study design (PICO-SD). Study subjects (P) were elderly people aged 60 years or older, and intervention (I) was set as an intervention related to swallowing function. The control group (C) included both single or control group studies, and the intervention outcome (O) included studies suggesting the effect of swallowing interventions as objective or subjective results. The study design (SD) included randomized controlled trials (RCTs) and Quazi experimental designs.

Literature search was conducted by one researcher as follow International and Korean databases: International databases were used PubMed and Medline, and Korean databases were used by Research Information Sharing

Service (RISS), Science On, Korean studies Information Service System (KISS), and Korean Citation Index (KCI).

The data search was conducted for about two weeks from December 21, 2022. The category of publication time was based on a review study of sleep interventions in older adults, with more than 65% of searches comparing no year limit to 2010 onwards, referring to prior studies that limited searches to literature from 2010 onwards¹⁹⁾. In this study, as a result of the first search centered on key questions and keywords, overseas databases accounted for a relatively large proportion of documents, with literature since 2010 accounting for more than 78% of the total literature, and domestic documents accounting for more than 79%. Therefore, based on the most up-to-date evidence, we set the search criteria to literature published from 2010 to 2022 to provide researchers with useful data on elder swallowing interventions.

For literature search in International databases, the main keywords were used based on MeSH and combined through the operator AND/OR. The main keywords and operators were set to ‘old OR aged OR elderly OR senior’ and ‘masticatory function OR masticatory function measurement’ or ‘biting OR chewing OR mastication OR masticatory’ OR ‘myofunctional’. In addition, Korean database search based on the search strategy used when searching overseas, keywords such as ‘elderly’, ‘swallowing’, ‘dysphagia’, ‘chewing’, ‘bite’, and ‘muscle function’ were searched in combination.

3. Selection criteria

The inclusion and exclusion criteria for literature selection were as follows (Table 1). The subjects of the study were the elderly over 60 years old, including the female elderly, the elderly in the community and at home, and the elderly in nursing facilities. Elderly people with a history of diseases that cause swallowing disorders, elderly people suffering from moderate or severe dysphagia, and elderly people with total dentures were excluded because they were difficult to generalize. Elderly people with stroke, dementia, or full dentures also were excluded due to the difficulty of generalizing the intervention outcomes in such cases. Even if the study subjects were not only elderly but also mixed with other age groups such as young and middle-aged people, it was excluded due to difficulties in comparing between studies. Interventions included all interventions except pharmacological interventions to improve and improve swallowing function but excluded studies whose effectiveness was unreliable because interventions were terminated within one day, interventions that were not similar or clear to controls, papers where the validity of the results was not guaranteed, qualitative studies, end-of-the-questions, case studies, and correlation studies. It was included studies published in English and Korean, and excluded studies that did not provide full text such as abstracts, posters, and conference archives. However, in the case of Korean database literature, dissertations were included in addition to acade-

Table 1. Selection Criteria

Criteria	Inclusion	Exclusion
Paper publication year	2010~2022	Before 2010, after 2022
Type of literature	Journal article, thesis	Book, conference paper
Study object	Elderly (≥ 60)	Not elderly (< 60)
Study design	Clinical trial	Review analysis, systematic analysis, meta-analysis
Contents	Randomized controlled trial	
	Intervention of care program	Not intervention
	Interventional application	Examine of protocol, tool
	Accessible full text	Only abstract
	Without illness	Specific occupation (ex. nurse, care worker)
	Korean or English	Disorder or illness patients (ex. dementia, stroke, cancer etc.)
	Intervention study	Korean or English
	Not accessible paper	
	Not intervention study	
	Not topic related	

mic papers to review the contents of the intervention in various ways.

The process of literature search and selection was carried out independently by one researcher. Then the other researcher checked the degree of agreement with the search method and results and collected opinions on overlapping and inconsistent items. Since then, the final included literature was independently selected by two researchers based on the inclusion and exclusion criteria, completing the cross-validation process. Inclusion and exclusion process, 20 out of a total of 1,164 articles excluding duplicates were the subject of this literature review (Fig. 1). The list of selected Studies is presented in Table 2^{12-15,18,20-34}.

4. Analysis

To examine the characteristics of the 20 selected literature, it was extracted the time of publication, the number of subjects and the sex ratio, the study design, the length and duration of the study, and the intervention method and evaluation method by type. The frequency and percentage of each analysis element were measured and presented as a table and graph. We conducted an analysis and discussion on intervention methods, variables, and duration. We also reviewed the measurement tools used to

evaluate the effectiveness of each intervention method and confirmed the results.

Results

1. Characteristics of the literature included in the review

1) State of intervention studies by period

From 2010 to 2022, a total of 20 pieces of literature on interventions for swallowing function in the elderly that met the selection criteria of this study were identified from 2014 to 2022, and the publication year was counted in 3-year increments (Fig. 2). It was confirmed that the ‘Intervention studies for swallowing function in the elderly published in International journals’ (hereinafter “International” or “International literature”) has been steadily increasing from 2017 to the last 3 years, showing an upward curve with 4 papers in 2017 to 2019 and 7 papers in 2020 to 2022. ‘Research published in Korea’ (hereinafter “Korea” or “Korean literature”) has also steadily increased since 2014, showing a similar trend.

