REVIEW ARTICLE

Characterizing the Literature on Validity and Assessment Tool of Oral Frailty: A Systematic Scoping Review

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Abstract

Aim: To systematically review all studies on assessment tools used to diagnose oral frailty in older adults.

Materials and methods: A systematic search of PubMed, Google Scholar, and Scopus for articles yielded the tools published from January 2010 to January 2022. The search included articles reporting the use of the Oral Frailty risk assessment tool in older adults. A standardized protocol Joanna Briggs Institute (JBI) was used for data extraction. Flowchart and tables were used to demonstrate the results.

Results: A total of 19 studies were eligible out of 58 studies retrieved from selected databases. A total of three tools were structured for oral frailty assessment in older adults as follows: Oral and maxillofacial frailty index, oral frailty index-8 (OFI-8), and oral frailty checklist. The most critical parameter in assessing oral frailty was tongue pressure and dryness of the mouth. Other parameters for assessing oral frailty include the number of remaining teeth, oral diadochokinesis (ODK), masticatory performance, pain, dysphagia, taste alteration, use of dentures, bacterial count in the tongue coat, and presence or absence of periodontitis. The predictive validity of tools for differentiating high and low risks for oral frailty did not explore yet.

Conclusion: There has not been much research into assessment tools for oral frailty. This comprehensive review of the available literature identified only three structured assessment tools as follows: The oral frailty checklist, the oral and maxillofacial frailty index, and OFI-8. The oral frailty checklist is the only available validated oral frailty assessment tool despite the disproportionately high prevalence of oral frailty and the projected increase.

Clinical significance: Because an oral function examination for the elderly in their 60s is required to promote effective oral frailty countermeasures, an oral frailty assessment tool appropriate for the setting must be developed. This tool can be used as a population-wide standard of practice for screening oral frailty.

Keywords: Geriatric, Older adults, Oral and maxillofacial frailty, Oral frailty, Oral health-related quality of life.

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Introduction

The proportion of older persons in the population is increasing in every country. The number of elderly people is expected to more than double to 1.5 billion by 2050.[1] Frailty is defined as a clinically recognizable state in which older people's ability to cope with daily or acute stressors is compromised by an increased vulnerability caused by age-related declines in physiological reserve and function across multiple organ systems.[2] Frailty is a quite a prevalent condition of older adulthood with 4–59% old adult population suffering from it.[3] Frailty is a clinical and public health issue because it increases the risk of negative health outcomes such as falls, morbidity, physical and psychosocial dependency, hospitalization, and death.[2] Given the significance, the World Health Organization (WHO) has designated this decade until 2030 as "the decade of healthy aging."

Oral health is critical for the elderly to maintain overall health.[4] The WHO recognizes oral health-related quality of life (OHRQoL) as an important component of overall health and well-being (WHO, 2003).[5] "Oral health status" nomenclature later shifted to "OHRQoL." The OHRQoL measures aspects of oral functioning affected by oral diseases.[6] As far as older adults are concerned, starting at the age range 60–70 years, the complaint about loss of chewing ability rockets, and addressing this functional issue is becoming critical. Based on these findings, the concepts of oral functioning- Oral frailty and oral hypofunction have been introduced in Japan.[7,8] Oral frailty is a series of phenomena and processes that lead to changes in various oral conditions (number of teeth, oral hygiene, oral function, etc.) associated with aging and accompanied by decreased interest in oral health and reduced physical and mental reserve capacity. Moreover, an increase in oral frailty leads to eating dysfunction and deteriorating physical and mental function.[8] Oral hypofunction, on the other hand, considers decreased oral function caused not only by aging but also by a variety of factors such as diseases and disorders.

In 2022, a conceptual definition was suggested as follows: Oral frailty is the age-related functional decline of orofacial structures.[9] In summary, the oral frailty concept addresses four distinct oral

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health factors: deterioration of oral health status; deterioration of oral motor skills; chewing, swallowing, and saliva disorders; and oral pain.[9] Oral frailty strongly predict physical frailty, sarcopenia and mortality.[4] Oral health markers can be very reliable indicators of frailty further down the line. There exists an association between oral frailty and general frailty according to the latest studies.[4,9–11] It is critical to raise awareness of oral frailty and to improve oral health literacy in order to promote healthy aging. Since multiple parameters are involved in assessing oral frailty, it is necessary to know the current evidence of oral frailty in the literature. There are numerous tools for evaluating physical frailty, but only a few for evaluating oral frailty.[12] This systematic scoping review aimed to address the known nature and availability of oral frailty assessment tools.

