Supporting Information

Title: Association between Dysphagia and Frailty in Older Adults: A Systematic Review and Meta-Analysis

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Table S1. Newcastle–Ottawa Scale for Critical Appraisal of Cross-Sectional and Longitudinal Studies

		Selection				Comparability	Outcome		
Source	**Study design**	**Representativeness of the sample**	**Sample size**	**Non-respondents**	**Ascertainment of exposure**	**Based on design and analysis**	**Assessment of outcome**	**Statistical test**	**Total score**
Chang 2011	Cross-sectional	+1 (b)	+0 (b)	+0 (c)	+1 (b)	+2 (a & b)	+2 (b)	+1 (a)	7/10
Gonzalez-Fernandez 2014	Cross-sectional	+0 (c)	+0 (b)	+0 (c)	+2 (a)	+0	+2 (a)	+0 (b)	4/10
Bahat 2019	Cross-sectional	+0 (c)	+0 (b)	+0 (c)	+2 (a)	+2 (a & b)	+2 (b)	+1 (a)	7/10
Watanabe 2019	Cross-sectional	+1 (b)	+0 (b)	+1 (a)	+2 (a)	+0	+1 (c)	+0 (b)	5/10
Ambagtsheer 2020	Cross-sectional	+1 (b)	+0 (b)	+0 (c)	+0 (c)	+2 (a & b)	+1 (c)	+1 (a)	5/10
Cohen 2020	Cross-sectional	+1 (a)	+1 (a)	+1 (a)	+0 (c)	+2 (a & b)	+2 (b)	+1 (a)	8/10
Nishida 2020	Cross-sectional	+1 (a)	+0 (b)	+0 (b)	+1 (b)	+2 (a & b)	+1 (c)	+1 (a)	6/10
Shimazaki 2020	Cross-sectional	+1 (b)	+0 (b)	+0 (b)	+2 (a)	+2 (a & b)	+1 (c)	+1 (a)	7/10
Wang 2020	Cross-sectional	+1 (b)	+0 (b)	+0 (c)	+2 (a)	+2 (a & b)	+2 (b)	+1 (a)	8/10
Nishida 2021	Cross-sectional	+1 (b)	+0 (b)	+0 (c)	+2 (a)	+2 (a & b)	+1 (c)	+1 (a)	7/10
Albani 2021 (Newcastle 85+)	Cross-sectional	+1 (b)	+0 (b)	+0 (c)	+1 (b)	+2 (a & b)	+1 (c)	+1 (a)	6/10
Albani 2021 (TOOTH)	Cross-sectional	+1 (b)	+0 (b)	+0 (c)	+1 (b)	+2 (a & b)	+1 (c)	+1 (a)	6/10

		Selection				Comparability	Outcome			
Source	**Study design**	**Representativeness of the exposed cohort**	**Selection of the non-exposed cohort**	**Ascertainment of exposure**	**Outcome was not present at start**	**Based on design and analysis**	**Assessment of outcome**	**Follow up long enough**	**Adequacy of follow up**	**Total score**
Tanaka 2018	Longitudinal	+1 (b)	+1 (a)	+1 (b)	+1 (a)	+2 (a & b)	+1 (b)	+0 (b)	+1 (b)	8/9