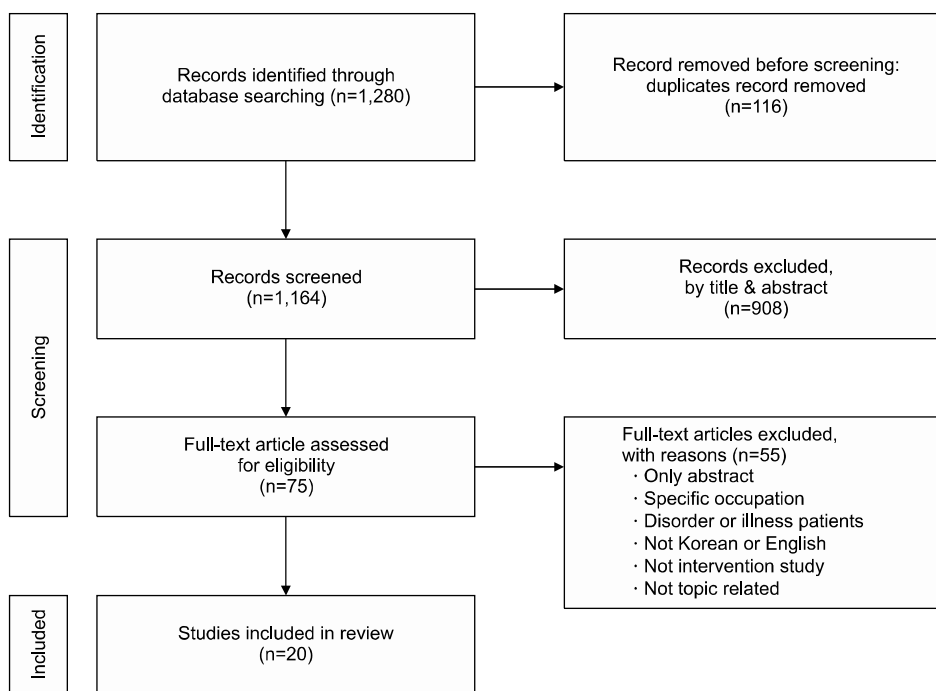


Fig. 1. Flow chart of study selection process for the review. First, 1,280 literatures were searched through national and international databases. Then the duplicates literature was removed, and the title and abstract were checked to perform the first screening. The second screening was conducted by checking the full text of the studies in detail. Finally, 20 studies were selected for the review.

Table 2. List of Included Studies

No. ^a	Author	Title	Journal
1	Yano et al. ¹³⁾	Effects of tongue-strengthening self-exercises in healthy older adults: a non-randomized controlled trial.	Dysphagia
2	Van den Steen et al. ¹⁴⁾	Tongue-strengthening exercises in healthy older adults: effect of exercise frequency - a randomized trial.	Folia Phoniatr Logop
3	Szynkiewicz et al. ²⁰⁾	A randomized controlled trial comparing physical and mental lingual exercise for healthy older adults.	Dysphagia
4	Kim et al. ¹⁸⁾	Simple oral exercise with chewing gum for improving oral function in older adults.	Aging Clin Exp Res
5	Ki et al. ²¹⁾	Effect of oral health education using a mobile app (OHEMA) on the oral health and swallowing-related quality of life in community-based integrated care of the elderly: a randomized clinical trial.	Int J Environ Res Public Health
6	Park et al. ²²⁾	Effects of neuromuscular electrical stimulation synchronized with chewing exercises on bite force and masseter muscle thickness in community-dwelling older adults in South Korea: a randomized controlled trial.	Int J Environ Res Public Health
7	Lee et al. ²³⁾	Effects of lingual exercises on oral muscle strength and salivary flow rate in elderly adults: a randomized clinical trial.	Geriatr Gerontol Int
8	Kim et al. ²⁴⁾	Improvements in oral functions of elderly after simple oral exercise.	Clin Interv Aging
9	Fujiki et al. ¹⁵⁾	Secondary voice outcomes of a randomized clinical trial comparing two head/neck strengthening exercises in healthy older adults: a preliminary report.	J Speech Lang Hear Res
10	Agrawal et al. ²⁵⁾	Swallow strength training exercise for elderly: a health maintenance need.	Neurogastroenterol Motil
11	Park et al. ²⁶⁾	Effect of expiratory muscle strength training on swallowing-related muscle strength in community-dwelling elderly individuals: a randomized controlled trial.	Gerodontology
12	Kim ²⁷⁾	The effect of tongue strength training program combined with oral exercise to improve oral and cognitive functions of the elderly.	Unpublished doctoral dissertation
13	Ki ²⁸⁾	Effect of home visit oral health education on xerostomia and quality of life related to swallowing in older adults.	Unpublished master's thesis
14	Hong et al. ²⁹⁾	The effects of bilateral chewing exercise on occlusion force and masseter muscle thickness in community-dwelling elderly.	JKCBOT
15	Lee et al. ¹²⁾	The effects of the oral care program for improving swallowing function of the elderly using welfare centers on depression, self-efficacy, subjective oral health status and swallowing related quality of life.	J Korean Acad Community Health Nurs
16	Choi and Kim ³⁰⁾	Current status of the elderly's swallowing disorder and changes in quality of life related to swallowing after swallowing education in the elderly in the community: around the gangdong-gu area.	Korea Aging Friendly Ind Assoc
17	Moon ³¹⁾	Effect of integrated oral health care program for older adults in long-term care facilities.	Unpublished doctoral dissertation
18	Jang and Lee ³²⁾	Effects of oral health promotion program on oral function in the elderly.	KJOHSM
19	Kim et al. ³³⁾	Effects on quality of life and oral health of the elderly in an oral health promotion program.	Indian J Sci Technol
20	Ha and Lee ³⁴⁾	Effects of swallowing rehabilitation program among elderly in geriatric hospitals.	J Korean Public Health Nurs

^a Article no. 1 ~ 11 (Literature published on International journal), 12~20 (Literature published in Korea, Korea).

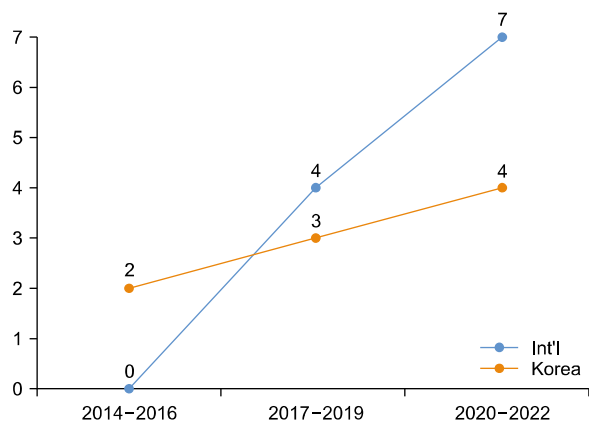


Fig. 2. Publish years of included studies. It shows the status of intervention studies for the elderly swallowing by period. ‘Literature published on International journal (Int'l)’ has been published as 4 from 2017 to 2019, and 7 from 2020 to 2022. ‘Literature published in Korea (Korea)’ has been published as 2 from 2014 to 2016, 3 from 2017 to 2019, and 4 from 2020 to 2022.

2) General characteristics of selected literature

The general characteristics of the study are shown in [Table 3](#). The sample size of papers to be studied was the largest with 7 papers (63.6%) by 20~39 in International literature, and 4 (44.4%) by 40~59 in Korean literature. As for the gender of the study subjects, the literature that studied men and women together was the largest with 10 International literatures (90.9%) and Korean 8 literatures (88.8%), and the study design had the largest number of Non-equivalence Control Group Pre-Post Designs (NCGPPD) with International 5 (45.5%) and Korean 6 literatures (66.7%) ([Table 3](#)). Except for some literature not mentioned in the text, the Seniors welfare center had the most with 5 (25.0%), and day service centers and nursing hospitals had the least with 1 (5.0%) each ([Table 3](#)). Finally, the intervention application period was the most common with 5 (45.5%) between 5~6 weeks in International literature, and 4 (44.4%) between 7~8 weeks in the Korean literature ([Table 3](#)).

