Unfavourable Outcomes in Older Adults with Oral Frailty: A Scoping Review

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Background: The significant occurrence of oral frailty (OF) in older patients highlights the necessity of addressing this concern. OF is associated with complications and mortality in elderly patients. The objective of this study is to identify unfavorable outcomes in older patients with OF to increase awareness and mitigate risks.

Methods: This review employed specific MeSH terms to perform an extensive literature search on OF and its unfavorable outcomes across PubMed, Web of Science, Embase, Cochrane Library, Scopus, and CINAHL databases. The review included English-language papers published from inception to March 31, 2024, focusing on individuals aged 60 and above, adverse outcomes related to OF, and studies employing cross-sectional or cohort designs.

Results: The review comprised 28 articles: 20 cross-sectional and 8 prospective cohort studies. Among these articles, 10 were rated as "Good" and 18 as "Fair", reflecting the high quality of the literature. Next, 20 OF assessment tools were summarized, and the most frequently used methods for assessing OF were the methods of Tanaka et al and Oral Frailty Index-8 (OF-8). The most frequently unfavorable outcomes related to OF in the elderly were physical frailty, malnutrition, low dietary variety, social withdrawal, disability, and low gait speed.

Conclusion: High levels of OF significantly increase the risk of adverse outcomes in older adults, including physical frailty, malnutrition, low dietary variety, social withdrawal, disability, and low gait speed. Effective risk stratification and management are essential to reduce these outcomes.

Keywords: oral frailty, physical frailty, unfavorable outcomes, elderly

Introduction

Frailty is a biological syndrome characterized by a decline in physical status and activities, leading to increased vulnerability to adverse health outcomes.[1] Its social implications and associated factors, such as gender and daily functioning, vary across cultural contexts.[2] As the understanding of frailty evolves, oral frailty (OF) emerges as a specific type that underscores its significance in the health management of older adults.[3] OF, a concept recently introduced in Japan, is now recognized as a key factor in dental and oral health policy. Measures to address OF have become a focus of Japan's medical and welfare policies.[4] OF is defined as

> A series of events and processes that contribute to changes in oral conditions including number of teeth, oral hygiene and oral functions due to aging. These occurrences are accompanied by a decline in interest in oral health, reduced physical and mental capacity, and an increase in OF, leading to eating dysfunction and further declines in overall physical and mental functions.[4]

It is a comprehensive concept encompassing the diversity of oral functions.[5] Functions such as chewing, swallowing, oral motor skills, and tongue pressure decline with age. This concept represents a state where multiple declines overlap.[5]

Global population aging is accelerating rapidly, with projections suggesting that by 2050, the number of people aged over 65 will approach 2 billion.[6] Older adults also suffer from poor oral health due to diseases such as tooth decay, periodontal disease, and cavities. Compared to the general population, these issues accumulate throughout their lifetime and are exacerbated by frequent visits to oral health professionals.[3,7] Consequently, OF is more prevalent among the elderly. The prevalence of OF among the elderly varies by region and study population. A meta-analysis of pooled results indicated that the prevalence of OF and pre-OF was 24% and 57%, respectively.[8] Increasingly, OF in the elderly is becoming a significant concern for overall health.

Factors associated with OF in old age, such as nutritional status and social aspects, are intricate.[9,10] One study shows OF predicted the risk of subsequent physical frailty, the need for long-term care, and mortality, suggesting that oral function may be a more accurate reflection of generalized frailty than physical function.[5,11] Additionally, older adults with OF have also reported poor gait performance,[12] malnutrition,[9,10] higher rates of eating alone,[13] and lower food satisfaction.[14] Furthermore, OF can initiate a negative spiral: food restriction and the selection of easier-to-eat food lead to further reduction in chewing ability, which in turn places individuals with OF at heightened risk of physical frailty and muscle loss.[5] Hence, unfavorable outcomes of OF impact physical health, psychological well-being, social interactions, and overall quality of life (QoL) can be clearly observed.

Although numerous studies have focused on OF and its unfavorable outcomes, existing research is often limited by small sample sizes, variations in OF assessment methods, geographic differences, and inconsistent results across studies.[10,13,15] Thus, further evidence is needed to elucidate the relationship between OF and unfavorable outcomes in older adults. Therefore, this study aims to review the associated unfavorable outcomes of OF in elderly individuals comprehensively and systematically. Specifically, we will explore the definition of OF, assessment methods, and its association with generalized health. The findings of this study will enhance the development of targeted interventions, improve overall health outcomes, and reduce healthcare costs in elderly populations.

Methods
This review was conducted and reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis extension for Scoping Reviews (PRISMA-ScR) Guidelines.[16] The protocol had been registered with Open Science Framework (OSF, https://osf.io/9mf 25).

Scoping Review Question
1. What are the assessment tools for OF in older adults?
2. What are the unfavorable outcomes of OF in older adults?

Inclusion/Exclusion Criteria
The review includes only studies with the highest quality from inception until March 31, 2024. The primary search included terms related to OF and older people.

The following were the inclusion criteria for this scoping review:

1. A cross-sectional or cohort study.
2. People aged ≥ 60 years.
3. Reported the relationship between OF and unfavorable outcomes.
4. Published in English.

Studies were excluded if they,

1. Had been published in other languages.
2. Reviews, meetings, conferences, or cases.
3. The full text cannot be obtained.

Definition of of

OF, as defined by the Japanese Dental Association (JDA), covers the following main areas:[4]

1. Overall decline in oral function, including decreased chewing, swallowing, and articulation.
2. Deterioration of oral hygiene: As oral function declines, an individual's oral hygiene may deteriorate, leading to an increased risk of oral disease.
3. Deterioration in the quantity and quality of teeth: loss or damage to teeth, periodontal disease, and other problems are prevalent.
4. Decreased salivary production leading to dryness of the mouth, affecting chewing, swallowing, and overall oral health.
5. Social and psychological impact: As a result of oral dysfunction, older people may face difficulties in eating, verbal communication, and social activities, which affects their mental health and social participation.