Table S2. Sensitivity Analysis

	Odds of Frailty and Pre-Frailty		
Sequential Exclusion of Studies	Pooled Odds Ratio [95% CI]	I^2, %	*P* Value for Heterogeneity
All included studies	3.24 [2.51, 4.20]	77%	< .00001
One study excluded			
Chang 2011	3.26 [2.51, 4.24]	79%	< .00001
Gonzalez-Fernandez 2014	3.29 [2.53, 4.28]	79%	< .00001
Tanaka 2018 (Kashiwa Study)	3.61 [2.87, 4.55]	67%	.0008
Watanabe 2019 (ONEHOME)	3.10 [2.38, 4.05]	79%	< .00001
Ambagtsheer 2020	3.25 [2.48, 4.26]	79%	< .00001
Cohen 2020 (NIS-HCUP-AHRQ)	3.14 [2.14, 4.59]	78%	< .00001
Nishida 2020	3.07 [2.21, 4.25]	78%	< .00001
Shimazaki 2020	2.97 [2.27, 3.88]	76%	< .00001
Wang 2020	3.19 [2.41, 4.21]	79%	< .00001
Nishida 2021	3.22 [2.46, 4.22]	79%	< .00001
Albani 2021 (Newcastle 85+ Study)	3.41 [2.60, 4.48]	76%	< .0001
Albani 2021 (TOOTH Study)	3.50 [2.72, 4.51]	74%	< .0001
Two studies excluded			
Gonzalez-Fernandez 2014 and Tanaka 2018	3.67 [2.89, 4.64]	69%	.0006
Gonzalez-Fernandez 2014 and Cohen 2020	3.21 [2.16, 4.77]	80%	< .00001
Cohen 2020 and Tanaka 2018	3.50 [2.45, 5.00]	70%	.0004
Albani 2021 (Newcastle 85+ Study) and Albani 2021 (TOOTH Study)	3.75 [2.89, 4.87]	71%	.0003
Albani 2021 (Newcastle 85+ Study) and Tanaka 2018	3.91 [3.10, 4.93]	60%	.008
Albani 2021 (TOOTH Study) and Tanaka 2018	3.96 [3.22, 4.85]	54%	.02
Three studies excluded			
Albani 2021 (Newcastle 85+ Study), Albani 2021 (TOOTH Study) and Tanaka 2018	4.28 [3.60, 5.09]	33%	.16
Four studies excluded			
Albani 2021 (Newcastle 85+ Study), Albani 2021 (TOOTH Study), Tanaka 2018 and Gonzalez-Fernandez 2014	4.34 [3.64, 5.18]	37%	.14
Albani 2021 (Newcastle 85+ Study), Albani 2021 (TOOTH Study), Tanaka 2018 and Cohen 2020	4.70 [3.85, 5.74]	4%	.40
Five studies excluded			
Albani 2021 (Newcastle 85+ Study), Albani 2021 (TOOTH Study), Tanaka 2018, Cohen 2020 and Gonzalez-Fernandez 2014	4.77 [3.97, 5.74]	0%	.44