2. Status of intervention and assessment method

1) Intervention method trends of included literature

In the selected literature, the status of interventions type for swallowing in the elderly is shown in [Table 4](#). Intervention methods were divided into intense exercise

intervention, which focused on oral muscle strength training, and program intervention, which included oral exercise training, education, and expert management.

In the case of intensive exercise interventions, depending on the type of exercise performed, Tongue muscle strengthening Exercise (TE), Masseter muscle strengthening Chewing Exercise (MCE), Head and Neck strengthening Exercise (HNE), Swallowing muscle Exercise (SE), Expiratory muscle strengthening exercise (EXP), Simple Oral Exercise (SOE), Mental Exercise (ME), Neuro-Muscular Electrical Stimulation (NMES) were sub-grouped. Program intervention was subdivided into Oral Exercise (OE), Oral Health Education (OHE), Oral Massage (OM), Customized oral health Care Management (CCM), Expert Oral Care (EOC). For the intensive exercise intervention literature, we counted all exercise types used in the study and for the program intervention literature, all the compositions included in the program. In the case of International literature, 10 intensive exercise interventions (90.9%) and 1 program intervention (9.1%) were mostly intensive exercise interventions, while in the Korean literature, program interventions were more common with 2 intensive exercise interventions (22.3%) and 7 program interventions (77.7%). In the intervention-specific subcategories, TE accounted for the most intensive exercise interventions with 5 (45.5%), while program interventions consisted of OE and OHE, and programs consisting of OE, OHE, OM, and CCM had the most 2 (22.2%) each.

2) Assessment method trends of included literature

The status of the selected literature by type of measure for evaluating interventions is shown in [Table 5](#). The Assessment variables for evaluate of swallowing interventions effect were divided into muscular strength, oral function ability/disability, oral health and hygiene status, Quality of Life (QoL) and Nutritional Status (NS), and these were classified and counted. The subcategories were Tongue Muscle (TM), Masseter Muscle (MM), Oral Facial Muscle (OFM), Pharyngeal Muscle (PM), Expiratory Pressure (EP), Saliva Flow Ability (SFA), Swallowing Ability (SA), Mouth Opening (MO), Acoustic Outcome (AO), Oral Health Statue (OHS), Plaque Index/Gingival Index (PI/GI), Halitosis, oral Comfort/discomfort (Comf), swal-

Table 3. General Characteristics of Included Studies

Characteristics	Int'l ^a	Korea ^b	Total
Sample size			
20 ~ 39	7 (63.6)	2 (22.2)	9 (45.0)
40 ~ 59	2 (18.2)	4 (44.4)	6 (30.0)
60 ~ 79	1 (9.1)	1 (11.1)	2 (10.0)
80 ~ 99	1 (9.1)	2 (22.2)	3 (15.0)
Gender			
Men & Women	10 (90.9)	8 (88.8)	18 (90.0)
Women	1 (9.1)	1 (11.1)	2 (10.0)
Study design			
NCGPPD	5 (45.5)	6 (66.7)	11 (55.0)
NCGPD	1 (9.1)	0 (0.0)	1 (5.0)
NCGND	3 (27.3)	0 (0.0)	3 (15.0)
OPPD	0 (0.0)	2 (22.2)	2 (10.0)
TPPD	2 (18.1)	1 (11.1)	3 (15.0)
Sample site			
Day services center	1 (9.1)	0 (0.0)	1 (5.0)
Community-dwelling	2 (18.2)	2 (4.5)	4 (20.0)
Nursing home	1 (9.1)	1 (11.1)	2 (10.0)
Senior citizens center	2 (18.2)	0 (0.0)	2 (10.0)
Seniors' welfare center	2 (18.2)	3 (33.3)	5 (25.0)
Long-term care home	0 (0.0)	2 (4.5)	2 (10.0)
Nursing hospital	0 (0.0)	1 (11.1)	1 (5.0)
No mention	3 (27.3)	0 (0.0)	3 (15.0)
Intervention period (wks)			
1 ~ 2	1 (9.1)	0 (0.0)	1 (5.0)
3 ~ 4	1 (9.1)	2 (22.3)	3 (15.0)
5 ~ 6	5 (45.5)	3 (33.3)	8 (40.0)
7 ~ 8	4 (36.4)	4 (44.4)	8 (40.0)

Values are presented as n (%).

NCGPPD: Non-equivalent Control Group Pre-Posttest Design, NCGPD: Non-equivalent Control Group Posttest Design, NCGND: Nonequivalent Control Group No-synchronized Design, OPPD: One group Pre-Posttest Design, TPPD: Two group Pre-Posttest Design.

^aLiterature published on International journal (Int'l), ^bLiterature published in Korea (Korea).

lowing-related QoL (SWAL-QoL) or oral health-QoL, and NS. In the case of the International literature, 10 (90.9%) were evaluated for oral muscle strength to measure the effect of the intervention, while the Korean literature, 8 (88.9%) were evaluated for QoL.

3. Assessment results according to the intervention method

The analysis of the Assessment results according to the intervention method for swallowing function in the elderly is as follows, which is summarized and presented in Table 6.

1) Intense exercise intervention

① Tongue muscle strengthening exercise

TE were performed with Tongue Strengthening self-Exercise (TSsE) using PEKO PANDA, Tongue Strengthening Exercise (TSE) using IOPI, and physical lingual exercise using a tongue depressor, and the intervention effect was evaluated as Tongue Pressure (TP) and Tongue Strength (TS), which were statistically significant ($p \leq 0.05$).

② Masseter muscle strengthening chewing exercise

MCE were performed by chewing exercise using Gum or No-Sick exerciser devices, and the intervention effects were evaluated by Mixing Ability Index (MAI), Chewing Force (CF), Occlusal Force (OF), Masseter Muscle Thickness (MMT), Unstimulated Salivary Flow Rate (USFR),

Table 4. Intervention Type of Included Studies

Article No. ^a	Intense exercise intervention							Program intervention ^b					
	TE	MCE	HNE	SE	EXP	SOE	ME	NMES	OE	OHE	OM	CCM	EOC
Int'l				10 (90.9)						1 (9.1)			
1	O												
2	O												
3	O												
4		O				O							
5									O	O	O	O	
6		O											
7	O												
8						O							
9			O										
10				O									
11					O								
Korea				2 (22.3)						7 (77.7)			
12	O												
13									O	O	O	O	
14		O											
15									O	O	O		
16									O	O			
17									O	O		O	
18									O				O
19									O	O			O
20									O	O			
Total				12 (60.0)						8 (40.0)			

Values are presented as n (%).