Materials and Methods

The proposed scoping review was carried out in accordance with the JBI scoping review methodology.

Review Question

What are the oral frailty assessment tools available for community-dwelling older adults?

Search Strategy

The search strategy sought both published and unpublished research. To identify articles on the topic, a preliminary search of PubMed and Google Scholar was conducted. The text words found in relevant article titles and abstracts, as well as the index terms used to describe the articles, were used to create a full search strategy for (PubMed, Google Scholar, and Scopus). Search strategy for literature selection were broadly set as follows:

Population: Older adults above 40 years of age
Concept: Oral frailty assessment
elder* OR old*
- oral frail* OR pre-frail*
- and assessment tools
(elder*) OR (old*)) AND (oral frail*)) OR (pre-frail*)) AND (assessment tools)

The search strategy, which included all identified keywords and index terms, was tailored to each database and/or information source included. Additional studies were found in the reference list of all included sources of evidence. Original peer reviewed articles published from January 1980 to February 2021 was searched, initially in February 2021. Later on, to identify any new studies, the search was repeated in March 2021 and December 2021. Hence, original peer reviewed articles published from January 1980 till December 2021 in any language were eligible for data extraction.

Inclusion Criteria

Participants

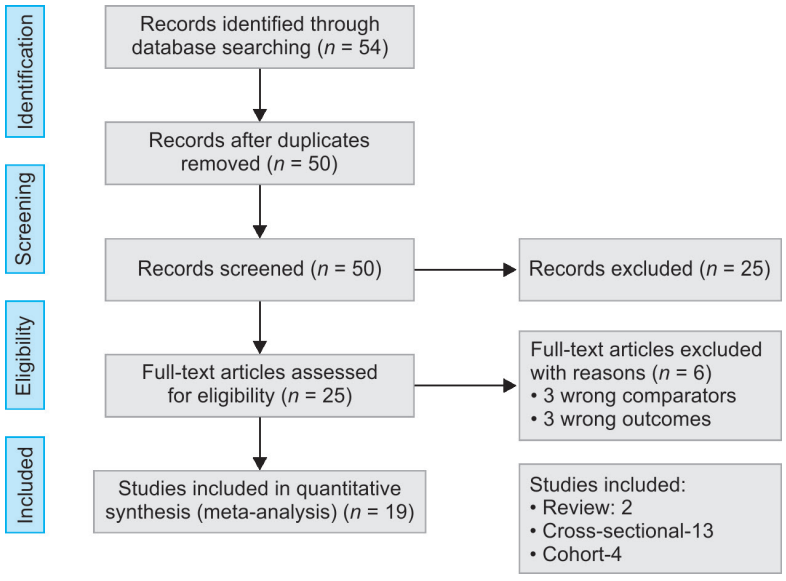
The original peer-reviewed articles had to meet the following criteria in order to be considered. The article should describe oral frailty. Only peer-reviewed articles written in English that describe the original quantitative, qualitative, or mixed methods research were considered. Grey literature, narratives, commentaries, and other document types such as reports, and essays were not permitted. All eligible studies' reference lists were also carefully revised for additional relevant studies. Text and opinion papers were also considered for inclusion in this scoping review.

Exclusion Criteria

Articles that did not meet the inclusion criteria, as well as those that had incorrect outcomes and comparators, were excluded.

Following a pilot test, two independent reviewers assessed the titles and abstracts against the review's inclusion criteria. Potentially relevant sources were retrieved in their entirety, and their citation information was imported into the JBI System for the Unified Management, Assessment, and Review of Information (JBI SUMARI) (JBI, Adelaide, Australia).[13] Two independent reviewers scrutinized the full text of selected citations against the inclusion criteria (SKN and CJ). Disagreements between the reviewers were resolved through discussion at each stage of the selection process. The results of the search and study inclusion process were fully reported in the final scoping review and depicted in a Preferred Reporting Items for Systematic Reviews and Meta-analyses Extension for Scoping Review (PRISMA-ScR) flow diagram[14] (Flowchart 1).