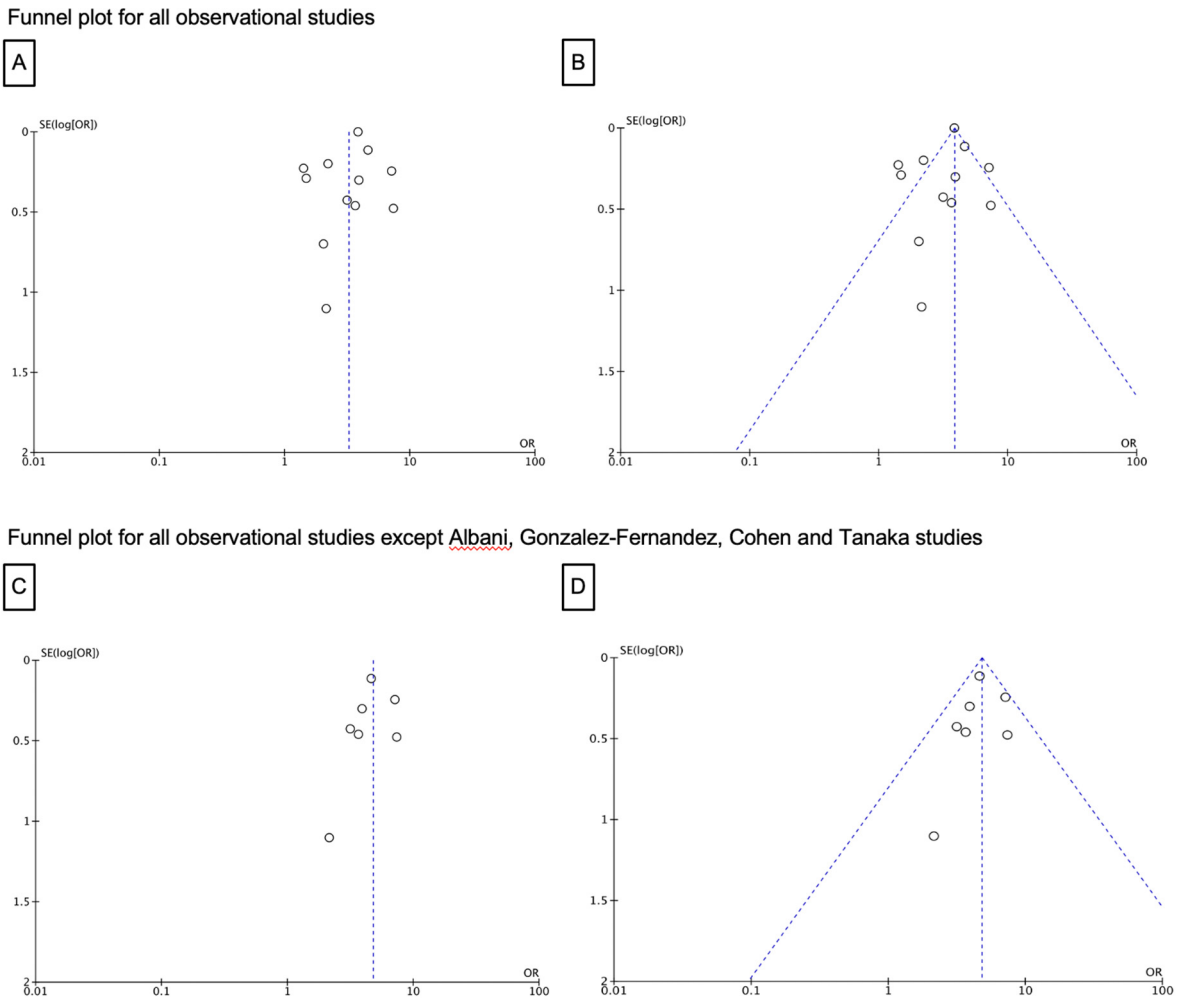

Figure S1. Funnel plots showing potential publication bias. (A). Funnel plots for all 12 observational studies; (B). Funnel plots of (A) showing 95% confidence interval (dotted oblique line); (C). Funnel plots for all observational studies except Albani, Gonzalez-Fernandez, Cohen, and Tanaka studies; (D). Funnel plots of (C) showing 95% confidence interval (dotted oblique line).