TE: Tongue muscle strengthening Exercise, MCE: Masseter muscle strengthening Chewing Exercise, HNE: Head and Neck strengthening Exercise, SE: Swallowing muscle Exercise, EXP: Expiratory muscle strengthening exercise, SOE: Simple Oral Exercise, ME: Mental Exercise, NMES: Neuro-Muscular Electrical Stimulation, OE: Oral Exercise, OHE: Oral Health Education, OM: Oral Massage, CCM: Customized Oral Health Care Management, EOC: Expert Oral Care.

^aArticle no. 1 ~ 11 (Literature published on International journal, Int'l), 12 ~ 20 (Literature published in Korea, Korea), ^bShaded cells: Program intervention type article.

Repetitive Saliva Swallowing Test (RSST) and was statistically significant ($p \leq 0.05$).

③ Head and neck strengthening exercise

HNE were performed with Head-Lift Exercise (HLE) and Recline Exercise (RE), and the intervention effect was evaluated by vocal ability indicators, and the increase in high vocal frequencies was statistically significant ($p \leq 0.05$). However, there was no significant difference between Cepstral Peak Intensity (CPP) and Perceived Phonatory Effort (PPE).

④ Swallowing muscle strengthening exercise

SE were performed by Swallowing Against Laryngeal Restriction (SALR) using placebo sRed (swallow Resistance exercise device) that compresses the upper occipital region. The intervention effects were evaluated by the

value of Pharyngeal Contractile Integra (PhCI), Maximum Upper Esophageal Sphincter (UES) opening, Hyolaryngeal Excursions (HE), Posterior Pharyngeal Wall Thickness (PPWT). The intervention results showed that repeated swallowing movements without pressure, placebo SALR, significantly increased PhCI only, while for SALR, Maximum UES opening, HE, and PPWT values all increased significantly ($p \leq 0.05$).

⑤ Expiratory muscle strengthening exercise

EXP were performed with Expiratory Muscle Strength Training (EMST), which involves biting mouthpiece with the nasal cavity closed and exhaling as strongly and fast as possible, and the intervention effects were evaluated strength as Orbicularis Oris Muscles (OOM), Buccinator Muscles (BM), and Suprahyoid Muscles (SM). As a result of the

Table 5. Assessment Variables of Included Studies

Article No. ^a	Muscular strength					Oral function				Oral health and hygiene status				QoL	NS	
	TM	MM	OFM	PM	EP	SFA	SA	MO	AO	OHS	PI/GI	Halitosis	Comf			
Int'l		10 (90.9)					6 (54.5)				2 (18.2)				2 (18.2)	0 (0.0)
1	O															
2	O															
3	O						O									
4		O				O	O									
5	O									O				O		
6		O														
7	O		O			O								O		
8		O				O	O							O		
9									O							
10				O												
11			O		O											
Korea		6 (66.7)					7 (77.8)				5 (55.6)				8 (88.9)	1 (11.1)
12	O	O				O	O		O					O		
13	O						O								O	
14		O														
15										O				O	O	
16							O								O	
17		O				O				O	O	O			O	
18			O			O	O	O				O			O	
19		O				O	O				O				O	
20							O								O	
Total		16 (34.04)					13 (27.65)				7 (14.89)				10 (21.27)	1 (2.12)

Values are presented as n (%).

TM: Tongue Muscle, MM: Masseter Muscle, OFM: Oral-Facial Muscle, PM: Pharyngeal Muscle, EP: Expiratory Pressure, SFA: Saliva Flow Ability/Oral Moisture, SA: Swallowing Ability/Dysphagia Risk, MO: Mouth Opening, AO: Acoustic Outcome, OHS: Oral Health Statue, PI/GI: Plaque Index/Gingival Index, Comf: self-reported oral comfort/discomfort, QoL: Quality of life, NS: Nutritional status.

^aArticle no. 1 ~ 11 (Literature published on International journal, Int'l), 12 ~ 20 (Literature published in Korea, Korea).

intervention, only OOM increased when placebo EMST was performed without resistance, but BM and SM were significantly enhanced when EMST was performed with resistance ($p \leq 0.05$).

⑥ Simple oral exercise

SOE were performed with bare-body exercises consisting of lip stretching, tongue stretching, cheek stretching, masticatory muscle exercises, and swallowing movements, and the intervention effects were measured by MAI, OF, USFR, RSST, and Oral Moisture, which was statistically significant ($p < 0.01$).

⑦ Mental exercise

ME was performed with Mental Practice using Motor Imagery (MP-MI), and the intervention effect was assessed as Maximum Isometric tongue Pressure (MIP) and

Regular Effort Saliva Swallowing (RESS) in parallel with physical tongue exercise. MIP values were not statistically significant when MP-MI was performed only ($p > 0.05$), but both MIP and RESS values were statistically significant when MP-MI and physical tongue exercises were performed together ($p < 0.01$).

⑧ Neuro-muscular electrical exercise

NMES were performed using STIMPLUS DP200 (Cybermedic Corp., Iksan, Korea) and were performed in combination with chewing exercises. The intervention effect was evaluated as Maximum Occlusal Force (MOF) and MMT, and both were statistically significant, and the improvement rate of MMT was significantly higher when NMES was combined compared to chewing exercises alone ($p < 0.01$).