Flowchart 1: PRISMA flowchart



Data Extraction

Two independent reviewers (SKN and CJ) extracted data from papers included in the scoping review using a data extraction tool developed by the reviewers. The extracted data included information about the participants, the concept, the author and year, the study methods, and key findings relevant to the review question/s (Tables 1 and 2).

During the process of extracting data from each included evidence source, the data extraction tool was modified and revised as needed. Disagreements between the reviewers were settled through discussion.

Data Analysis and Presentation

Flowchart and tables were used to demonstrate the results.

Table 1: Characteristics of participants

Number	*Author, year, and country of study*	*Type of research design*	*Age and type of participants*	*Sample size*
1.	Choi et al. (2020)[18] Korea	A cross-sectional study based on telephone interviews	Above 50 years	300 Male:149 Female:151
2.	Hironaka et al. (2020)[19] Japan	Cross-sectional	Community-dwelling individuals aged above 65 years	682 Male: 267 Female: 415
3.	Iwasaki et al. (2021)[17] Japan	Cohort study	Above 70 years	1,054 Male: 428 Female: 626
4.	Kosaka et al. (2021)[20] Japan	Cross-sectional	Elderly patients came for dental checks with a mean age of 65.6	1,201 Male: 500 Female: 701
5.	Kugimiya et al. (2020)[8] Japan	Cross-sectional	65 years and above	679 Male: 282 Female: 397
6.	Nagayoshi et al. (2017)[21] Japan	Cross-sectional	40 years and above	1,982 Male: 821 Female: 1,161
7.	Nakagawa et al. (2017)[22] Japan	Cross-sectional	Mean age, 78	12 Male: 3 Female: 9
8.	Nakamori et al. (2020)[23] Japan	Cross-sectional	65 years and older with lifestyle-related diseases (such as hypertension, diabetes mellitus, dyslipidemia, and chronic kidney disease)	254 Male: 163 Female: 91
9.	Nam et al. (2018)[30] Korea	Review	N/A	N/A
10.	Shiraishi et al. (2020)[31] Japan	Review	N/A	N/A
11.	Yamanashi et al. (2018)[24] Japan	Cross-sectional	Community-dwelling age, above 60 years	1,603 Male: 650 Female: 953
12.	Tanaka et al. (2018)[4] Japan	Cohort study	Above 65 years, both urban and rural	2,044 Male: 1013 Female: 1031
13.	Tanaka et al. (2021)[16] Japan	Cohort study	Above 60 years (mean age, 73 ± 5.5)	832 Male: 303 Female: 529
14.	Takeuchi et al. (2021)[25] Japan	Cross-sectional	Above 60 years	188 Male: 58 Female: 130
15.	Tai et al. (2020)[15] Taiwan	A population-based prospective cohort study	Community-dwelling adults aged above 58 years	2,905 Male: 1,426 Female: 1,479
16.	Satake et al. (2019)[26] Japan	Questionnaire study	Above 60 years	467 Male: 173 Female: 294

(Contd...)

Table 1: *(Contd...)*

Number	*Author, year, and country of study*	*Type of research design*	*Age and type of participants*	*Sample size*
17.	Nomura et al. (2020)[27] Japan	Cross-sectional	Above 50 years	701 Male: 351 Female: 250
18.	Nishida et al. (2020)[29] Japan	Questionnaire	Above 65 years	3,475 Male: 1,555 Female: 1920
19.	Nishida et al. (2019)[28] Japan	Cross-sectional	Above 65 years	202 Male: 35 Female: 167

Results

Study Inclusion

A total of 58 articles were retrieved from the electronic databases. After 4 duplicates were removed, the title and abstracts of the remaining 54 articles were examined to determine the appropriateness of each study. Finally, a total of 19 articles was included in the final analysis. The process and outcome of the literature selection are presented in detail in Flowchart 1.