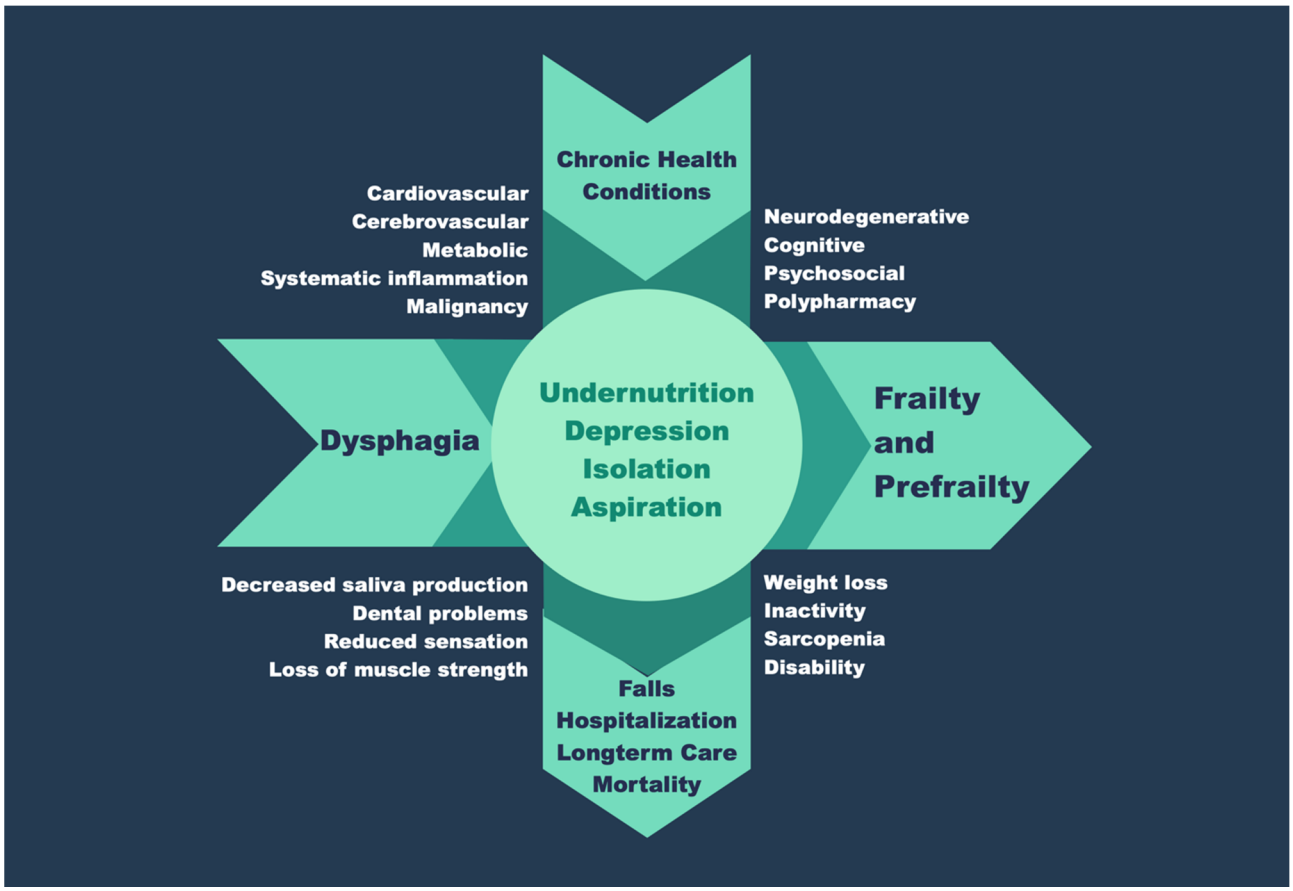

Figure S2. Illustration of potential linkage between dysphagia and frailty.

Methods S1. Detailed Search Strategy

We systematically searched three databases, namely PubMed, Embase, and Cochrane Database of Systematic Reviews. We used free text search first and then used MeSH terms. The search results were presented as follows.

PubMed

Initial search performed on 25 November 2020
Follow-up search performed on 20 April 2022
No limits applied

#	Search Term	No. of Results
1	"swallow"[Title/Abstract] OR "swallowing"[Title/Abstract] OR "absorb"[Title/Abstract] OR "devour"[Title/Abstract] OR "drink"[Title/Abstract] OR "eat"[Title/Abstract] OR "gobble"[Title/Abstract] OR "gulp"[Title/Abstract] OR "ingest"[Title/Abstract] OR "wash down"[Title/Abstract]	90 089
2	"disturbance"[Title/Abstract] OR "loss"[Title/Abstract] OR "impairment"[Title/Abstract] OR "dysfunction"[Title/Abstract] OR "decline"[Title/Abstract] OR "reduc*"[Title/Abstract] OR "decreas*"[Title/Abstract] OR "diminish*"[Title/Abstract] OR "difficult*"[Title/Abstract] OR "problem*"[Title/Abstract] OR "trouble"[Title/Abstract] OR "issues"[Title/Abstract] OR "deficit*"[Title/Abstract] OR "deficien*"[Title/Abstract] OR "insufficien*"[Title/Abstract] OR "hard"[Title/Abstract] OR "poor"[Title/Abstract] OR "bad"[Title/Abstract] OR "low"[Title/Abstract]	11 1262 132
3	1 AND 2	49 921
4	"dysphagia"[All Fields] OR "deglutition disorders"[All Fields]	42 054
5	3 OR 4	84 909
6	"old"[Title/Abstract] OR "old adult"[Title/Abstract] OR "aged"[Title/Abstract] OR "aging"[Title/Abstract] OR "elder"[Title/Abstract] OR "elderly"[Title/Abstract]	2 104 711
7	5 AND 6	15 732
8	"frailty"[All Fields]	21 846
9	7 AND 8	117

Controlled Vocabulary: Medical Subject Headings (MeSH)

Initial search performed on 25 November 2020
Follow-up search performed on 20 April 2022
No limits applied

#	Search Term	No. of Results
1	"deglutition disorders"[MeSH] AND "frailty"[MeSH]	19
2	"deglutition disorders"[MeSH] AND "frailty"[MeSH] AND ("aged"[MeSH] OR "aging"[MeSH])	15