Table 6. Summary of Included Studies

Article No. ^a	Subject	Intervention		Con.	Assessment	Outcome
		Exp.				
1	Elderly (n=27) - 65 ≤ aged - Day services center	<ul style="list-style-type: none"> • Tongue Strengthening self Exercises (TSsE) using PEKO PANDA: pushing the anterior tongue against the hard palate. - 30 time/set, 3 set/d, 5 d/wk, 8 wks 	No intervention	<ul style="list-style-type: none"> • MTP • ETP - Baseline, 2 wks, 4 wks, 6 wks, 8 wks 	MTP* (▲) ETP** (▲)	
2	Elderly (n=20) - 70 ≤ aged - Nursing home	<ul style="list-style-type: none"> • Tongue Strengthening Exercises (TSE) using IOPI. • Tongue-pressure resistance training (TPRT) method. - 3 or 5 set/wk, 8 wks 	No intervention	<ul style="list-style-type: none"> • MIP (MIPA) using IOPI. • Pswal (PswalA, PswalP) using IOPI. - Baseline, 4 wks, 8 wks recall: 12 wks, 16 wks 	3 set a wk MIPA*** (▲) PswalA***, (▲) 5 set a wk MIPA***, (▲) PswalA***, (▲)	
3	Elderly (n=29) - 60 ≤ aged - Community-dwelling	<ul style="list-style-type: none"> • Mental Practice using Motor Imagery (MP-MI). • Physical lingual exercise=physical TSE using tongue depressor. - 3 times/d, 3 d/wk, 6 wks 	No intervention	<ul style="list-style-type: none"> • MIP using IOPI. • RESS using IOPI. - Baseline, 2 wks, 4 wks, 6 wks 	MP-MI only MIP* (▲) TSE only Nothing MP-MI and TSE MIP** (▲) RESS** (▲)	
4	Elderly (n=96) - 65 ≤ aged - Senior culture center	<ul style="list-style-type: none"> • Simple Oral Exercise (SOE). • Gum chewing Exercise with SOE (GOE) Using chewing gum. - 2 min/1 set, 2 set/d, 7 d/wk, 8 wks 	No intervention	<ul style="list-style-type: none"> • MAI • OF • USFR • RSST - Baseline, 2 wks, 5 wks, 8 wks recall 10 wks 	SOE Nothing GOE MAI** (▲) OF** (▲)	
5	Elderly (n=40) - 65 ≤ aged - Community-dwelling	<ul style="list-style-type: none"> • Oral health education mobile app program (OHEMA): oral health education, customized oral health care management, oral exercises (with chewing and tongue exercise), oral massage. - 50 min/1 set, 1 set/wk, 6 wks 	No intervention	<ul style="list-style-type: none"> • TP • GOHAI • USFR • SWAL-QoL - Baseline, 6 wks 	TP*** (▲) GOHAI*** (▲) USFR*** (▲) SWAL-QoL*** (▲)	
6	Elderly (n=35) - 65 ≤ aged - Senior welfare center	<ul style="list-style-type: none"> • Neuro Muscular Electrical Stimulation (NMES) using STIMPLUS DP200. • Chewing Exercises (CE) using No-Sick exerciser. - 20 min/set, 1 set/d, 5 d/wk, 6 wks 	CE only	<ul style="list-style-type: none"> • MOF with ACCURA • MMT using portable ultrasound. - Baseline, 6 wks 	NMES and CE MOF*** (▲) MMT*** (▲) Con. CE only MOF** (▲) MMT** (▲)	

Table 6. Continued

Article No. ^a	Subject	Intervention		Assessment	Outcome
		Exp.	Con.		
7	Elderly (n=74) - 65 ≤ aged - Senior welfare center	<ul style="list-style-type: none"> • Tongue-Hold Swallowing (THS). • TPRT using IOPL. - 30 times/set, 3 set/d, 3 d/wk, 8 wks	No intervention	<ul style="list-style-type: none"> • ATS, PTS using IOPL. • Lip strength using IOPL. • SFR • OHIP-14 - Baseline, 8 wks	THS ATS* (▲) PTS* (▲) SFR*** (▲) TRRT ATS** (▲) SFR* (▲) Poor oral health MAI** (▲) USFR** (▲) RSST*** (▲) Good oral health OM* (▲) Vocal range*** (▲)
8	Elderly (n=84) - 65 ≤ aged - Senior citizen center	<ul style="list-style-type: none"> • SOE: lip stretching, tongue stretching, cheek stretching, masticatory muscle exercise and swallowing movements. - 2 set/d, 1 wk	No intervention	<ul style="list-style-type: none"> • MAI • USFR • OM using Mucus • RSST • Self-reported discomfort. • Baseline, 1 d, 1 wk. • Vocal range. • Cepstral peak premaintenance. • Perceived phonatory effort. - Baseline, 6 wks recall 12 wks	MAI** (▲) USFR** (▲) RSST*** (▲) Good oral health OM* (▲) Vocal range*** (▲)
9	Elderly (n=22) - 60 < aged < 85 - No mention	<ul style="list-style-type: none"> • Head-lift exercise (HLE). • Recline exercise (RE). - 3 set/d, 7 d/wk, 6 wks	No intervention	<ul style="list-style-type: none"> • Maximum UES opening. • HE • PhCI • PPWT - Baseline, 6 wks	sRED UES*** (▲) HE* (▲) PPWT* (▲) Con. no sRED PhCI* (▲)
10	Elderly (n=38) - 70 ≤ aged- No mention	<ul style="list-style-type: none"> • Swallowing against laryngeal restriction exercise using sRED: sRED device was placed around the neck overlying tight the laryngeal cartilage. - 3 set/d, 7 day/wk, 6 wks	Placebo sRED No pressure, no agamst swallowing exercise	<ul style="list-style-type: none"> • Maximal expiratory pressure with micro RPM. • BM, OOM with IOPL. • SM - Baseline, 4 wks	Placebo EMST OOM* (▲) EMST BM* (▲) OOM* (▲) SM* (▲)
11	Elderly (n=24) - 65 ≤ aged - No mention	<ul style="list-style-type: none"> • Expiratory Muscle Strength Training (EMST) using EMST devices, EST mouthpiece: hold a mouthpiece and exhale maximally, as strong & fast as possible. - 125 time/set, 1 set/day, 5 d/week, 4 wks	Placebo EMST using resistance-free EMST devices	<ul style="list-style-type: none"> • Dry mouth and behaviors. • Discomfort in chewing. • Swallowing disorder. • OM using Mucus. • Chewing force • RSST • Pronounce function (Pronunciation). • TP using TPM. - Baseline, 8 wks	Dry mouth, behaviors* (▼) Swallowing disorder** (▼) OM*** (▲) RSST* (▲) Pronunciation* (▲) TP* (▲)
12	Elderly (n=29) - 65 ≤ aged - Senior welfare facilities	<ul style="list-style-type: none"> • Oral education. • Oral Exercises Program (OEP). • TSsE using PEKO PANDA. - 2 times/wk (OEP), 45 reps/d, 3 d/wk (TSsE), 8 wks	<ul style="list-style-type: none"> • OEP • No TSsE 	<ul style="list-style-type: none"> • Pronounce function (Pronunciation). • TP using TPM. - Baseline, 8 wks	Pronunciation* (▲) TP* (▲)

