

Frailty, Frailty Components, and Oral Health: A Systematic Review

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A systematic review was conducted to assess the relationship between frailty or one of its components and poor oral health. A search strategy was developed to identify articles related to the research question in the PubMed, EMBASE, Cochrane, LILACS, and SciELO databases that were published in English, Spanish, or Brazilian Portuguese from 1991 to July 2013. Thirty-five studies were identified, and 12 met the inclusion criteria, seven of which were cross-sectional and five were cohort studies. Of the 12 articles, five (41.7%) were rated good and seven (58.3%) as fair quality. The published studies applied different oral health and frailty criteria measures. Variations in definitions of outcome measures and study designs limited the ability to draw strong conclusions about the relationship between frailty or prefrailty and poor oral health. None of the studies that were evaluated longitudinally showed whether poor oral health increases the likelihood of developing signs of frailty, although the studies suggest that there may be an association between frailty and oral health. More longitudinal studies are needed to better understand the relationship between frailty and oral health. *J Am Geriatr Soc* 63:2555–2562, 2015.

Key words: frail; elderly; oral health; aged

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Frailty may be a physiological precursor and an etiological factor of disability in elderly adults, and it has been reported to be a predictor of mortality and functional limitations in this population.¹ Various measurements exist for assessing frailty. One is the Fried Frailty Index (FFI),¹ which classifies frailty according to the presence of three or more of the following items: unintentional weight loss, low physical activity, low handgrip strength, slow walking speed, and exhaustion. The increases in life expectancy and in the number of elderly people have made frailty a critical component of total health expenditure.²

Handgrip strength can be used as a measure of sarcopenia and predicted accelerated decline in activities of daily living, disability, and decreased cognition, which contribute to dependency.³ In addition, a rapid decline in walking speed has been associated with high risk of all-cause mortality,⁴ and impaired mobility and physical inactivity have been shown to predict dependence and death.⁵ Unintentional weight loss can also be a signal for (predictor of) higher morbidity and mortality.⁶ Finally, fatigue can reduce the level of daily and work-related activities and has been associated with slow speed of cognitive processing.⁷

The relationship between poor oral health and frailty has rarely been evaluated. General health and oral health are interrelated and have a complex and multifaceted relationship, especially in elderly adults.⁸ Oral health is instrumental to older people's health, life satisfaction, quality of life, and self-perception.⁹ Oral infections may have biological consequences that manifest in health problems later.¹⁰ Oral status can also contribute to changes in diet, weight,^{11–13} and physical function.¹³ Hence, poor oral health can affect an individual's overall well-being, and because of the cumulative burden of oral diseases, elderly adults may experience more dental problems, such as tooth loss, than younger individuals.

The aim of this systematic review was to critically appraise all evidence related to the association between poor oral health and frailty. The research question was as follows, "Is there evidence of an association between

frailty or frailty's components and poor oral health in individuals aged 60 and older?"

METHODS

The following databases were searched to identify articles related to the research question: PubMed, Cochrane, EMBASE, LILACS, and SciELO. The reference lists of the selected papers were manually searched for additional potentially studies. Initially, the relevance of the reports was assessed through their titles and abstracts. Inclusion and exclusion criteria were developed and primary (frailty) and secondary (prefrailty) outcomes were defined. Studies of any type of design of human subjects aged 60 and older published in peer-reviewed journals in English, Spanish, or Brazilian Portuguese that used physical phenotype definition were included. Studies with small sample size and poorly defined outcomes were excluded. The outcome considered in this study was frailty¹ or its components.

Frailty is defined as a combination of biological, physiological, social, and environmental changes that occur with advancing age.¹⁴ A person is classified as prefrail when one or two of the components are present¹ and robust when none are present. The decision to limit the search to the frailty phenotype defined by Fried and colleagues¹ was pre-specified before the search was undertaken.

Search Strategy

The systematic search included combined Medical Subject Headings (MeSH) and free-text terms as elder*, loss of teeth, and frail* (Appendix S1). Only articles from 1991 (the first year the term “frail” was indexed as a MeSH term) to July 2013 were considered. The search strategies used in other databases were derived from the primary search in PubMed (Figure 1).