Characteristics of Included Studies

A total of 4 studies were cohort studies,[4,15–17] 13 were cross-sectional studies,[8,18–29] and two reviews were related to oral frailty.[30,31] The selected studies were conducted in three countries, Japan, Korea, and Taiwan. Most of the studies were reported in Japan (n = 16), Two studies were in Korea,[18,30] and one study was from Taiwan.[15] Most of them studied community-dwelling older adults (n = 18). In most of the studies, female participants were more (n = 17) (Table 1).

Review Findings

Oral frailty was described differently in studies. The concept of oral frailty, prefrailty, and non-frailty was described in one study.[4] At baseline, according to a prospective study, 16% of the participants had oral frailty, which was associated with a 2.4-, 2.2-, 2.3-, and 2.2-fold increased risk of physical frailty, sarcopenia, disability, and mortality, respectively.[4]

The tools most used for assessing oral frailty were oral and maxillofacial frailty index (OMFI Index),[18] oral frailty checklist,[27] Tanaka's 16 measures,[4] OFI-8,[16] Oral health impact profile,[15] and EAT-10 assessment tool.[28] Regarding the OMFI tool, only the preliminary study is over. Tanaka's 16 measure is now modified to OFI-8 for simplicity.

Oral frailty was described by a battery of measures such as tongue pressure, dry mouth, number of remaining teeth/numbers of functional dentition/number of natural teeth, dysphagia, periodontal status, ODK rate, masticatory performance, salivary bacterial count, etc. (Tables 2 and 3).

Tongue pressure[8,17,19,21,24–26] and dry mouth[4,8,16,18,20,22,25,27] were the most commonly assessed parameters (Table 3). The low tongue pressure was defined as <27.4 kPa in men and <26.5 kPa in women.[32] A decrease of approximately 10 kPa [1-standard deviation (SD) decrement] in maximum isometric pressure (MIP) was a strong predictor of the risk for frailty, according to another study.[24] Another important parameter, oral dryness, was assessed subjectively in some the studies.[4,16,18,20,25,27,29] Unstructured parameters are explained in Table 3. The sensitivity and specificity of these tools are not evaluated yet.

Discussion

The results of this scoping review provide current evidence of assessment tools for oral frailty. The findings provide insight for oral frailty assessment in community-dwelling elderly.

First, we found that most of the studies are conducted in Japan. More than 1 in 4 individuals are 65 years or above in Japan.[33] They have identified that oral frailty among the community-dwelling elderly is closely associated with their nutritional condition, and they are taking measures to prevent oral frailty.[17]

Second, we found that different studies assessed oral frailty by various parameters. Out of the 19 studies that assessed oral frailty, only the following 3 structured tools were identified: Oral frailty checklist, OMFI, and OFI-8 (a simplified version of Tanaka's 16 measures).[16,18,27] The first tool oral frailty checklist, which is a simple and easy questionnaire, is now validated for assessing oral frailty and widely used for the screening of oral frailty of the Japanese people.[27,34] The second tool, the OMFI was created on the premise that oral frailty should be assessed using the following five criteria: Difficulty in chewing, the need for water when eating dry food, difficulties in jaw or tongue movements, difficulty speaking or pronunciation, and difficulties in facial expression.[18] Twenty items were referenced from various existing measurement tools. The third tool, OFI-8 (OFI-8), helps to screen older adults who are at risk of oral frailty in the community setting.[4] The eight-item questionnaire, assesses tooth loss, poor oral function, oral health-related behaviors, and declining social participation. The tool includes two types of cut-off values which indicate the necessity of a dental check-up and the risk associated with oral frailty among older adults, respectively.[16] The above-mentioned three tools are subjective, easy to administer, non-invasive, and cheap. The psychometric properties of these tools are not calculated in any of the studies; so, the discussion is beyond the scope of this article.