Table 6. Continued

Article No. ^a	Subject	Intervention		Assessment	Outcome
		Exp.	Con.		
13	Elderly (n=40) - 65 ≤ aged - Community-dwelling	<ul style="list-style-type: none"> • Home Visit Oral Health Education program: oral health education music intervention, oral exercise (gum chewing exercise, tongue clock exercise), massage, customized oral health care management. - 50 min/set 1 set/wk, 6 wks 	No intervention	<ul style="list-style-type: none"> • Saliva amylase (stress test) • TP using TPM. • RSST • USFR • OM • SWAL-QoL - Baseline, 6 wks • MMT using SONON 300L. • OF using ACCURA. - Baseline, 3 wks, 6 wks 	<ul style="list-style-type: none"> TP*** (▲) RSST*** (▲) OM*** (▲) SWAL-QoL** (▲)
14	Elderly (n=29) - 65 ≤ aged - Senior Welfare Center	<ul style="list-style-type: none"> • Bilateral chewing exercise using No-Sick Exerciser. - 20 min/set, 1 set/d, 5 day/wk, 6 wks 	-	<ul style="list-style-type: none"> • MMT using SONON 300L. • OF using ACCURA. - Baseline, 3 wks, 6 wks 	<ul style="list-style-type: none"> MMT* (▲) OF* (▲)
15	Elderly (n=45) - 65 ≤ aged - Senior Welfare Center	<ul style="list-style-type: none"> • Intervention mapping protocol (IMP): music intervention, oral exercises program, massage, oral health education. - 1 d/wk, 5 wks 	No intervention	<ul style="list-style-type: none"> • Depression • Self-efficacy • Subjective oral health status • Oral-comport • SWAL-QoL - Baseline, 5 wks 	<ul style="list-style-type: none"> Self-efficacy** (▲) Subjective oral health status*** (▲) Oral-comport*** (▲) SWAL-QoL*** (▲)
16	Elderly (n=98) - 65 ≤ aged - Community-dwelling	<ul style="list-style-type: none"> • Swallowing education program: oral stretching (a.e.i.o.u), oral exercises program (Lip, Tongue, cheek stretching, vocalization exercise), oral health education. • 30 min/set, 1 set/d, 1 d/wk, 4 wks 	No intervention	<ul style="list-style-type: none"> • Dysphagia Risk Assessment using dysphagia risk screening system. • SWAL-QoL • Baseline, 4 wks 	<ul style="list-style-type: none"> Dysphagia Risk*** (▲) SWAL-QoL* (▲)
17	Elderly (n=44) - 65 ≤ aged - Long-term care home (Long-term care facilities)	<ul style="list-style-type: none"> • Integrated Oral Health Care Program: Oral health education, oral exercises program (Lip, Tongue, cheek stretching), customized oral health care management. • 1 h/set, 1 set/d, 2 d/wk, 8 wks. 	No intervention	<ul style="list-style-type: none"> • PI, GI, Halitosis • OM using Mucus. • Perceived dry mouth, chewing ability, oral health. - Baseline, 4 wks • OM using Mucus. • Mouth opening. • Oral muscle strength. • RSST • Halitosis test. - Baseline, 4 wks 	<ul style="list-style-type: none"> PI*** (▲) GI*** (▲) Halitosis** (▲) OM** (▲) Perceived oral health** (▲) OM*** (▲) Mouth opening* (▲) Oral muscle strength* (▲) RSST* (▲)
18	Elderly (n=75) - 65 ≤ aged - Nursing home	<ul style="list-style-type: none"> • Oral Health Promotion Program: Oral exercises, Expert oral care (Watanabe method). • 30 min/set, 1 set/d, 2 d/wk, 4 wks. 	No intervention	<ul style="list-style-type: none"> • Mouth opening. • Oral muscle strength. • RSST • Halitosis test. - Baseline, 4 wks 	<ul style="list-style-type: none"> Mouth opening* (▲) Oral muscle strength* (▲) RSST* (▲)

Table 6. Continued

Article No. ^a	Subject	Intervention		Assessment	Outcome
		Exp.	Con.		
19	Elderly (n=50) - 65 ≤ aged - Long-term care home (Long-term care facilities)	<ul style="list-style-type: none"> • Oral Health Promotion Program: oral stretching (a.e.i.o.u), oral exercises program (neck, tongue, cheek, swallowing stretching, vocalization exercise), oral health education, expert oral care (Watanabe). • 1 set/d, 2 d/wk, 8 wks 	No intervention	<ul style="list-style-type: none"> <Oral health status> • PI O'Leary index • OM using Mucus. • Oral muscle strength • OF using GM10 • RSST • OHIP-14 - Baseline, 2 wks, 4 wks, 6 wks, 8 wks 	Oral health status** (▲) OHIP-14*** (▲)
20	Elderly (n=85) - 65 ≤ aged - Nursing Hospital	<ul style="list-style-type: none"> • Swallowing rehabilitation program: Oral exercises program neck stretching, lip stretching, cheek stretching, tongue, chin exercise. • 15 min/set, 1 set/d, 5 d/wk, 8 wks 	No intervention	<ul style="list-style-type: none"> • Dysphagia stage • Nutritional status (MAMC, Total lymphocytes counts, Hemoglobin, Albumin, Total cholesterol) • SWAL-QoL - Baseline, 8 wks 	MAMC* (▲) SWAL-QoL*** (▲)

MTP: Maximum Tongue Pressure, ETP: Endurance of Tongue Pressure, MIP: Maximum Isometric tongue Pressure, MIPA: Maximum Isometric tongue Pressure Anterior, Pswal: tongue strength during an effortful saliva swallow, PswalA: Anterior tongue strength during an effortful saliva swallow, PswalP: Posterior tongue strength during an effortful saliva swallow, RESS: Regular Effort Saliva Swallowing, MAI: Mixing Ability Index, OF: Occlusal force (=Occlusal strength), USFR: Unstimulated Salivary Flow Rate, RSST: Repetitive Saliva Swallowing Test, TP: Tongue Pressure, GOHAI: Geriatric Oral Health assessment Index, SWAL-QoL: Swallowing-Quality of Life, MOF: Maximum Occlusal Force, MMT: Masseter Muscle Thickness, ATS: Anterior Tongue Strength, PTS: Posterior Tongue Strength, SFR: Salivary Flow Rate, OHIP-14: Oral Health Impact Profile, OM: Oral Moisture, UES: Upper Esophageal Sphincter, HE: Hyolaryngeal Excursions, PhCI: Pharyngeal Contractile Integral, PPWT: Posterior Pharyngeal Wall Thickness (PPW-Hold: before the initiation of swallow, PPWMax: during swallow), BM: Buccinator Muscles, OOM: Orbicularis Oris Muscles, SM: Suprahoid Muscles, PI: Plaque Index, GI: Gingival bleeding Index, MAMC: Mid-upper Arm Muscle Circumference, Exp.: Experimental group, Con.: control group. -: not available.