Quality Assessment

One review author extracted the data, and another independently checked them. Decisions were made by consensus. The quality of the papers was assessed using a checklist based on previously designed checklists.^{15–19} Six methodological items were considered for cross-sectional and cohort studies (Appendix S2). The studies were rated as good (met all or all but one criterion), fair (did not meet 2–3 criteria), or poor (did not meet 4–6 criteria).

Data extracted from the studies were organized in evidence tables. Prevalence information on main outcomes is presented as it was in the original studies or was generated from the absolute numbers provided.

The β coefficient estimates from the regression models in the studies (log odds) were converted to odds ratios

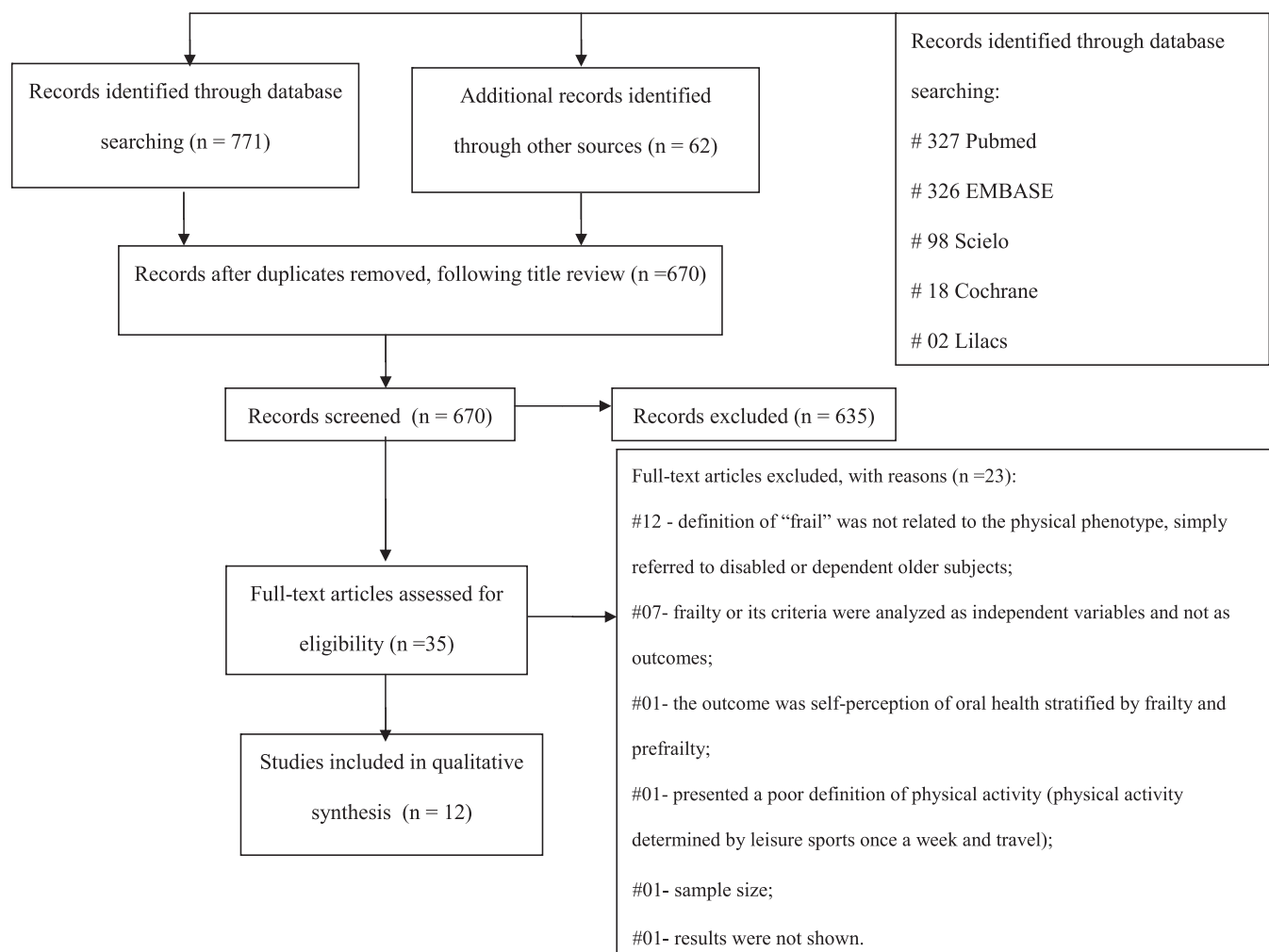


Figure 1. Flowchart of each stage of search of the articles.

(ORs) using VassarStats software (VassarStats, Poughkeepsie, NY).

RESULTS

Overview

After the initial screening of titles and abstracts, 35 articles were selected, 12 of which were included in the study (Figure 1): seven cross-sectional^{10–26} and five longitudinal.^{10,27–30} In relation to the frailty outcome, two studies adapted the FFI,^{24,26} and regarding the prefrailty outcome, one study measured fatigue using the Mobility-Tiredness Scale,²⁹ two used weight loss criteria,^{27,28} and seven measured handgrip strength^{10,20–23,25,30} (Table 1). There were some associations between oral health and frailty.

To describe the relationship between frailty or frailty components and oral health, it was decided to present the results according to the oral health measures found in the articles included in this systematic review and the discussion into the frailty components.

Four studies did not specify the study settings,^{21–23,25} and in the majority, data collection took place at least in part at participants' homes.^{24,26,27,29} Three studies did not state whether subjects lived in assisted living facilities or in nursing homes,^{10,20,21} although in one study,²¹ some volunteers from one ward participated. Three of the studies had the same first author^{22,23,25} but were not duplicates. These three studies were the only ones that took place solely in rural communities.

Quality Appraisal