Embase

Initial search performed on 25 November 2020
Follow-up search performed on 20 April 2022

#	Search Term	No. of Results
1	("dysphagia" OR "deglutition disorders") AND ("old" OR "old adult" OR "aged" OR "aging" OR "elder" OR "elderly") AND "frailty"	235

Cochrane Database of Systematic Reviews

Initial search performed on 25 November 2020
Follow-up search performed on 20 April 2022
Word variations excluded (the default function in advanced search, for greater precision)
No other limits applied

#	Search Term	No. of Results
1	"swallow" OR "swallowing" OR "absorb" OR "devour" OR "drink" OR "eat" OR "gobble" OR "gulp" OR "ingest" OR "wash down"	18 737
2	"disturbance" OR "loss" OR "impairment" OR "dysfunction" OR "decline" OR "reduc*" OR "decreas*" OR "diminish*" OR "difficult*" OR "problem*" OR "trouble" OR "issues" OR "deficit*" OR "deficien*" OR "insufficien*" OR "hard" OR "poor" OR "bad" OR "low"	472 430
3	1 AND 2	7 131
4	"dysphagia" OR "deglutition disorders"	5 176
5	3 OR 4	11 639

6	"old" OR "old adult" OR "aged" OR "aging" OR "elder" OR "elderly"	638 414
7	5 AND 6	5 400
8	"frailty"	2 555
9	7 AND 8	39

Controlled Vocabulary: Medical Subject Headings (MeSH)
Initial search performed on 25 November 2020
No limits applied

#	Search Term	No. of Results
1	Deglutition disorders explode all trees	18
2	Frailty explode all trees	51
3	"aged" OR "aging"	555 920
4	1 AND 2 AND 3	1

Methods S2. MOOSE checklist

MOOSE (Meta-analyses Of Observational Studies in Epidemiology) Checklist

A reporting checklist for Authors, Editors, and Reviewers of Meta-analyses of Observational Studies. You must report the page number in your manuscript where you consider each of the items listed in this checklist. If you have not included this information, either revise your manuscript accordingly before submitting or note N/A.

Reporting Criteria	Reported (Yes/No)
Reporting of Background	
Problem definition	YES
Hypothesis statement	YES
Description of Study Outcome(s)	YES
Type of exposure or intervention used	YES
Type of study design used	YES
Study population	YES
Reporting of Search Strategy	
Qualifications of searchers (eg, librarians and investigators)	YES
Search strategy, including time period included in the synthesis and keywords	YES
Effort to include all available studies, including contact with authors	YES
Databases and registries searched	YES
Search software used, name and version, including special features used (eg, explosion)	YES
Use of hand searching (eg, reference lists of obtained articles)	YES
List of citations located and those excluded, including justification	YES
Method for addressing articles published in languages other than English	YES
Method of handling abstracts and unpublished studies	YES
Description of any contact with authors	YES
Reporting of methods	
Description of relevance or appropriateness of studies assembled for assessing the hypothesis to be tested	YES
Rationale for the selection and coding of data (eg, sound clinical principles or convenience)	YES

Reporting Criteria	Reported (Yes/No)
Documentation of how data were classified and coded (eg, multiple raters, blinding, and interrater reliability)	YES
Assessment of confounding (eg, comparability of cases and controls in studies where appropriate)	YES
Assessment of study quality, including blinding of quality assessors; stratification or regression on possible predictors of study results	YES
Assessment of heterogeneity	YES
Description of statistical methods (eg, complete description of fixed or random effects models, justification of whether the chosen models account for predictors of study results, dose-response models, or cumulative meta-analysis) in sufficient detail to be replicated	YES
Provision of appropriate tables and graphics	YES
Reporting of Results	
Table giving descriptive information for each study included	YES
Results of sensitivity testing (eg, subgroup analysis)	YES
Indication of statistical uncertainty of findings	YES
Reporting of Discussion	
Quantitative assessment of bias (eg, publication bias)	YES
Justification for exclusion (eg, exclusion of non-English-language citations)	YES
Assessment of quality of included studies	YES
Reporting of Conclusions	
Consideration of alternative explanations for observed results	YES
Generalization of the conclusions (ie, appropriate for the data presented and within the domain of the literature review)	YES
Guidelines for future research	YES
Disclosure of funding source	YES

Once you have completed this checklist, please save a copy and upload it as part of your submission. DO NOT include this checklist as part of the main manuscript document. It must be uploaded as a separate file.