Definition of Unfavorable Outcomes

The definition of unfavorable outcomes may vary across healthcare settings and studies, but at its core, it refers to outcomes that negatively affect a patient's health and QoL.[17] It is a widely used term in the fields of medicine and healthcare management. These unfavorable outcomes may involve the worsening of the disease, failure of treatment, development of complications, medication side effects, dysfunction, death, etc.

Identifying Relevant Studies

A search was undertaken on PubMed, Web of Science, Embase, Cochrane Library, Scopus, and CINAHL using the Mesh terms from inception until March 31, 2024: "oral frailty", "OF", "oral frailty", and "oral health" in combination with "aged", "elderly", "aging", and "geriatric", "old people", "older adult", "elder". We also adopted a snowballing method to search the relevant literature. The search strategy is presented in Table 1.

Study Selection and Data Extraction

First, the articles collected by researchers (SR Zhu and WZ Tang) from various electronic databases were merged in Endnote, and duplicates were eliminated. Then, two independent reviewers screened the titles and abstracts of studies retrieved from the search. Studies that met the eligibility criteria underwent full-text review. Any disagreement was resolved by a third researcher (ST Mo).

A standardized data extraction template was independently filled out by two researchers (SR Zhu and WZ Tang) and crosschecked by another pair (Xiu-Juan Feng). Descriptive data for the study characterization included information on the first author, study design, sample size, assessment tools, and the unfavorable outcomes of OF identified from each article.

Collating, Summarizing, and Reporting Results

The results were presented in two formats. Descriptive numerical analysis was used to summarize the incidence of unfavorable outcomes of OF. Additionally, the key conclusions from the studies are outlined through a narrative summary, addressing the issues discussed in this review.

Assessment of Risk of Bias

Each study's risk of bias was reviewed and assessed meticulously utilizing the Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies (QATOCCS).[18] It was assessed independently by two researchers (SR Zhu and WZ Tang), any disagreement was resolved by a third researcher (ST Mo). Not all criteria are equally significant in assessing bias, and responses marked as "No", "Cannot Determine (CD)", or "Not Reported (NR)" are disregarded. Research is rated "good" if it has two or fewer demerits, "fair" if it has three to six demerits, and "poor" if it has more than six demerits. Criteria marked as "not applicable (NA)" do not count as demerit.

Table 1 Search Strategy

Database	Search Term and Strategy	No. Matches
PubMed #1 #2 #3	 Search "oral frailty" OR "oral frail" OR "oral frail*" OR ("oral health [MeSH]") Search (("aged" [MeSH]) OR "elderly" OR "older" OR "geriatric" OR "ageing" OR "old people" OR "older adult" OR "elder*" Search #1 AND #2	99
Web of science #1 #2 #3	 Search "oral frailty" OR "oral frail" OR "oral frail*" OR ("oral health [MeSH]") Search "aged" OR "elderly" OR "older" OR "geriatric" OR "ageing" OR "old people" OR "older adult" OR "elder*" Search #1 AND #2	88
Embase #1 #2 #3	 Search "oral frailty" OR "oral frail" OR "oral frail*" Search "aged" OR "elderly" OR "older" OR "geriatric" OR "ageing" OR "old people" OR "older adult" OR "elder*":ab,ti Search #1 AND #2	104
Cochrane library #1 #2 #3	 Search Title Abstract Keyword: oral frailty OR oral frail OR oral frail* OR oral health Search Title Abstract Keyword: aged OR elderly OR older OR geriatric OR ageing OR old people OR older adult OR elder* Search #1 AND #2	428
Scopus #1 #2 #3	 Search "oral frailty" OR "oral frail" OR "oral frail*" Search "aged" OR "elderly" OR "older" OR "geriatric" OR "ageing" OR "old people" OR "older adult" OR "elder*" Search #1 AND #2	105
CINAHL #1 #2 #3	 Search "oral frailty" OR "oral frail" OR "oral frail*" Search "aged"OR "elderly" OR "older"OR "geriatric"OR "ageing"OR "old people"OR "older adult"OR "elder*" Search #1 AND #2	74

Results

Literature Selection and Results

The initial search identified 898 potentially relevant articles, of which 319 were removed as duplicates. Following a secondary screening of titles and abstracts, 65 articles were selected for full-text review. Twenty-eight articles were included after the full-text review. The literature screening process is depicted in Figure 1.

Basic Features of the Included Literature

Among the final 28 studies published between 2017 and 2024, 20 were cross-sectional,[3,6,9,10,12,15,19–32] and 8 were prospective cohort studies.[5,33–39] This scoping review included a total of 28,329 patients. Twenty-two studies were from Asia, covering countries/provinces with Japan,[3,5,6,9,10,12,15,20,24,26–29,31,33,34,36,37,39] Singapore,[21] India,[19] and Taiwan,[32] making up 78.57% of all Asian studies. America contributed three studies from Mexico,[38] Ecuador,[22,] and Chile.[23] Additionally, one study was from Australia[30] in Oceania, and two studies from Europe, specifically from the United Kingdom[35] and Switzerland.[25] These included studies involved 20 different assessment tools for OF, identifying 15 unfavorable outcomes. The incidence of Unfavorable outcomes related to OF in older adults with ranged from 22% to 74%. The fundamental characteristics are detailed in Table 2.