Of the 12 studies, five (41.7%) were rated as good and seven (58.3%) as fair quality. The most common problem was the representativeness of the sample. Regarding weight loss, one study was rated as fair,²⁸ and one was considered of good quality.²⁷ Both studies that applied the FFI were rated as good,^{24,26} and the fatigue study was also rated as good.²⁹ Of the handgrip strength studies, one was rated as good,²⁵ and six were rated as fair.^{10,20–23,30}

Prevalence of Frailty and Its Components

In the two studies that used the FFI, the prevalence of frailty ranged from 8.5% ($n = 117$) for a Brazilian population to 15% ($n = 105$) for a Mexican population.^{24,26} One possible explanation for this variation is that frailty is age related³¹ and that the studies assessed different age groups. For the studies that assessed only one criterion, approximately half of the participants ($n = 287$) felt fatigued at baseline, and the proportion increased with age.²⁹ In the study that considered weight loss, the prevalence of 10% of weight loss over 1 year was 9% ($n = 51$),²⁷ and the prevalence of 5% weight loss over 2 years was 13.4% ($n = 140$).²⁸ Of the seven studies that measured handgrip strength, mean values ranged from 31.5 to 35.1 kg for men and from 19.4 to 20.8 kg for women.^{10,20,21}

Association Between Poor Oral Health and Frailty or Its Components

Predictors and covariates found in the studies were number of teeth, masticatory ability, occluding pairs of teeth (Eichner Index), dental prosthesis, periodontal disease, dental service use, self-report of oral health, and Geriatric Oral Health Index Assessment (GOHAI).^{10,20–29} These predictor and covariates were assessed to verify their associations with the FFI or one of its criteria according to the methodology of each study (Table 2).

Number of Teeth

Six reports used number of teeth as the covariate. Having more teeth (≥ 20) was associated with less chance of being frail.²⁶ Number of teeth was not associated with fatigue when the model was adjusted for smoking or socioeconomic position.²⁹ Being edentulous was a risk factor for weight loss of 4% and 10% over 1 year.²⁷ Handgrip strength was positively associated with number of teeth only in men,¹⁰ but in another study,²¹ when adjusted for confounders, the association was no longer significant.