Protocol

Protocol for a systematic review and meta-analysis on the associations between dysphagia and frailty and prefrailty outcomes in older adults

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No existing protocols are currently available for this topic. This protocol is not registered. This work is investigator-initiated. The corresponding author received funding from the Ministry of Science and Technology of the Republic of China (Taiwan) under grant MOST 109-2511-H-567-001-MY2 and, in part, funded by Cardinal Tien Hospital under grant CTH109A-2207 and CTH110A-2202. The funders had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

Introduction

Aging is an ongoing global health concern. The total number of people aged ≥60 years worldwide is estimated to rise from approximately 1 billion in 2020 to 2 billion by 2050.[1] Notably, according to experts, the older-age dependency ratio, defined as the number of people aged ≥65 years per 100 working-age adults (aged 20-64 years), is projected to nearly double from 17 in 2020 to 30 in 2050; this signifies that the ratio of working-age adults to older persons will drop to only 3:1.[2] To address this trend, the World Health Organization initiated an action plan in 2020 to improve functional ability, intrinsic capacity, and environment, which are considered crucial components for achieving the goal of "healthy aging."[3] Of these components, optimizing functional ability in older adults is the most effective for achieving independent and healthy aging.

Safe and effective swallowing is a bodily function essential to human life. Safe swallowing involves an alternating on-and-off interaction between respiration and swallowing and an integrated cough reflex.[4,5] Effective swallowing also requires intact muscular and neurocognitive coordination. However, these life-sustaining functions decline with advanced ages.[6] Strategies for adapting to these hazardous aging-related changes, including modifications to food consistency, adoption of swallow postures and maneuvers, and cortical compensation,[7] may help minimize the effect of such changes on quality of life; nevertheless, the accumulation of precipitating factors (eg, decreased saliva production; worsening dental problems; reduced oral, pharyngeal, and esophageal mucosal sensitivity; and loss of muscle mass and strength) may lead to decompensation that engenders an increased susceptibility to swallowing dysfunction.[8] Consequently, swallowing difficulties manifest with aging.[9,10]

Dysphagia is a subjective feeling of difficulty or discomfort in safely and effectively moving a dietary bolus from the oral cavity to the stomach. The difficulty or discomfort may involve the passage of the bolus from the oral cavity to the esophagus (ie, oropharyngeal dysphagia), passage of the bolus from the esophagus to the stomach (ie, esophageal dysphagia), or both. The prevalence of dysphagia increases with advanced age.[11] Using submental surface electromyography and nasal airflow measurement, Wang et al[12] demonstrated that compared with the young- and middle-aged participants, healthy older community-dwelling participants had a significantly delayed onset of swallowing, a longer

duration of swallowing apnea, and a greater probability of piecemeal deglutition. In individuals aged younger than 60 years, dysphagia is usually associated with oncologic and neurologic pathologies, but in older individuals, it is related to the aging process alone or engendered by neurological and neurodegenerative comorbidities.[11,13] Dysphagia is highly prevalent in different cohorts of older people,[14] including community-dwelling individuals (11.4%-33.7%), facility-dwelling individuals (38%-51%), hospitalized individuals (29.4%-47%), and hospitalized individuals with community-acquired pneumonia (55%-91.7%), compared with the general population. Because dysphagia is a multifactorial disorder that is caused by multiple etiological factors, the relationship between dysphagia and the aging process or geriatric syndromes such as frailty, regardless of other comorbidities, remains a focus of research.