Risk of Bias

For risk bias, 10 studies were rated as good quality[5,6,12,19,34–39] and 18 were rated as fair.[3,9,10,15,20–33] All high-quality studies clearly described the research question, defined the study population, had high participation rates, recruited participants in the same cohort of patients, and assessed key confounding variables. Among the 18 studies rated as fair
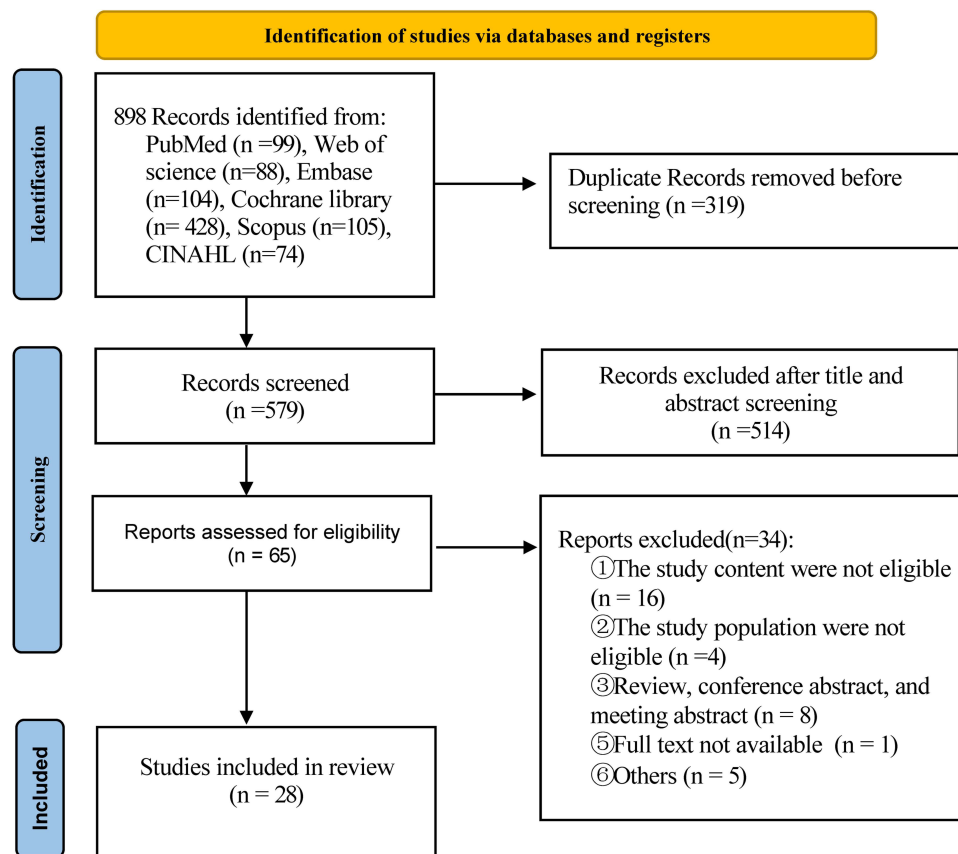
Figure 1 The literature screen flow chart.

quality, the main limitation is the report and assessment of exposure and outcome. Furthermore, no articles provided specific sample size justification or effect estimates.

Twenty articles were cross-sectional studies,[3,6,9,10,12,15,19–32] that is, their assessments of exposure and outcomes were conducted over the same period; therefore, questions 6 and 7 were rated "No". In addition, their follow-up measurement is not applicable to loss. The results are presented in Supplementary Table 1.

Operationalizing and Measuring of

Various OF assessment tools were utilized in older patients, with 20 different measures identified across the included studies. Most studies assessed OF based on the methods of Tanaka et al,[9,10,12,19,27,31,34,39] and some studies used tools, namely OF Index-8,[24,25,36] OF 5-Item Checklist,[15,37] OF Checklist,[32] Revised Oral Assessment Guide,[21] Oral Health Assessment Test),[30] Kihon Checklist 6,[3] and Tanaka's 16 measure.[5] A number of parameters have also been used in some studies to assess OF, such as oral hypofunction assessment with seven parameters,[22] six subjective and objective parameters,[20] interview and clinical evaluation,[23] eight parameters for assessing oral hypofunction and the oral function questionnaire about Kion checklist,[33] oral examination and self-reported oral health,[35] seven parameters for assessing oral function,[29] determining oral health conditions using nine parameters,[38] oral function evaluation with seven parameters,[6] and oral function evaluation with five parameters,[28] as presented in Table 3.

The most common method for assessing OF is the method developed by Tanaka et al.[5] This method categorizes the outcome into three groups: non-OF, pre-OF, and OF, based on the final score. Various assessment methods have since been developed based on Tanaka et al's approach. These methods often modify the number of items or incorporate additional subjective items to evaluate the degree of OF.[10,20,33] Among the commonly used parameters commonly are teeth status, chewing ability, oral diadochokinetic rate, and tongue pressure. These assessments are typically conducted by well-trained dentists, dental hygienists, nurses, and allied health professionals. The simplest assessment tool contains

Table 2 An Overview of the 31 Studies Included in the Scoping Review

First author/ Year (Reference)	Country	Study Design	Sample Size	Age	Assessment Tools	Unfavorable Outcomes	The Incidence/OR of Outcome
Ayoob2024[19]	India	Cross-sectional	250	68 ±6.02	Oral functions and dental status	Physical frailty	Risk of physical frailty 74%
Baba2022[20]	Japan	Cross-sectional	210	74.2 ±6.1	Six subjective and objective parameters	Oral candidiasis	NR
Chew2023[21]	Singapore	Cross-sectional	465	79.2 ±8.3	ROAG	Physical frailty, malnutrition	1.76 times for higher risk of physical frailty, 2.76 times for higher risk of malnutrition
Cruz-Moreira2023[22]	Ecuador	Cross-sectional	589	72 (66–82)	Oral hygiene, oral dryness, occlusal force, tongue-lip motor function, tongue pressure, masticatory function, and swallowing function.	Physical frailty	2.06 times for higher risk of physical frailty
Diaz-Toro2022[23]	Chile	Cross-sectional	3036	≥60	Interview and clinical evaluation	Physical frailty	28% had physical frailty
Hasegawa2020[33]	Japan	Prospective	425	72.2 ±5.6	The number of remaining teeth, oral hygiene, oral moisture, occlusal force, masticatory performance, swallowing ability, speech motor control, salivary bacterial count, and answers to the questionnaire concerning the oral functions in the KCL.	Social withdrawal	1.8 times for more likely to develop withdrawal
HOSHINO2021[10]	Japan	Cross-sectional	481	75.9 ±6.3	The methods of Tanaka et al	Low dietary variety	2.857 times for higher risk low dietary variety
Ishii2022[24]	Japan	Cross-sectional	111	79.7 ±3.8	The OFI-8	Physical frailty	1.34 times for pre-frailty and 1.55 times for frailty
Iwasaki2020[9]	Japan	Cross-sectional	1054	77±4.8	The methods of Tanaka et al	Malnutrition	2.17 times for severe malnutrition
Iwasaki2020[34]	Japan	Prospective	466	76.4 ±4.1	The methods of Tanaka et al	Malnutrition	2.24 for deteriorating nutritional status
Iwasaki2021[12]	Japan	Cross-sectional	1082	77.1 ±4.7	The methods of Tanaka et al	Low gait speed, short stride length, short step length, wider step width, longer double support duration, higher stride time	0.51 times for stride length, 0.79 times for step length, 0.70 times for stride time, 7 times for double-stance duration, 0.67 times for step width, −2.45 times for step length, −4.84 times for stride length, −0.059 times for gait speed
Iwasaki2024[15]	Japan	Cross-sectional	1206	74.7 ±5.5	OF-5	Physical frailty, low dietary variety, social withdrawal	1.43 times for physical frailty via low dietary variety, 1.42 times for physical frailty via social withdrawal
Kamdem2017[25]	Switzerland	Cross-sectional	992	74.9 ±1.39	Dental status, oral health, oral pain, masticatory ability	Physical frailty	1.72 times for physical frailty
Kamide2023[26]	Japan	Cross-sectional	237	76.0 ±5.7	OFI-8	Fall risk	2.38 times for fall incidence
Kimble2023[35]	United Kingdom	Prospective	5212	70–92	Denture use, tooth count, periodontal disease, self-rated oral health, dry mouth, and perceived difficulty eating.	Physical frailty	Progression to frailty was associated with dentition (0.97 times), <21 teeth with (1.74 times), without denture use (2.45 times) and symptoms of dry mouth (1.8 times)
Komatsu2021[27]	Japan	Cross-sectional	380	72.8 ±5.6	The methods of Tanaka et al	Physical frailty, low gait speed	2.4 times for physical frailty, 0.85 times for gait speed
Kuo2022[32]	Taiwan	Cross-sectional	308	79.7 ±7.2	OF checklist	Physical frailty	22% had physical frailty
Nagatani2023[39]	Japan	Prospective	1410	72.4 ±5.2	The methods of Tanaka et al	Mild cognitive impairment	30.2% had mild cognitive impairment