Masticatory Ability

Self-assessed masticatory ability was associated with handgrip strength,^{22,23} although one study²¹ did not find an association between number of chewable foods and grip strength after adjustment for various confounders, although it reported an association between this oral health measure and other physical fitness assessment methods. In addition, the chewing surface (defined as the maximum number of intact functional units adjacent to each other) did not predict weight loss,²⁷ and chewing problems were not associated with frailty.²⁴

Occluding Pairs of Teeth

In three studies conducted in Japan,^{20,22,30} no relationship was observed between occlusion and handgrip strength in elderly adults. Functional units did not predict weight loss either.²⁷

Dental Prostheses

The need for a dental prosthesis²⁶ was a covariate of prefrailty and frailty.

Periodontal Disease

Periodontitis was not associated with handgrip strength in men or women in the cross-sectional analysis but was a predictor of handgrip strength decline over 5 years.¹⁰ Frailty was not associated with severe periodontitis,²⁴ and gingival recession did not predict weight loss,²⁷ but one study verified that a probing depth of 6 mm or deeper was the strongest predictor of 5% weight loss over a 2-year period.²⁸

Table 1. Study Overview and Quality Appraisal Summary According to the Independent Predictors (Frailty and Frailty Components)

Prevalence of Frailty or its Components	Oral Condition, %	Study Design	n	Dropout Rate, %	Female: Male	Age	Country	Quality	Author, Year
Fried Frailty Index (modified)									
Frail, 8.5%; prefrail, 40.7%; nonfrail, 50.8%	Edentulous, 44.8; dentate, 55.2	Cross-sectional	1,374	43.7	59.7:40.3	≥60	Brazil	Good	Andrade et al., 2013 ²⁶
Frail, 15%	Edentulous, 23.5; dentate, 76.5	Cross-sectional	838	13.1	53.2:46.8	≥70	Mexico	Good	Castrejón-Pérez et al., 2012 ²⁴
Fatigue Scale (Avlund Mobility-Tiredness): fatigued, 50.1%; not fatigued, 49.9%	Edentulous, 41.5; dentate, 58.5	Cohort (baseline, 5, 10, 15 years)	573	5 years, 19.7	51.7:48.3	70	Denmark	Good	Avlund et al., 2011 ²⁹
Handgrip strength, kg									
27.1 ± 7.5	Mean number of remaining teeth, 14.6 ± 10.3; GOHAI, 52.6 ± 7.7	Cross-sectional	354	15.9	48.9:51.1	≥65	Japan	Good	Moriya et al., 2012 ²⁵
NR									
	Self-assessed masticatory ability: good, 66.7; fair, 26.2; poor, 7.1	Cross-sectional	381	7.3	62.2:37.8	67–74	Japan	Fair	Moriya et al., 2011 ²³
Overall, 32.5 ± 8.9; men 39.6 ± 5.8; women 24.6 ± 3.5	Occluding pairs: EI 4 zones (Class A), 30.7 1–3 zones or anterior contact (Class B), 44.8 No contact (Class C), 24.4	Prospective cohort study (baseline, 8 years)	348	49.8	50.9:49.1	71	Japan	Fair	Okuyama et al., 2011 ³⁰
NR									
	Occluding pairs: 4 zones, 17.3 1–3 zones or anterior contact, 29.5 No contact, 53.2	Cross-sectional	821	82.5	56.3:43.7	65–84	Japan	Fair	Moriya et al., 2009 ²²
Men, 35.1; women, 20.0	Edentulous, 59.1; dentate, 40.9	Cross-sectional, prospective cohort (baseline, 5 years)	193	5 years, 59.1	71.5:28.5	80	Finland	Fair	Hämäläinen et al., 2004 ¹⁰
Overall, 25.1 ± 7.4; men, 31.5 ± 6.4; women 20.8 ± 4.1	Edentulous, 34.6 Dentate, 65.4	Cross-sectional	644	49.8	60.3:39.7	80	Japan	Fair	Takata et al., 2004 ²¹
70-year-old men, 39.0 ± 5.7 and women, 24.3 ± 3.7; 80-year-old men, 32.6 ± 5.5 and women, 19.4 ± 3.8	Occluding pairs: EI 4 zones/no contact (Class A/C) 70 years, 26.2/25.2 80 years, 7.8/64.3	Cross-sectional	742	1.8	50.2:49.8	70 and 80	Japan	Fair	Yamaga et al., 2002 ²⁰
Weight loss									
Over 24 months: 13.4% (n=140) had ≥5% weight loss	Periodontal pockets with probing depth ≥6 mm, 37	Prospective cohort (baseline, 2 years)	1,053	65.8	50.3:49.7	≥65	US	Fair	Weyant et al., 2004 ²⁸
Over 12 months: 33% had ≥4% weight loss 9% had ≥10% weight loss	Edentulous, 39; dentate, 61	Prospective cohort (baseline, 1 year)	563	1 year- 51.3	57.5:42.5	≥70	US	Good	Ritchie et al., 2000 ²⁷