In clinical geriatric medicine, frailty typically refers to progressive multisystem dysfunction and increasing vulnerability. The American version of the *International Classification of Diseases*, *Tenth Revision, Clinical Modification* includes the diagnostic code R54 for reimbursement claims effective from October 1, 2020; this code is currently applicable for defining clinical entities not otherwise specified, including frailty, old age, senescence, senile asthenia, and senile debility, except for age-related cognitive decline, sarcopenia, senile psychosis, and senility. Because of the lack of a rigid set of aging biomarkers and the variance in the onset time of the transition from dysfunction to disease among elderly people, controversy remains about whether aging represents a disease that should be included in the *upcoming International Classification of Diseases, Eleventh Revision, Clinical Modification* diagnosis codes. Frailty is characterized by a declining physiological reserve and loss of resistance to minor internal or external stressors caused by cumulative age-related functional deficits.[15] Fried et al[16] described 5 elements of a frailty phenotype: low strength, slow motor performance, exhaustion, low physical activity, and recent unintentional weight loss. Dysphagia and frailty share the characteristics of a geriatric syndrome because they are highly prevalent among older adults;[17,18] are caused by multiple factors; are associated with several comorbidities; predict poor clinical outcomes such as falls,[19] disability,[20] hospitalization,[21] long-term care institutionalization, and mortality,[15,22] and require a multidisciplinary approach for their imrpovement.[13] Therefore, recognizing amendable factors associated with the development of frailty is a crucial aspect of aging care.

Bahat et al.[8] reported an independent association of dysphagia with frailty scores—regardless of age, existence of neurodegenerative disorders, number of chronic diseases, or polypharmacy—in older adults selected from a geriatric outpatient clinic. Researchers have reported a strong association between deteriorated swallowing function and frailty,[23,24] and an increasing number of studies have suggested that dysphagia is a risk factor for frailty in older adults;[8,23-29] nevertheless, the findings of epidemiologic research on the connections between dysphagia and frailty have been inconclusive.[30-33] Integrated studies investigating the association between dysphagia and frailty are inadequate.

Moreover, whether dysphagia disorders in older people living in different settings, which could have multiple etiologies, are risk factors for frailty is unclear. Accordingly, we conducted a systematic review and meta-analysis of cross-sectional and longitudinal studies to substantiate the potential associations between dysphagia and frailty. We hypothesized that dysphagia in older adults may demonstrate an increased risk of frailty-related phenomena, regardless of phenotype. Clarifying these associations might provide new perspectives for delaying the development of frailty in older adults.

Methods

This protocol was written with reference to the Meta-Analysis of Observational Studies in Epidemiology (MOOSE) checklist. Ethical approval is not required as we will only conduct a secondary analysis of available data published in the literature. We will submit for peer-review publication and conference presentations after completion of the systematic review and meta-analysis.

Eligibility Criteria

Inclusion criteria:

1. Population: adults aged ≥50 years, including community-dwelling, residential care institutions or residential facilities dwelling and hospitalized old adults.
2. Exposures: impairment of function of swallowing, deglutition disorders or dysphagia, measured using objective or validated subjective assessments, as well as self-report.
3. Comparators: participants without impairments of function of swallowing, deglutition disorders or dysphagia as defined above.
4. Outcomes: prevalence, incidence or progression of pre-frailty and frailty, defined based on original or modified versions of validated criteria. For example, the Fried frailty phenotype defines pre-frailty as the presence of 1-2, and frailty as ≥3 of the following 5 criteria:
    (1) unintentional weight loss (10 lbs in past year)
    (2) self-reported exhaustion
    (3) weakness (grip strength)
    (4) slow walking speed
    (5) low physical activity

However, we will accept other definitions of frailty and discuss the limitations of this approach.

5. Study type: observational studies (cross-sectional, longitudinal, and case-control) published as full-length articles or conference abstracts in peer-reviewed journals.

Exclusion criteria:

1. Specific sub-populations/special risk groups (e.g. individuals with cardiovascular disease or with dementia).

2. Presence of impairments of swallowing function in the definition of frailty.
3. Disease-specific instead of motor function-specific or non-motor function-specific associations (e.g. stroke, brain tumors, dementia, depression, head and neck cancers, irradiations, esophageal cancer or other gastrointestinal disorders that will cause impaired swallowing function, psychiatric disorders).

We will not limit the searches by historical time constraints or language.

Information Sources

We will systematically search 3 databases (PubMed, Embase and the Cochrane Database of Systematic Reviews). We will also hand-search the reference lists of the included articles and relevant reviews or journals, where applicable. We will accept published poster abstracts if they are indexed in the above databases. We will attempt contact with the corresponding authors to obtain additional unpublished information such as crude number of participants that was stratified by dysphagia and frailty development and covariate-adjusted effect estimates.