Shimazaki2020[29]	Japan	Cross-sectional	978	65–85	Oral hygiene, oral dryness, occlusal force, tongue-lip motor function, tongue pressure, masticatory function, and swallowing function.	Physical frailty	2.1 times for physical frailty
Shwe2023[30]	Australia	Cross-sectional	115	80±8.0	OHAT	Physical frailty	1.24 times for physical frailty
Tanaka2018[5]	Japan	Prospective	2011	73.0 ±5.5	Tanaka's 16 measure	Physical frailty, low dietary variety, disability	2.4-, 2.2-, 2.3-, and 2.2-fold increased risk of physical frailty, sarcopenia, disability, and mortality
Tanaka2021[36]	Japan	Prospective	2011	73.0 ±5.5	OFI-8	Disability	1.1-fold increase in the risk of disability
Tanaka2023[37]	Japan	Prospective	2031	73.1 ±5.6	OF-5	Physical frailty, physical disability	39.3% physical frailty, 1.4 times for physical disability
Tani2022[31]	Japan	Cross-sectional	381	72.6 ±3.9	The number of teeth remaining, oral functions, such as masticatory performance, tongue pressure strength, and ODK	Physical frailty	The physical pre-frailty status was associated with masticatory performance (0.819 times), e (OR, 1. low ODK (1.864 times).
Velázquez-Olmedo 2021[38]	Mexico	Prospective	663	68.1 ±6.1	Functional teeth, presence of coronal caries, root caries, periodontal disease, dental calculus, dental biofilm, root remains, xerostomia, and need for dental prosthesis.	Physical frailty	2.4 times likely to become frail
Watanabe2016[28]	Japan	Cross-sectional	4720	72.1 ±5.6	The numbers of present teeth and functional teeth were counted, and occlusal force, masseter muscle thickness, and ODK rate.	Physical frailty	NR
Yoneyama2024[3]	Japan	Cross-sectional	586	59	Kihon Checklist 6	Lower urinary tract symptoms	26% had lower urinary tract symptoms
Yoshida2021[6]	Japan	Cross-sectional	340	75	Oral hygiene, oral dryness, occlusal force, tongue-lip motor function, tongue pressure, masticatory function, and swallowing function.	Physical frailty	26% had physical frailty

Abbreviations: ROAG, The Revised Oral Assessment Guide; KCL, The Kihon Check List; OFI-8, The Oral Frailty Index-8; OF-5, Oral Frailty 5-Item Checklist; OF, Oral Frailty; OHAT, Oral Health Assessment Test; ODK, Oral Diadochokinesis; NR, not reported.