NR = not reported; EI = Eichner Index.

Table 2. Results of Selected Articles According to Independent Predictors (Frailty or Frailty Components) from 1991 to 2014

Independent Predictor	Predictor	Description Predictor	β	Adjusted Odds Ratio (95% Confidence Interval)	P-Value	Coefficient of Determination
Prefrility ²⁶	Need for dental prosthesis	Yes		1.46 (1.09–1.94)	.01	
Frailty ²⁶	Need for dental prosthesis	Yes		1.84 (1.13–3.00)	.01	
	Number of teeth (reference 0)	≥ 21 teeth		0.25 (0.07–0.91)	.04	
Frailty ²⁴	Self-perception of oral health (reference better)	Same		1.76 (0.96–3.24)	.07	
		Worse		3.23 (1.45–7.21)	.004	
	Use of dental services	No		2.10 (1.19–3.71)	.01	
Fatigue (baseline, 5, 10 years) ²⁹	No association with any oral health predictor in the final model after adjustment					
Handgrip strength ²⁵						
Model 1	GOHAI—total score		0.07	1.07	.02	
Model 2	GOHAI—subdivision score: pain and discomfort		0.24	1.27	.03	
Handgrip strength ²³	Handgrip strength	According to SAMA (poor, fair, good)			.01	
		Good \times poor SAMA			.02	
Handgrip strength decline ³⁰	Eichner Index (occlusion condition)	No association			NS	
Handgrip strength 65–74 year-old ²²	SAMA	Good/fair/poor	–1.44	0.24	$P < .01$	0.69
		Good + fair/poor	–2.30	0.1	$P < .01$	
Handgrip strength 75–84 year-old ²²	SAMA				NS	
Handgrip strength ¹⁰	Number of teeth (men)	>19 teeth			.02	
Change (decline) in handgrip strength ¹⁰	Periodontitis	Periodontitis (at baseline)			.01	
Handgrip strength ²¹	Number of chewable foods		0.027	1.03	.34	0.64
Handgrip strength ²¹	Number of teeth		0.005	1	.87	
	Number of chewable foods (reference 0–4)	5–9		0.54 (0.17–1.71)	NS	
		10–14		0.69 (0.23–2.02)	NS	
		15		1.00 (0.33–3.05)	NS	
Handgrip strength ²¹	Number of teeth (reference 0)	1–9		1.24 (0.66–2.33)	NS	
		10–19		1.16 (0.56–2.38)	NS	
		≥ 20		0.79 (0.35–1.78)	NS	
Handgrip strength ²⁰	No association with any oral health predictor in the final model					
Weight loss $\geq 5\%$ over 2 years ²⁸	Periodontitis	Site ≥ 6 mm probing depth, (best model)		1.55 (1.36–1.78)		
4% weight loss over 1 year ²⁷	Edentulousness			1.63 (1.09–2.43)	$<.05$	
10% weight loss over 1 year ²⁷	Edentulousness			2.03 (1.05–3.96)	$<.05$	

GOHAI = Geriatric Oral Health Index Assessment; SAMA = self-assessed masticatory ability.