Compared with the purely subjective assessment using questionnaires in the above tools, some studies used objective assessments. The tongue pressure and oral dryness are found to be the most assessed parameters for the assessment of oral frailty. Maximum isometric tongue pressure is a non-invasive and simple measurement that can help identify those at high risk of frailty.[24] The mechanism of muscle movement during swallowing underpins the link between tongue pressure, tooth number, and frailty.[27] However, There are two drawbacks to tongue pressure testing-first one is varying tongue pressure at different positions in the mouth, and the second one is the difference in tongue tip pressure between dentulous and edentulous older people.[24] Tongue thickness has also been found to be a sensitive indicator of oral frailty, as it decreases with age.[23] Next, the common factor, oral dryness (dry

Table 2: Data extraction tool

Author(s) and year	*Predictors of oral frailty*	*Tool accuracy*	*Validation*
Choi et al. (2020)[18]	OMFI index: A 20-item questionnaire was used for evaluation of oral frailty. It includes the following: 1. Pain and/or bleeding in the tooth or gum 2. Difficulty in chewing 3. Dry mouth 4. Jaw pain 5. Taste alteration 6. Difficulties in jaw or tongue movements/swallowing/speaking 7. Dysphagia 8. Difficulties in facial expression	Based on the parsimony principle, the authors suggested five items for an OMFI: 1. Difficulties in chewing 2. The necessity of water when eating dry food 3. Difficulties in jaw or tongue movements 4. Difficulties in speaking or pronunciation 5. Difficulties in facial expression The sum scores of the five items could be the OMFI and used as the severity of oral and maxillofacial frailty.	No
Hironaka et al. (2020)[19]	The number of teeth present masticatory performance Tongue pressure ODK	A total of 380 (55.7%) of the 682 participants had pre-oral frailty and 65 (9.5%) had oral frailty.	No
Iwasaki et al. (2020)[32]	Oral frailty was defined as the presence of three or more of the following components: (i) Lower number of remaining teeth: <20 (ii) Low masticatory performance: Increased surface area of the comminuted gummy jelly in the lowest quintile according to gender (men: <1,138 mm^2; women: <1,767 mm^2) (iii) Low articulatory oral motor skill: ODK "ta", men: <5.2 times/s; women: 5.4 times/s (iv) Low TP: men: <27.4 kPa; women: <26.5 kPa (v) Difficulties in eating hard foods: Answer of "yes" to the question "Do you have any difficulties eating tough foods compared to 6 months ago?" (vi) Difficulties in swallowing tea or soup: answer of "yes" to the question "Have you choked on your tea or soup recently?" ODK	Of 1,054 individuals included in the analysis, 215 (20.4%) were presented with oral frailty. Oral frailty was significantly associated with the level of malnutrition based on the MNA®-SF score [Odds ratio (OR) 2.79; 95% confidence interval (CI), 2.07–3.77]. Oral frailty was significantly associated with the level of malnutrition based on the serum albumin level (unadjusted OR 1.97; 95% CI, 1.39–2.81; adjusted OR 1.59; 95% CI, 1.10–2.31). The prevalence of malnutrition is high among older adults, and it is more severe among adults with oral frailty.	No
Kosaka et al. (2021)[20]	Number of functional teeth, occlusal support, and health status of periodontal tissue. Scores were assigned to each predictor at baseline based on multiple regression analysis.	They created a model to forecast how masticatory performance will change over the next 5 years.	No
Kugimiya et al. (2020)[8]	The number of existing teeth (20) Masticatory performance was assessed using a color-changing chewing gum (men: 14.2, women: 10.8) and ODK/ta/(men: 5.2, women: 5.4), tongue pressure (27.4 kPa for men, 26.5 kPa for women). Difficulties in swallowing tea or soup and eating difficult foods. The sum of the six items was used to calculate the oral frailty score, and each item below the cut-off value was worth one point. A score of 0 was considered robust, 1–2 points was considered oral prefrailty, and 3 points or more was considered oral frailty. Hypofunction of the mouth: TCI (≥50%), oral moisture (<27), occlusal force (<200 N), number of present teeth (<20), ODK/ta/(6 times/s), tongue pressure (<30 kPa), masticatory function was evaluated by test gummy gelly (score <2) and EAT-10 (score >2).	They proposed the concept that oral frailty and oral hypofunction are separate entities. Oral frailty was found in 22.3% of men and 22.7% of women. Oral hypofunction was found in 39.0% of men and 46.9% of women. The overall rate of oral hypofunction ranged 43.6–46.4%.	No

(Contd...)