Table 3 Description of Oral Frailty Measurement Tools

Tools	Predictors of Oral Frailty	Scoring Standard
The assessment of OF was based on several parameters[19]	Determination of OF with two categories: 1. Oral functions: Chewing ability, the frequency of Xerostomia, tongue endurance and strength, the Repetitive Saliva-Swallowing Test, Oral diadochokinetic rate, Kihon Checklist (three subjective measures were taken from the 25-item questionnaire). 2. Dental status: Number of teeth present and absent, mobility, wasting diseases, tender on percussion, fractured teeth, denture. The Oral and Maxillofacial Index (ten items).	According to OFscore: Less than 2/More than 2
Six subjective and objective parameters[20]	Assessment of oral health indicators: Objective items: 1. Number of remaining teeth 2. Masticatory performance 3. Tongue pressure 4. ODK Subjective assessments: 5. "Do you have any difficulty eating tough foods compared to 6 months ago?" 6. "Have you choked on your tea or soup recently?"	Number of remaining teeth < 20, masticatory performance < 14.2 for men and < 10.8 for women, tongue pressure < 27.4 kPa for men and < 26.5 kPa for women, and an ODK < 5.2 times/s for men and < 5.4 times/s for women. Including the subjective items, participants presenting with three or more of the above items were classified as experiencing OF.
ROAG[21]	Voice, lips, mucous membranes, tongue, gums, teeth/dentures, saliva and swallowing.	Each category was described and rated according to a score of 1 (healthy) to a score of 3 (severe problems). Oral health risk was rated low if all categories were scored as 1, moderate if any category scored 2 and high if any category scored 3.
Seven parameters[22]	Evaluate oral hypofunction: poor oral hygiene, oral dryness, reduced occlusal force, decreased tongue-lip motor function, decreased tongue pressure, decreased masticatory function, and deterioration of swallowing function.	Each item was assigned 0 if it was negative or 1 point if it was positive. If the final score was 3 points or higher, the person was considered to have oral hypofunction.
The interview and clinical evaluation[23]	1. The number of teeth was categorized as the presence of i) 0 to 20 teeth, and ii) more than 20 teeth. 2. Self-reported: in general, would you say your oral health is? Dental Prostheses Use (yes/no), and Tooth Decay (yes/no) were obtained from the clinical examination performed by the health professional. 3. Oral pain was assessed using the following question: are my teeth the cause of suffering and pain?	Each of these variables was used independently to assess oral health.
The assessment of oral functioning was based on several parameters[33]	Evaluation of oral functioning: the number of remaining oral hygiene and moisture, masticatory performance, swallowing ability, speech motor control, salivary bacterial count, and answers to the questionnaire about concerning the oral functions in KCL	The cut-off values for each component were defined as follows: number of remaining teeth < 20, measurement value of <27 for both the buccal mucosa and the tongue, oral hygiene level= requiring caution or with issues, occlusal force value of <30 kgf, masticatory performance a score of 2 or below, swallow saliva as many times as possible for 30s, tongue pressure value of 30 kPa or below, pronounced the syllable less than six times per second, a bacterial level of 4 or above.
The methods of Tanaka et al[5,27]	OF was evaluated by the six parameters: 1. The number of present teeth 2. ODK/ "ta" (pronunciation of the "ta" sound) 3. Tongue pressure 4. Chewing ability 5. Current subjective difficulties in eating 6. Difficulties in swallowing.	The criteria for OF cut-offs included the number of present teeth (<20), ODK / "ta"/ (male: <5.2, female: <5.4), tongue pressure (male: <27.4, female: <26.5), chewing ability with color-changing gum (male: <14.2, female: <10.8), difficulty eating tough food (yes), and difficulty in swallowing tea and soup (yes). For each item, a score of 1 was defined as a score below the cutoff. The total score of the 6 items was 0 points for non-OF, 1–2 points for pre-OF, and 3 or more points for OF.

OFI-8[24]	The OFI-8 score was the sum of the scores for each of the following questions. Q1: Do you have any difficulties eating tough foods compared to 6 months ago? (2 points for Yes) Q2: Have you choked on your tea or soup recently? (2 points for Yes) Q3: Do you use dentures? (2 points for Yes) Q4: Do you often have a dry mouth? (1 point for Yes) Q5: Do you go out less frequently than you did last year? (1 point for Yes) Q6: Can you eat hard foods like squid jerky or pickled radish? (1 point for No) Q7: How many times do you brush your teeth in a day? (3 or more times/day) (1 point for No) Q8: Do you visit a dental clinic at least annually? (1 point for No)	OFI-8 score is in the range of 0–11. An OFI-8 score ≥4 was defined as OF.
OF-5[15]	The OF-5 consists of the following five components: 1. "Fewer teeth" is indicated by a response of "0–19 teeth" to the question "How many of your natural teeth are left?" 2. "Difficulty in chewing" is indicated by a response of "yes" to the question "Do you have any difficulties eating tough foods compared to 6 months ago?" 3. "Difficulty in swallowing" is indicated by a response of "yes" to the question "Have you choked on your tea or soup recently?" 4. "Dry mouth" is indicated by a response of "yes" to the question "Do you often experience having a dry mouth?" 5. "Low articulatory oral motor skills" is indicated by a response of "yes" to the question "Have you had a difficulty in clear pronunciation recently?"	Each component is allocated 1 point if present. The overall OF-5 score ranges from 0 to 5 (0 = best to 5 = worst) and indicates the presence (2 to 5 points) or absence (0 or 1 point) of OF
The assessment of oral healthy was based on several parameters[25]	Several variables were operationalized based on the questions about oral health: 1. "Do you still have your natural teeth?" "How your missing teeth were replaced?" 2. Orla health (two items) 3. Oral pain: "Do you have any pain or sensitivity on gums or teeth while chewing?" 4. Impaired masticatory ability: "Are you able to chew all types of food?"	Each of these variables was used independently to assess oral health.
The assessment of oral healthy was based on several parameters[35]	1. Objective measures of oral health: count of remaining natural teeth and periodontal disease assessment. 2. Self-reported oral health measures: overall self-rated oral health; difficulty eating due to mouth, teeth or dentures, sensitivity to hot/cold/sweets, dry mouth (Xerostomia Inventory Scale; BRHS, single question; HABC)	1. Number of natural teeth was operationalised as a continuous variable and as a 3-level categorical variable (≥21, 1–20 and 0 teeth) for analyses. Dental status measure was based on ≥21 natural teeth, <21 teeth with use of dentures and <21 teeth without use of dentures. Periodontal status measures were determined in those who were dentate and classified as 0–20% and >20% of sites with pocket depth >3.5 mm (BRHS) or ≥3mm (HABC Study) pocket depth, and loss of attachment >5.5 mm (BRHS) or ≥3mm (HABC Study). 2. Self-rated oral health was grouped into excellent/good versus fair/poor; dry mouth symptoms were categorized as 0, 1 to 2, and 3 or more symptoms (BRHS) or yes/no (HABC Study), difficulty eating/chewing was binary (yes or no). The composite measure of poor oral health was categorized as having 0, 1, or 2 or more oral health problems.
OF checklist[32]	The checklist consists of eight items: 1. Find it more difficult to eat hard food now than half a year ago 2. Sometimes choke on tea or soup (choking) 3. Use dentures 4. Have concerns regarding oral dryness 5. Go out less frequently now than half a year ago 6. Capable of chewing hard food, such as pickled radish or shredded and dried squid 7. Brush teeth at least twice a day; and (8) visit a dentist at least once a year	If subjects answered yes to item 1, 2 or 3, two points were given, and if yes to item 4, 5 or 6, one point was given for each answer. When the subjects answered no to item 7, 8 or 9, one point was given for each answer. The maximum score was 11. The OF criteria were defined based on the sum of the scores: 0–2 points indicated low risk, 3 points indicated moderate risk, and >4 points indicated high risk.
The assessment of oral function was based on several parameters[29]	Seven items were assessed in the oral function examinations: 1. Oral hygiene 2. Oral dryness 3. Occlusal force 4. Tongue–lip motor function 5. Tongue pressure 6. Masticatory function 7. Swallowing function	Oral hypofunction was defined when at least three of these seven measurements met the criteria: 1. The total number of microorganisms exceeded $10^{6.5}$ CFU/mL (level 4) 2. Values<27.0 indicated oral dryness 3. An occlusal force <500 N 4. Reduced tongue–lip motor function was defined as fewer than six /pa/, /ta/ or /ka/ generated per second 5. Tongue pressure: A maximum value of less than 30 kPa 6. Masticatory function: values <100 mg/dL indicated decreased 7. Total score of ≥3 indicated reduced swallowing function