Dental Service Use

Individuals who did not use dental services in the previous year were more likely to be frail.²⁴

Self-Report of Oral Health

Self-report of worse oral health than peers was associated with greater likelihood of being frail.²⁴

Geriatric Oral Health Index Assessment

Handgrip strength was correlated with the GOHAI and its pain and discomfort category.²⁵

DISCUSSION

The findings of this systematic review identified different oral health predictors and covariates that are associated with frailty or its components. Number of teeth was the oral health variable most often investigated in relation to frailty, followed by periodontal disease, occluding pairs of teeth, and chewing ability. The assessment of oral health status and the results varied among the studies, which used different protocols and parameters. The small number of studies examining the frailty index and oral health is a major drawback. In addition, the lack of standardization limits comparisons and can result in over- or underestimations of the measures of association presented.

The results suggest that there is a possible association between frailty and oral health, because the studies that assessed FFI observed an association with a need for a dental prosthesis, self-report of oral health, and dental service use. Number of teeth was associated in one of the FFI studies²⁶ but not in the other.²⁴ According to the second study,²⁴ people may compensate for poor oral health, but if it is concomitant with deterioration of their general health, it may become an important factor in the development of anorexia and subsequent weight loss, a pathway that leads to frailty.

Fried Frailty Index

Participants who needed a dental prosthesis were more likely to be frail or prefrail, having functional dentition was related to less chance of being frail,²⁶ and the use of a dental prosthesis was not associated with prefrailty or frailty, indicating that the need for a dental prosthesis is a more-reliable measure of functional oral impairment than the use of a dental prosthesis. The other study that used the FFI found an association between self-reports of worse oral health and not using dental services and greater probability of being frail.²⁴ The fact that a perception of bad oral health reflects a decline in general health explains this result; not using oral health services may also reflect compromised general health and constriction of life space.²⁴ In that study,²⁴ there was no association between number of teeth or chewing problems and frailty, suggesting that the high proportion of overweight and obese individuals might have hidden the effect.²⁴ Oral health has a cumulative effect on frailty throughout life, which can be low in early life but progress and contribute to the development of additional chronic conditions and to generating a network of interacting and self-perpetuating mechanisms, which can lead quickly to deterioration in health. In that sense, oral health can be an indicator of, a risk factor for, or even an outcome of general health.³²

Fatigue

In the one study that assessed fatigue, the association between number of teeth and fatigue was not significant,

which suggests, according to the authors, that socioeconomic position early in life partly explains this relationship.²⁹

Handgrip Strength

Another study²⁵ assessed the GOHAI and its dimensions and the relationship between handgrip strength and number of teeth. The authors observed an association between the GOHAI, its pain and discomfort dimension, and handgrip strength, suggesting that oral health problems associated with discomfort may be significant indicators of a decline in body muscle strength. Another study¹⁰ that showed that men with well-fitting prostheses had greater grip strength than those with ill-fitting prostheses because the latter can cause discomfort supported these findings. Another study²³ showed that self-assessed masticatory ability was associated with handgrip strength, and elderly adults with weaker masticatory strength could chew only soft or pureed food. Moreover, a decline in strength may be a consequence of new diseases that subjects with poor oral health developed.¹⁰

There was no association between handgrip strength and number of teeth in a previous study.²⁵ Another study²¹ did not find an association between number of teeth or chewable foods and handgrip strength but found associations between number of chewable foods and other measures of physical fitness, suggesting that chewing ability may be related to skeletal muscle mass through nutritional status and nutrient intake.²² Hence, improving chewing ability could improve performance of activities of daily life and prevent disability.²¹ In another study,³⁰ handgrip strength was not associated with occlusal condition. Similar results, showing no association between these variables, were found in two other studies.^{20,22} These findings suggest that occluding pairs of teeth might be related to measures that represent static balance function^{20,22,30} and might not be the best covariate for evaluating handgrip strength because other oral measures have been associated.²²