^a Article no. 1 ~ 11 (Literature published on International journal, Int'l), 12~20 (Literature published in Korea, Korea).

2) Program intervention

① Oral exercise and oral health education program

Swallowing rehabilitation program³⁴⁾ and Swallowing education program³⁰⁾ consisted of OE and OHE. Swallowing rehabilitation program had a statistically significant difference between Mid-upper Arm Muscle Circumference (MAMC) and SWAL-QoL before and after the program ($p < 0.05$), but there was no statistically significant difference in the Dysphagia stage. For the Swallowing education program, there was a statistically significant difference between Dysphagia risk and SWAL-QoL before and after the program ($p < 0.05$).

② Oral Exercise, Oral Health Education, and oral massage program

Intervention Mapping Protocol (IMP) program¹²⁾, consisting of OE, OHE, and OM, then intervention effects with depression, self-esteem, subjective oral health status, oral comfort, and SWAL-QoL, with statistically significant differences in all items except depression ($p < 0.05$).

③ Oral Exercise, Oral Health Education, and customized oral health care management program

For the Integrated Oral Health Care Program³¹⁾, which consists of OE, OHE, and CCM. Then intervention effects were assessed using PI and GI, Halitosis, OM, perceived dry mouth, perceived chewing ability, and perceived oral health. There were significant differences in PI and GI, Halitosis, OM, and perceived oral health before and after the program ($p < 0.01$), and there was no statistically significant difference in perceived dry mouth and perceived chewing ability.

④ Oral Exercise, Oral Health Education, and Expert Oral Care Program

In the case of the Oral Health Promotion Program^{32,33)}, which consists of OE, OHE, and EOC. Then intervention effects were assessed using OM, MO, Oral muscle strength, RSST, Halitosis. There was a significant difference ($p < 0.05$), except for Halitosis.

⑤ Oral Exercise, Oral Health Education, Oral Massage, Customized oral health Care Management program

For the Oral Health Education Mobile App (OHEMA) program²¹⁾ and the Home Visit Oral Health Education program, all OE, OHE, OM, and CCM were included

except for EOC. For the OHEMA program using the mobile app OHEMA, there was a statistically significant difference in TP, Geriatric Oral Health assessment Index (GOHAI), USFR, and SWAL-QoL before and after the program ($p < 0.001$). For the Home Visit Oral Health Education program²⁸⁾, there was a statistically significant difference in TP, RSST, OM, and SWAL-QoL ($p < 0.001$), but Saliva amylase and USFR were not statistically significant.

Discussion

1. Key results interpretation and comparison with the previous studies

Swallowing refers to a series of processes in which food is recognized, taken into the mouth, and sent through the mouth, pharynx, and esophagus to the stomach^{9,35)}. This is done by swallowing-related muscles present in the mouth, pharynx, esophagus, etc., and when the function of the muscles decreases due to aging, swallowing control is difficult, and food residues in the mouth increase, resulting in dysphagia in severe cases³⁶⁾. Age-induced deterioration in swallowing function is a symptom not only in unhealthy older adults, but also in healthy older adults, and interventions to strengthen swallowing function are necessary for all older adults⁹⁾. In recent years, with the increasing interest in the health and quality of life of the elderly, various intervention studies have been proposed for swallowing function in the elderly^{6,11)}, and the intervention methods and evaluation methods between these studies are very different^{21-23,26)}, limiting their practical application. Therefore, in order to establish an effective elder swallowing intervention program, this study reviewed Korean and International literatures about elder swallowing intervention published from 2010 to the present and compared the effects of the intervention methods.

In this study, the literature on the application of swallowing interventions in elderly people over 60 years of age was selected, and a total of 20 studies were included in 11 International literatures and 9 Korean literatures. Although the total number of literature on the elderly swallowing intervention was somewhat limited, the number of Korea and International published literature steadily

increased from 2014 to the last three years, indicating that interest in elderly swallowing intervention was increasing. Especially in the literature published in international academic journals, it was evident that studies conducted by Korean researchers on elderly intervention have been recognized, indicating a vibrant interest in this area in Korea recently. This is evidenced by the fact that Korea, as a country experiencing rapidly declining birth rates and rapid aging, is entering an ultra-aged society at a faster pace even on a global scale¹⁾. As a result, there has been an increased interest in elderly health issues. However, it should be noted that some Korean literature is observed with the same author's name. This suggests that research on the elderly swallowing function intervention is not yet actively conducted in various fields except for some researchers. Therefore, it is considered necessary to actively pursue further research on swallowing intervention for the elderly in the future, especially as the issue of aging becomes increasingly serious.

On the other hand, the analysis of the general characteristics of the selected literature reveals that seniors' welfare centers had the largest number of sample sites, with five and day care centers and nursing hospitals with one. Unlike senior care centers, which belong to leisure care facilities for the elderly, day care centers provide care and relief programs for people with geriatric diseases³⁷⁾, and nursing hospitals are medical institutions that provide necessary care to elderly people with dementia or strokes. Most elderly people living in day care centers and nursing hospitals are elderly people who need physical and mental care, and problems such as eating disorders due to dysphagia can aggravate the health problems of the elderly, making swallowing interventions more necessary^{34,38)}. There are also advantages to day care centers having regular group activities for a certain period of time^{39,40)} and nursing hospitals being staffed by resident medical staff, so swallowing interventions can be carried out more effectively³²⁾. Therefore, it is believed that studies should be conducted on the elderly in more diverse places, targeting research sites that are currently lacking, such as day care centers and nursing hospitals. In addition, it seems that it will be meaningful to organize the program in consideration of the characteristics of each institution

when conducting research on intervention programs. For intervention periods, 1~2 weeks, 3~4 weeks, 5~6 weeks, and 7~8 weeks, most of them were 6 and 8 weeks. When swallowing interventions were applied for 1 week, in the study²⁴⁾, the intervention effect was clear in the elderly with an unhealthy oral environment, but there was no change in masticatory and swallowing function in the elderly with a healthy oral environment. The 4 week study³⁰⁾ showed an improvement in the risk of dysphagia and SWAL-QoL, but did not measure indicators that directly affect swallowing, such as oral muscle strength, swallowing ability, and salivation capacity, so it was difficult to judge that the intervention was effective in improving swallowing function. On the other hand, 6 and 8 weeks of interventions showed a clear improvement in most of the endpoints, and the effect of the intervention was maintained after the end of the intervention^{14,18)}. Therefore, interventions of at least 6 weeks can be taken into consideration to identify specific intervention effects and complete intervention performance when developing swallowing interventions in the future.