(Continued)

Table 3 (Continued).

Tools	Predictors of Oral Frailty	Scoring Standard
OHAT[30]	1. The extent of the plaque 2. Quality of saliva 3. Risk factors for poor oral health hygiene 4. A general inspection of the oral cavity	Each category is scored 0, 1 or 2,the maximum score is 16. A score of 0–3 suggests a healthy oral state, 4–8 identifies individuals those at risk, and a score of >9 indicates poor oral health.
Tanaka's 16 measure[5]	1. Dental status: number of natural teeth and functioning teeth, community periodontal index, tongue thickness, and turbidity of mouth-rinsed water. 2. Oral functions: maximum occlusal force, chewing ability, maximum tongue pressure, repetitive saliva-swallowing test, three different sounds ("pa", "ta", and "ka"), and oral wettability. 3. Subjective assessments: difficulties in eating and swallowing, and experience of dry mouth measured using the questionnaire.	Each item is typically scored on a scale, such as 0 (no problem) to 1 (problem present). The total score is between 0 and 16. Higher scores indicate greater OF.
The assessment of oral function was based on several parameters[31]	1. Oral function: examined and counted the number of teeth present in each participant 2. Masticatory performance 3. Tongue pressure 4. ODK	1. Teeth present: teeth with increased mobility and those without a crown were excluded from the count as they were nonfunctional. 2. Participants chewed gum freely at a rate of once per second for 60s. The color of the chewed gum was measured on a 10-point scale immediately after chewing to minimize the color change with time. 3. The maximum tongue pressure value was recorded after three measurements using a tongue Depressor. 4. ODK: the count was less than six times per second, the tongue–lip motor function was considered to be decreased.
The assessment of oral health was based on several parameters[38]	Functional teeth (< 20 teeth, ≥ 20 teeth); coronal caries; root caries (presence/absence); periodontal disease (presence/absence of clinical attachment, ≥ 4 mm in at least one tooth); dental calculus (presence/absence); dental biofilm (presence/absence); root remains (presence/absence); xerostomia, for which the Xerostomia Inventory (≥ 28 points) was used; need for removable dental prosthesis (absence of stability and retention); and the presence or absence of edentulism (total absence of teeth in the oral cavity).	Each of these variables was used independently to assess oral health.
The assessment of oral function was based on several parameters[28]	1. Oral examination: counting the number of teeth present and the number of functional teeth 2. Occlusal force 3. Differences in masseter muscle thickness 4. ODK	Each of these variables was used independently to assess oral function.
Kihon Checklist 6[3]	It's a simple self-report questionnaire with 25 yes/no questions: 1. Daily living 2. Physical function 3. Nutritional status 4. Oral function 5. Cognitive function 6. Depressive mood	OF risk was defined as having two or more of ral function questions
The assessment of oral function was based on several parameters[6]	Seven items were assessed in the oral function examinations: 1. Oral hygiene 2. Oral dryness 3. Occlusal force 4. Tongue- lip motor function 5. Tongue pressure 6. Masticatory function 7. Swallowing function	Oral hypofunction was considered when at least three of the seven parameters met criteria:

Abbreviations: ODK, Oral Diadochokinesis; ROAG, The Revised Oral Assessment Guide; KCL, The Kihon Check List; OF, Oral Frailty; OFI-8, The Oral Frailty Index-8; OF-5, BRHS, The British Regional Heart Study; HABC, The Health, Aging, and Body Composition Study; Oral Frailty 5-Item Checklist; OHAT, Oral Health Assessment Test; kPa, kPa refers to kilopascals, a unit of pressure. 1 KPa = 1000 pascals; kgf refers to kilogram-force, a unit of force. 1 kgf is the force exerted by gravity on a mass of 1 kilogram; s stands for seconds; mm stands for millimeters, a unit of length in the metric system; CFU/mL stands for colony-forming units per milliliter, a unit of measurement used to estimate the number of viable microorganisms (bacteria or fungi) present in a liquid sample; N stands for newtons, the unit of force in the International System of Units (SI); mg/dL stands for milligrams per deciliter, a unit of measurement commonly used to express the concentration of substances in blood or other fluids.

four parameters: oral examination, masticatory performance, tongue pressure, and oral diadochokinesis. The most comprehensive assessment tool includes 24 objective and subjective parameters.