Table 2: *(Contd...)*

Author(s) and year	*Predictors of oral frailty*	*Tool accuracy*	*Validation*
Nagayoshi et al. (2017)[21]	Tongue pressure	Having a social network involving neighbors and taking part in leisure activities were independently associated with higher tongue pressure.	No
Nakagawa et al. (2017)[22]	Gum chewing exercise can increase resting saliva secretion and occlusal force in elderly individuals.	Occlusal force can be raised and xerostomia might be alleviated in older adults using gum-chewing exercises.	No
Nakamori et al. (2020)[23]	Tongue thickness by ultrasonography and tongue pressure (sarcopenia).	Tongue thickness and pressure, both of which are sensitive indicators of oral frailty, decrease with age. Males' tongue thickness increases in 5-year increments. Tongue thickness decreased significantly with age. These findings point to the rate of progression of tongue muscle atrophy caused by aging.	No
Nam et al. (2018)[30]	The following are five common geriatric oral medicinal dysfunctional problems: Hypofunction of the salivary glands (dry mouth), chronic pain disorders of the oral mucosa (burning symptoms in the mouth) Disturbances in taste (taste disturbances), disorders of swallowing (dysphagia) and oral and maxillofacial movement (oromandibular dyskinesia and dystonia).	N/A	No
Yamanashi et al. (2018)[24]	Maximum isometric tongue pressure: MIP was defined as the best value of the three measurements.	The MIP performance is independently associated with frailty. The MIP also can be used as a simple screening tool for frailty.	No
Wakabayashi (2014)[38]	Dysphagia: Sarcopenia is related to presbyphagia and sarcopenic dysphagia.	N/A	No
Tanaka et al. (2017)[4]	16 measures for assessment of oral frailty: Dental status: Number of natural teeth and functioning teeth, community periodontal index, tongue thickness as a marker of oral nutrient status, and turbidity of mouth-rinsed water as a marker of oral hygiene. Oral functions: Maximum occlusal force, chewing ability as a marker of general masticatory performance, maximum tongue pressure, repetitive saliva-swallowing test (RSST), three different sounds ("pa," "ta," and "ka"), and oral wettability. Subjective assessments: difficulties in eating and swallowing, and experience of dry mouth measured using the questionnaire Oral frailty was defined as co-existing poor status in ≥3 of the six measures. A total of 16% of participants had oral frailty at baseline, which was significantly associated with 2.4-, 2.2-, 2.3-, and 2.2-fold increased risk of physical frailty, sarcopenia, disability, and mortality, respectively. Oral non-frailty as no poor status in the six targeted measures, oral prefrail status as poor status in 1 or 2 measures, and oral frailty status as poor status in three or more of the six targeting measures.	A total of 16% of participants had oral frailty at baseline, which was significantly associated with 2.4-, 2.2-, 2.3-, and 2.2-fold increased risk of physical frailty, sarcopenia, disability, and mortality, respectively.	No