Intervention methods were broadly divided into intensive exercise interventions and program interventions. The intensive exercise intervention was an intervention to enhance swallowing function by improving swallowing-related muscle strength through strength training. Among the intensive intervention types, the most studies applied TE and MCE. In the TE study, tongue resistance exercises were performed using PEKO PANDA, IOPI, and tongue depressors, and the intervention effect showed an improvement in tongue muscular strength. The tongue is an important muscle that forms a lump of food in the stage of swallowing the oral, and it can be expected to strengthen the function of swallowing by strengthening the tongue muscle¹³⁾. And it is noteworthy another side that various tools are considered for the same intervention. This study only identified research trends in the included studies and focused on intervention methods and results, but as various tools are being developed, comparative analysis and evaluation studies on intervention tools seem to be needed in the future. As the target of intervention is the elderly, it is important to consider not only the tool's effectiveness but also the price, ease of use, and sustain-

nability of the tool together. Yano et al.¹³⁾ also emphasized that IOPI is expensive and difficult to operate, making it difficult to use at home or in clinical settings, but PEKO PANDA is less accessible and can be easily used repeatedly by the elderly at home, Lazarus et al.⁴¹⁾ reported no significant difference in exercise effect between IOPI and tongue depressor. Like this, proactively evaluating the tool's entry barriers is expected to be meaningful when designing future interventions. In the MCE study, it has been shown to improve saliva flow as well as strengthen masticatory muscle. These results indicate that the contraction of the masticatory muscles⁴²⁾ was a result of stimulation parotid duct⁴²⁾. In the SE study, it was found to enhance the movement of muscles involved in the swallowing process, and in the EXP study was found to strengthen oral muscle strength involved in the swallowing process. And SE and EXP were found to be more effective in resistance training than non-resistance training. This seems to be because more effective muscle training is possible when you are properly overloaded and tired during muscle contraction⁴³⁾. Therefore, it can be taken into consideration to accompany resistance when developing an intervention plan using SE or EXP in the future. In the SOE, ME, and NMSE study, those have been shown to improve the mediating effect of muscle training further when performed in combination with other oral strength training but were ineffective when performed alone. Therefore, intervention research using SOE, ME, and NMSE in the future can be considered a method with other oral muscle exercises. However, more research is still needed to generalize this. Finally, in the HNE study found that only a high increase in high vocal frequency was observed as a result of the intervention, so then the researchers who conducted the study reported that these results alone were insufficient to be considered an effective intervention method to improve swallowing in older adults. Therefore, it is necessary to reconfirm its effectiveness through further research on HNE in the future.

Meanwhile, program interventions involving OE and OHE were structured including OM, CCM, or EOC. Intervention effects were assessed on a variety of factors, including dysphagia, oral cleanliness, subjective oral health, oral discomfort, and SWAL-QoL. Some papers have

evaluated depression, self-efficacy, and nutritional status. In the literature, the program with CCM or EOC confirmed improvements in oral hygiene conditions such as PI, GI, and Halitosis. Previous studies such as Lee et al.⁴⁴⁾ emphasized that it is more effective to include customized oral health care when customized oral health care, and Choi et al.⁴⁵⁾ has also been suggested that expert management oral care, such as Watanabe tooth brushing, should be combined with oral health programs. In a program studies with CCM^{28,31)} or EOC^{32,33)} identified in this study, those were also effectively identified at various endpoints compared to programs that only provide OE and OHE, supporting the claims of previous studies. This is likely due to the fact that when CCM or EOC is combined within the program, the subject is more immersed based on trust in the professional. However, in the case of program interventions, the improvement of the swallowing function is indirectly evaluated, details and methods of application, and evaluation items of the intervention methods were very different, making it difficult to compare them further. The fact that intervention methods and the duration and frequency of intervention delivery vary between studies suggests that a specific and precise intervention program for elderly swallowing intervention has not yet been established. Therefore, it is expected that studies should be conducted in the future to unify various indicators and provide standards for intervention programs.

2. Suggestions and limitations

This study performed PICO and PRISMA according to a systematic review, but the quality evaluation was not carried out, so it was difficult to generalize the results of the study by targeting only 20 articles. In future studies, the quality evaluation of the selected literature should be conducted to prove its validity, and a systematic review should be conducted through the expansion of the selected literature. Nevertheless, it is meaningful as a result of proving that research on elderly swallowing intervention should be conducted more actively than now. In addition, it analyzes interventions in elderly swallowing and considers their effects, which is meaningful. So, at a time when the population is aging, and the quality of life of the elderly is becoming more important, this study is expected

to be used as basic data when developing senior intervention programs or designing research in the future.

Conclusion

This review of the intervention program for the elderly sought to provide evidence for effective interventions for strengthening swallowing function in the elderly. The final 20 studies from 2010 to 2022 were selected and analyzed. Until recently, publication trends have been increasingly reported in both international and Korean journals, and interest in intervention for the elderly has been increasing. Mediation for senior citizens consisted largely of intensive exercise intervention and program intervention. TE was the most frequently involved in intensive exercise, and programs composed of OE, OHE, OM, and CCM were the most frequently involved. Intensive exercise intervention was mainly measured by strengthening oral muscle strength, and program intervention was measured by oral condition or quality of life. Referring to this study, it can help clinicians select effective swallowing interventions for older adults. This study is also meaningful in that it can be the basic data for future research designs focusing on interventions to swallow the difficulties of the elderly population.

Notes

Conflict of interest

No potential conflict of interest relevant to this article was reported.

Ethical approval

Not Applicable.

Author contributions

Conceptualization: Hee-Jung Lim and Na-Yeon Tak. Data acquisition: Na-Yeon Tak, Hanna Gu, Hyuong-Joo Kim, Jun-Yeong Kwon, and Hee-Jung Lim. Formal analysis: Na-Yeon Tak. Funding: Na-Yeon Tak, Hanna Gu, Hyuong-Joo Kim, Jun-Yeong Kwon, and Hee-Jung Lim. Supervision: Hee-Jung Lim. Writing-original draft: Na-Yeon Tak. Writing-review & editing: Hee-Jung Lim,

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Data availability

The data and materials of this article are included within the article. The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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