Identified Unfavorable Outcomes in Older Adults with of

Fifteen unfavorable outcome indicators were reported, with each study identifying between one and six of these indicators. The most frequently reported was the incidence of physical frailty, followed by malnutrition, low dietary variety, social withdrawal, disability, and low gait speed. Additionally, some unfavorable outcomes were reported in only one article each, including oral candidiasis, short stride length, short step length, wider step width, longer double support duration, higher stride time, lower urinary tract symptoms, mild cognitive impairment, and fall risk. Among these studies, one had a follow-up time of one year,[38] while three had a follow-up time of two years.[33,34] The follow-up time for one study varied between one and four years, depending on the outcome indicator assessed.[5] Another study had a follow-up time of six years.[36] One study had a follow-up time of eight years,[35] and two studies reported a follow-up time ranging from one to nine years.[37,39]

Physical Frailty Associated with of

Among the included articles, 19 studies assessed the effect of OF on physical frailty in older people.[5,6,15,19,21–25,27–32,35,37–39] Tanaka et al (2018) found that poor oral condition is a significant predictor of future physical frailty.[5] Another Tanaka et al (2023) reported that 39.3% of individuals with OF showed a significantly higher prevalence and new-onset rate of physical frailty.[37] Kimble et al (2023) highlighted that oral health issues, specifically tooth loss and dry mouth among older adults are linked to the development of frailty in later life.[35] Ayoob et al (2024) demonstrated that 74% of individuals faced an elevated risk of developing new-onset physical frailty.[19]

Malnutrition Associated with of

Three studies indicated that OF increases the risk of malnutrition among the elderly.[9,21,34] One study indicated that the likelihood of experiencing more severe malnutrition, as assessed by the MNA®-SF score, rose by 36% with each additional OF component.[9] Another study reported that individuals with poor oral health had a 2.76 times higher risk of malnutrition.[21] Additionally, a study demonstrated a significant correlation between OF and declining nutritional status, with 12.4% of participants showing worsening nutritional conditions.[33,34]

Low Dietary Variety Associated with of

The relationship between low dietary variety and OF in the elderly has been explored in three studies.[5,10,15] Among older adults, one study found a significant correlation between the severity of OF and dietary variety scores. Specifically, the absence of daily consumption of meat, eggs, and soybean products differed markedly depending on the severity of OF.[10] Another study identified a significant indirect association between OF and physical frailty through low dietary variety.[15] Furthermore, participants diagnosed with OF were notably more prone to experiencing decreased meal volumes and decreased meat intake.[5]

Social Withdrawal Associated with of

Research from two studies has examined the relationship between social withdrawal and OF.[15,33] Iwasaki et al (2024) demonstrated that the indirect effect of OF on physical frailty, mediated by social isolation, was significant.[15] Furthermore, Hasegawa et al (2020) discovered that oral hypofunction was linked to increased social withdrawal among older adults. The study identified several factors significantly linked to increased social withdrawal: the number of remaining teeth, gingival condition, occlusal force, masticatory efficiency, and issues related to swallowing and dry mouth.[33]

Disability Associated with of

Three studies assessed the impact of OF on disability in the elderly.[5,36,37] Tanaka et al (2018) found that poor oral condition significantly predicted future disability, with OF being related to a 2.3-fold higher risk of disability.[5] In a later

study, Tanaka et al (2021) found that each one-point increase in the OFI-8 score corresponded to a 1.3-fold higher risk of new-onset OF and a 1.1-fold increased risk of disability.[36]

Low Gait Speed Associated with of

Two studies explored the connection between low gait speed and OF.[12,27] Iwasaki et al (2021) found inverse linear correlations between the number of OF components and gait speed, stride length, and step length.[12] Similarly, Komatsu et al (2021) reported a notable correlation between gait speed and OF.[27]

Others

Baba et al (2022) demonstrated that the presence of *C. albicans* and *C. glabrata* in saliva samples is linked to OF.[20] Iwasaki et al (2021) noted that participants with OF exhibited slower gait speeds, shorter stride and step lengths, wider step widths, longer double support durations, and greater variability in stride and step lengths.[12] Yoneyama et al (2024) demonstrated that the risk of OF independently correlates with lower urinary tract symptoms.[3] Nagatani et al (2023) discovered significant correlations between a reduction in remaining teeth, low tongue pressure, and difficulty eating tough food with the onset of new mild cognitive impairment. Additionally, they discovered that individuals experiencing oral and physical frailty had an increased risk of mild cognitive impairment.[39] Kamide et al (2023) showed that OF was significantly linked to an increased risk of falls, independent of other potential confounding factors.[26]

Discussion

This study aimed to explore the relationship between oral frailty and unfavourable outcomes in elderly patients and summarize their findings to provide an overview of the evidence. 20 oral frailty assessment tools were summarized. Then the evidence collected and analyzed in this review shows that the most common adverse outcomes in older patients with oral fragility are physical frailty, malnutrition, limited dietary variety, social isolation, disability, and reduced gait speed. The following findings were revealed.

Assessment of Oral Frailty

In current research on oral frailty in elderly patients, a variety of assessment parameters are employed, but no unified standard has been accepted yet. Among the 20 tools identified, the following three were used most frequently: assessment according to the methods of Tanaka et al, the Oral Frailty Checklist, and OFI-8 (a simplified version of Tanaka's 16 measures). The first assessment method is based on the following six criteria, which are also important parameters of oral frailty: the number of present teeth, masticatory function, tongue pressure, oral diadochokinesis, difficulty swallowing, and difficulty chewing. This assessment method combines subjective and objective indicators but requires trained professionals to conduct the measurements.[9] The second tool, the Oral Frailty Checklist, is a simple and easy-to-use subjective questionnaire that has been validated for assessing oral frailty and is widely used for screening oral frailty among the Japanese population.[40,41] The third tool, OFI-8, is designed to screen older adults at risk of oral frailty in community settings.[11] This eight-item subjective questionnaire evaluates tooth loss, diminished oral function, oral health-related behaviors, and reduced social participation. It includes two types of cut-off values, indicating the need for a dental check-up and the level of risk associated with oral frailty among older adults.[12]

We found that the assessment of oral function in studies is widespread. However, healthcare and dental services, as well as insurance systems, vary between countries. Additionally, most tools have been developed in Japan, so there is a need to enhance the external reliability and effectiveness of these tools to increase their applicability. In the future, combining subjective and objective structured assessment tools will help monitor oral frailty in elderly patients, taking into account cultural backgrounds and demographic characteristics.

Physical Frailty, Reduced Gait Speed and Disability Associated with Oral Frailty

The connections and pathways between oral frailty with frailty, reduced gait speed and disability have been extensively discussed. To elaborate, oral frailty is a strong predictor of physical frailty and disability and is associated with various factors, such as dental issues (tooth loss and the need for dental prostheses), periodontal disease, reduced occlusal force,

decreased masseter muscle thickness, and oral motor dysfunction.[42–44] This dysfunction is often measured by the ability to accurately repeat a series of rapid, alternating sounds.