Weight Loss

Weight loss may be a more-sensitive and -specific indicator of how oral health is related to nutritional problems.³³ One study²⁷ found edentulousness to be associated with 4% or 10% weight loss over 1 year. In contrast, other measures of oral health such as number of teeth, number of functional units, and chewing surface did not predict weight loss. The study also highlighted that almost all of the edentulous participants wore dentures, which did not mediate the weight loss results. Although the condition of the dentures was not analyzed, the authors stated that old and poorly fitting dentures contribute to chewing difficulties. Despite these findings, the presence and extent of periodontal disease seems to affect weight loss independent of number of teeth and other known risk factors, such as diabetes mellitus and smoking, suggesting the influence of inflammatory mechanisms rather than a masticatory effect.²⁸ According to the study mentioned above,³³ older subjects normally can compensate for their poor oral health status, but in the presence of worsening general

health, oral health may become an important factor that contributes to the development of anorexia, followed by weight loss.

The loss of teeth decreases occlusal force and affects masticatory ability, which may lead older adults to change their food selections and affects their nutrient intake.³⁴ Difficulty in maintaining a nutritious diet may lead to physical disability and mortality in edentulous people without dentures,³⁵ suggesting that functional occlusion has a great influence on the lives of elderly people. Oral health is also linked to different medical conditions because of its association with nutrition.²⁸

Physical Activity and Walking Speed

No study that showed a relationship between walking speed or physical activity with oral health met the criteria, but there is evidence³⁵ that edentulous individuals without dentures have a significant risk of mobility impairments. Mobility can compromise dental service use, which is linked to frailty.²⁴ Furthermore, greater deterioration in dental state was associated with slower walking speed and low physical activity.³⁶

Strengths and Weakness

To the knowledge of the authors, this is the first systematic review about the association between frailty or one of its components and oral health. All of the studies included in this review had different designs and data collection methods, and these aspects might have influenced the conclusions reached. Several factors may affect the internal and external validity of the results, including inconsistencies among researchers in the measurement of frailty, frailty components, and the different oral health predictors evaluated in the studies; the lack of representative study samples; and dropout rates greater than 50%. The fact that articles published in languages other than English were screened decreases the possibility of bias. In addition, none of the articles that assessed FFI^{24,26} were longitudinal. Prospective studies may contribute to a better understanding of this relationship.

A metaanalysis could not be performed given the limited standardization of methods and parameters across studies. Finally, the checklist for methodological quality appraisal was drawn from different publications. Scales for measuring the quality of cross-sectional studies have not been properly developed and further limit the results of this study.

Besides nutrition, the relationship between poor oral health and frailty may have other intermediate factors²⁶ that should be explored, such as socioeconomic status, smoking, and chronic diseases.²⁹ The best-rated articles also supported the role of number of natural teeth present in the mouth^{26,29} and use of and need for dental prostheses²⁵⁻²⁷ when studying the association between frailty or its components and impaired oral health. Likewise, severe tooth loss results in the exclusion of sextants (for the purpose of a periodontal examination, a person's mouth is divided into six parts) when assessing periodontal disease, which affects its evaluation and prevalence and decreases its power in the analysis. Therefore, there is a need to

explore the presence and severity of periodontal disease further because it can lead to higher levels of inflammatory markers²⁴ and additional tooth loss.²⁹

Although most studies reported a relationship between frailty or prefrailty and poor oral health, the study designs limited the ability to draw strong conclusions. Therefore, there is a need for additional longitudinal studies to understand the relationship between frailty and oral health more fully, to develop strategies to prevent oral diseases, and to rehabilitate people in need in the growing elderly population.

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SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article:

Appendix S1. Search strategy used to query the PubMed database.

Appendix S2. Appraisal criteria created based on other appraisals found in the literature.

Appendix S3. Table of the excluded papers.

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