Tanaka et al. (2021)[16]	OFI-8 Questionnaire was used for evaluation of oral frailty. 1) Do you have any difficulties eating tough foods compared to 6 months ago? +2 points 2) Have you choked on your tea or soup recently? +2 points 3) Do you use dentures? +2 points 4) Do you often have a dry mouth? +1 point 5) Do you go out less frequently than you did last year? +1 point 6) Can you eat hard foods like squid jerky or pickled radish? +1 point 7) How many times do you brush your teeth in a day? (3 or more times/day) +1 point 8) Do you visit a dental clinic at least annually? +1 point They defined "oral non-frailty" as good performance on all six measures, "oral pre-frailty" as poor performance on one or two measures, and "oral frailty" as poor performance on three or more measures (i) the OFI-8 *t*-score can effectively discriminate between participants at higher and lower risk of oral frailty at a score of ≥4 points (3 points when prioritizing sensitivity over specificity) and those (ii) individuals with a score of ≥4 points are at high risk for new-onset oral frailty and subsequent need for long-term care.	The OFI-8 is an eight-item questionnaire that assesses tooth loss, poor oral function, oral health-related behaviors, and declining social participation. The OFI-8 also includes a question about a decrease in social participation, assessing oral function deterioration and its potential effect on social participation OFI-8 score can effectively discriminate between i) participants at higher and lower risk of oral frailty at a score of ≥4 points (3 points when prioritizing sensitivity over specificity) and that (ii) individual with a score of ≥4 points are at high risk for new-onset oral frailty and subsequent need for long-term care. This study proposed the use of the OFI-8 to identify community-dwelling older adults at an increased risk of developing new-onset oral frailty and requiring long-term care needs certification.	No
Takeuchi et al. (2021)[25]	Six parameters Bacteria counts in tongue coat, oral wettability, tongue pressure, ODK, masticatory ability, and bite force. The swallowing function was assessed using the 10-item eating assessment tool-10 (EAT-10).	The optimal cut-off value was an age of ≥71 years, giving a sensitivity of 85.1%, a specificity of 44.7%, a positive predictive value of 33.9%, and a negative predictive value of 90.0% in predicting declining swallowing function. The second-best parameter was ODK/pa/sound with an AUC of 0.638. Bacteria counts in tongue coat, oral wettability, tongue pressure, ODK/ka/sound, and number of functional teeth did not significantly correlate with declining swallowing function (p ≥0.05).	No
Tai et al. (2020)[15]	Seven parameters Functional limitation Physical pain Psychological discomfort Physical disability Psychological disability Social disability Handicap	Increased OHIP is associated with frailty. An inability to self-report height or weight (adj, 4.52; 95% CI, 3.52–5.81) and an increased OHIP-7T Q7 score (adj, 1.21; 95% CI, 1.06–1.37) were significantly associated with dementia. The cut-off points of the risk scores for frailty and dementia were 80 (sensitivity, 80.0%; specificity, 81.2%) and 77 (sensitivity, 83.4%; specificity, 71.5%) They developed easily applicable OHFD models which can be used to screen for frailty and dementia in communities or dental clinics.	No
Satake et al. (2019)[26]	Four parameters Number of teeth Presence or absence of periodontitis Tongue pressure ODK	Tongue pressure was inversely associated with age and positively associated with muscle index and the number of teeth. Revealed a significant correlation between the tongue pressure and the number of teeth and muscle index. No association was found between frailty and ODK.	No

(Contd...)

Table 2: *(Contd...)*

Author(s) and year	*Predictors of oral frailty*	*Tool accuracy*	*Validation*
Nomura et al. (2021)[27]	Oral frailty checklist The checklist consisted of eight items: 1: Harder to eat hard food than half a year ago (difficult to eat hard food) 2: Sometimes, choked by tea or soup (choking) 3: Do you use denture (using denture) 4: Minding about oral dryness (Xerostomia) 5: Less frequent going out times than half a year ago (less frequently going out) 6: Capable of chewing hard food like pickled radish or shredded and dried squid (feasible to chew hard food) 7: Brushing teeth at least twice a day (brushing teeth at least twice a day) 8: Attending dentist at least once a year (regular attendance of dental clinic). By the standard protocol, items 1, 2, and 3 are weighted as two points and others were one point. The screening criteria are defined by the sum of the scores: Low risk for 0–2 points, the risk for 3 points, and high risk for more than 4 points.	The questionnaire for the screening of oral frail is a validated, useful tool. The scoring system of the questionnaire should be established based on IRT analysis.	Yes
Nishida et al. (2020)[29]	The frailty checklist includes simple yes/no questions concerning lifestyle (Q1–5), physical function (Q6–10), nutrition (Q11–12), oral function (Q13–15), homebound status (Q16–17), cognitive function (Q18–20), and depressive mood (Q21–25).The domain of the oral function (impaired) Chewing function Swallowing function (impaired = dysphagia) Oral dryness The domain of nutrition (malnutrition) The domain of the physical function (impaired physical condition) The domain of homebound status (seclusion) The domain of the cognitive function (cognitive decline) The domain of depressive mood (depression)	Dysphagia was independently associated with oral, physical, cognitive, and psychological frailty. These results suggest that a frailty prevention strategy including swallowing training might be useful for community-dwelling independent elderly persons aged ≥65 years.	No
Nishida et al. (2020)[28]	EAT-10 and 100-mL WST EAT-10 and 100-mL WST Dysphagia assessment was performed using the EAT-10 and the 100-mL WST as subjective and objective examinations, respectively. The EAT-10 was used to measure self-reported dysphagia.[12] The EAT-10 is composed of 10 questions with responses given on a five-point Likert scale (from 0, no problem to 4, severe problem). The total score ranges from 0 to 40, with higher scores indicating severe dysphagia symptoms. In the 100-mL WST, the faster the swallowing capacity, the greater the volume per swallow, the shorter the time per second, and the absence of any choking signs meant a higher swallowing performance.	EAT-10 strongly reflects swallowing disorders caused by a decline in respiratory function among older people.	No