Search Strategy

We will search PubMed, Embase and Cochrane using the following search strategy:
Free text

#	Search Term
1	"swallow"[Title/Abstract] OR "swallowing"[Title/Abstract] OR "absorb"[Title/Abstract] OR "devour"[Title/Abstract] OR "drink"[Title/Abstract] OR "eat"[Title/Abstract] OR "gobble"[Title/Abstract] OR "gulp"[Title/Abstract] OR "ingest"[Title/Abstract] OR "wash down"[Title/Abstract]
2	"disturbance"[Title/Abstract] OR "loss"[Title/Abstract] OR "impairment"[Title/Abstract] OR "dysfunction"[Title/Abstract] OR "decline"[Title/Abstract] OR "reduc*"[Title/Abstract] OR "decreas*"[Title/Abstract] OR "diminish*"[Title/Abstract] OR "difficult*"[Title/Abstract] OR "problem*"[Title/Abstract] OR "trouble"[Title/Abstract] OR "issues"[Title/Abstract] OR "deficit*"[Title/Abstract] OR "deficien*"[Title/Abstract] OR "insufficien*"[Title/Abstract] OR "hard"[Title/Abstract] OR "poor"[Title/Abstract] OR "bad"[Title/Abstract] OR "low"[Title/Abstract]
3	1 AND 2
4	"dysphagia"[All Fields] OR "deglutition disorders"[All Fields]
5	3 OR 4
6	"old"[Title/Abstract] OR "old adult"[Title/Abstract] OR "aged"[Title/Abstract] OR "aging"[Title/Abstract] OR "elder"[Title/Abstract] OR "elderly"[Title/Abstract]
7	5 AND 6
8	"frailty"[All Fields]

9	7 AND 8

Controlled Vocabulary: Medical Subject Headings (MeSH)
No limits applied

#	Search Term
1	"deglutition disorders"[MeSH] AND "frailty"[MeSH]
2	"deglutition disorders"[MeSH] AND "frailty"[MeSH] AND ("aged"[MeSH] OR "aging"[MeSH])

Data Management
We will export the search results to EndNote to remove duplicates and manually screen the records.

Selection Process
We will screen potentially eligible studies based on title and abstract, following which, we will retrieve full texts for evaluation. This will be done by 2 independent reviewers.

Data Extraction & Data Items
We will extract data from each article into a standardized extraction template by using Review Manager (RevMan), Version 5.4 (The Cochrane Collaboration, London, United Kingdom). This data will include: first author, year published, study design, setting, country, region, sample size, percentage female, mean or median age, method of identifying dysphagia, frailty definition, and adjustment for confounders. One reviewer will extract the data, and this will be verified by at least 1 other reviewer.

Risk of Bias
We plan to use the Newcastle-Ottawa Scale (NOS), to evaluate the risk of bias at the outcome level. As per the NOS grading in past reviews, we will grade studies as having a high (<5 stars), moderate (5-7 stars) or low risk of bias (≥8 star). For longitudinal studies, the NOS assigns a score out of 9 to each study (where 9 indicates that the study meets all 9 criteria for quality assessments and 0 indicates that the study does not meet any of the criteria) based on potential domains of bias, such as selection, comparability, and outcome. For cross-sectional studies, the modified NOS[34] assigns a score out of 10 to each study.

Statistical Analysis
We will calculate pooled ORs by conducting a fixed-effects or random-effects meta-analysis of raw data extracted from each study. The precision levels of the effect sizes will be expressed as 95% CIs. We will assess the statistical heterogeneity and inconsistency of the effects across the included studies by using the Cochran Q test ($P < .10$) and I^2

statistics, respectively. We will perform subsequent subgroup analyses by stratifying the data by demographics, study design, and study population to characterize potential sources of heterogeneity. In the subgroup analyses, we will calculate the risk estimates for outcomes of frailty, prefrailty or frailty and prefrailty combined. Additionally, we will conduct sensitivity analyses by sequentially excluding individual studies to examine the effect of such exclusions on the overall risk estimate. Publication bias was evaluated visually through funnel plots. A 2-sided *P* value of <.05 was deemed statistically significant.

Keywords
deglutition disorders, dysphagia, aging, frailty, community-dwelling, residential facility dwelling

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