Additionally, interrelationships between oral hypofunction and dysphagia may contribute to frailty and disability through common pathways like changes in muscle function. These changes can affect the strength and coordination of swallowing muscles, including the geniohyoid muscle and tongue,[45] leading to impaired mastication, inefficient bolus transport, and increased aspiration risk.[46] Moreover, the relationship between oral frailty and physical frailty is likely to be bidirectional. Individuals with impaired physical function often have limited self-care abilities and restricted access to oral healthcare. Conversely, oral frailty is linked to sarcopenia, a precursor to overall frailty.[5] Another possible mechanism linking oral frailty and physical frailty is through diet, as individuals with poor oral health tend to consume fewer healthy foods, leading to overall physical weakness.[47]

Another study noted that participants with oral frailty exhibited poor gait performance, mirrored by slower gait speeds, shorter stride and step lengths, wider step widths, longer double support durations, and greater variability in stride and step lengths.[12] Firstly, oral diseases can cause occlusal interference and alter the position of the mandible. These changes can subsequently affect the posture of the head and neck, ultimately resulting in disturbances in overall body posture control and balance.[12] Then dental occlusion can adversely affect muscle tone, which is connected to knee muscular performance and ultimately influences gait.[48] Importantly, a study demonstrated a significant link between masticatory performance and gait speed, revealing that this relationship was mediated by protein intake.[49] Furthermore, oral frailty was significantly linked to an increased risk of falls, as gait impairment is a well-established risk factor for falls in older adults.[50] These findings emphasize the importance of a multidisciplinary approach to managing oral frailty, with dental care being a crucial component.

Malnutrition and Low Dietary Variety Associated with Oral Frailty

The accumulation of oral frailty increases the risk of low dietary variety and has a dose-response relationship with deteriorating nutritional status.[51] Specifically, poor dentition can exacerbate anorexia, leading to a loss of pleasure in eating and making individuals more prone to dietary changes.[52,53] Edentulous individuals (including those with dentures) may also have more difficulty chewing than those with natural teeth.[54,55] Additionally, one study found that edentulous subjects, regardless of whether they had a prosthesis, consumed fewer fruits and vegetables. This group also exhibited decreased intake of protein and micronutrients, particularly in individuals with fewer than 21 teeth.[56]

Biologically, OF, characterized by impaired chewing and swallowing, leads to the avoidance of foods that are difficult to chew, such as meats, vegetables, and fruits.[57] This avoidance can result in low dietary variety and poor diet quality.[58–60] Moreover, a complex condition related to OF, sarcopenic dysphagia, is characterized by a loss of muscle mass and strength in the swallowing muscles, leading to impaired swallowing and potentially resulting in malnutrition through multiple pathological mechanisms.[61] A previous study stated that older adults who experience chewing and swallowing impairments, often have insufficient intake of fiber, linoleic acid, potassium, calcium, magnesium, zinc, selenium, vitamins D, E, and K, folate, biotin, and molybdenum.[62]

Furthermore, among these pathophysiological mechanisms contributing to malnutrition, poor oral hygiene may play a crucial role by increasing the risk of progressive periodontal disease and dental decay.[55,63] Therefore, oral health screening for older adults is of great significance for improving overall health.

Social Withdrawal Associated with Oral Frailty

Previous studies have demonstrated that oral frailty is associated with social withdrawal.[64,65] The mouth is a crucial tool for social interaction, and individuals with oral frailty face difficulties in communication and social engagement due to impaired verbal motor skills.[65,66] Additionally, older adults with severe tooth loss often feel embarrassed and avoid face-to-face social activities, such as smiling, talking, and eating.[67] This avoidance can lead to reduced social engagement.[65,68] Furthermore, social outings often include eating and drinking. Studies have shown that individuals with oral frailty face dietary restrictions due to eating and swallowing disorders and may need to pause frequently during meals. This can create a psychological burden, making them reluctant to dine with others, reducing communication skills, and potentially worsening social withdrawal.[33] However, social withdrawal heightens the risk for experiencing loneliness in older adults,

making them more vulnerable to both mental and physical health conditions.[69] Therefore, medical staff should screen oral function and develop personalized management measures related to oral frailty, which is crucial in preventing the worsening of social withdrawal.

Strengths and Limitations

This scoping review has some strengths. First, to the best of our knowledge, this is the first scoping review on the topic that highlights the importance of oral frailty in older adults and be available to researchers and healthcare providers. Second, our study adopted a robust method to guide and report the results of the scoping review framework based on the established range, including study identification and selection, and data synthesis.

While it is important to consider several limitations that may impact the generalizability of our findings. For instance, some studies may have methodological flaws, such as small sample sizes, lack of control groups, or potential biases in data collection and analysis, which can undermine the overall strength of the evidence. Additionally, variations in study design, patient populations, outcome measures, and definitions of oral fragility leads to heterogeneity in the data, complicating the process of drawing definitive and cohesive conclusions.

Future Research and Recommendations

Future research can expand to meta-analysis, allowing for a quantitative synthesis of existing studies to strengthen the evidence's persuasiveness and applicability. Additionally, developing standardized assessment tools that are culturally adaptable will help optimize OF risk stratification and better identify varying degrees of OF in the elderly. Moreover, future research can compare the manifestations, causes, and effects of OF in older adults across cultures, helping to identify culture-specific factors and their impact on health outcomes. Furthermore, to reduce the prevalence of OF, future research should explore using Lean Thinking to optimize the collaborative processes of multidisciplinary teams (eg, dentistry, dietetics, nursing, social work) for the systematic identification and management of OF.[70]

Conclusion

The current scoping review highlights the unfavorable outcomes linked to OF in older patients. The evidence collected and analyzed in this review suggests that physical frailty, malnutrition, low dietary variety, social withdrawal, disability, and low gait speed are the most common unfavorable outcomes in older patients with OF. Identifying these unfavorable outcomes is crucial because it significantly impacts the health and quality of life of the elderly. Furthermore, it aids in the development of public health policies, the optimization of healthcare resource allocation, and the enhancement of overall societal well-being. Future research should explore cross-cultural differences in the prevalence and impact of these unfavorable outcomes to enhance understanding and improve public health interventions.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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