AUC, area under the ROC curve; OHFD, oral health for frailty/dementia; IRT, item response theory; WST, water swallowing test

mouth) is often due to the side effects of various medications, irradiation of the head and neck, stress, and systemic diseases such as Sjögren syndrome, etc. Because saliva plays an important role in the preservation and maintenance of oral health and function, evaluation of dry mouth is an essential issue for improving the oral health status of elderly individuals. Some previous studies have reported the associations between chewing ability and oral dryness, nutritional status, physical function, and cognitive function in community-dwelling elderly Japanese persons based on the results of objective examinations (such as moisture level in mucus, blood examination, grip strength, and the Mini-Mental State Examination).[29,35]

Table 3: Unstructured parameters

Parameters	*Number of studies*
Tongue pressure	Seven[8,17,19,21,24–26]
Dry mouth	Eight[4,8,16,18,20,22,25,27]
Number of teeth	Six[4,8,17,19,20,26]
Dysphagia	Seven[4,8,16–18,25,29]
ODK	Five[4,8,19,25,26]
Masticatory performance	Four[8,17,19,25]
Taste alteration	One[18]
Jaw pain	One[18]
Difficulty with facial expression	One[18]
Use of dentures	One[16]
Bacterial count in tongue coat	One[25]
Presence or absence of periodontitis	One[26]

The next standard parameter explored for assessing oral frailty was the number of remaining teeth. Edentulism can be the equivalent of mortality in the oral health field. A study conducted in the USA discovered a link between the number of extracted teeth and physical frailty among the USA's older adults aged 65 and above.[36] According to the findings of a cohort study, having more than 20 teeth is desirable for a healthier diet.[37] As malnutrition is linked to poor oral health and frailty, the 80–20 achievement rate has been adopted as a representative target in Japan's elderly. In contrast, one study found a contradictory result.[26]

Another important factor of oral frailty which can lead to changes in food habits and sarcopenia is impaired masticatory performance. Older adults with adequate chewing ability are less likely to be malnourished than those with impaired chewing ability. Masticatory function improvement has a significant positive impact not only on oral health but also on systemic health management in the elderly. If posterior teeth are lost, masticatory performance will be impaired. It is a proven factor that neurological and postural influences derived from the stomatognathic system are more powerful than other parts of the body due to direct neurological trigeminal input (without relay) to the cranial nuclei, which strongly affect skeletal postural muscle control, sleep, salivation, taste, swallowing, emesis, etc. The upper incisor contact (12–22) in centric occlusion is the most harmful according to recent studies. The decreased masticatory function has a strong association with frailty according to recent studies.[9] Gum chewing exercises can raise the occlusal force in older adults.[22]

The other important parameter articulatory motor skill – ODK – represents the dexterity of the tongue and tongue lip motor function. Speech–language pathologists (SLPs) use ODK tasks to assess and monitor motor speech disorders (e.g., dysarthria and apraxia).[38] These tasks involve repeating single syllables such as "Pa," "Ta," "Ka," or sequential multisyllables such as "Pa-Ta-Ka," "Buttercup," and so on as quickly as possible, in one breath or within a set period of time. One study this review identified is ODK as the second-best predictor of declining swallowing function in which age was identified as the best parameter.[25] However, some controversy is there as another study found no association between ODK and frailty.[26]

Next, important oral frailty parameters dysphagia and swallowing function were assessed by EAT-10 tool, 100-mL saliva swallowing test, and repetitive saliva swallowing test (RSST).[28] Other parameters such as pain in the oral cavity, taste alteration, jaw pain, difficulty with facial expression,[18] bacterial count in tongue coating,[25] and the presence or absence of periodontitis[26] were assessed only in one study each. Rather than the individual components, the accumulation of multiple components of oral frailty contributes to deteriorating nutritional status.[17]

There are very few structured and validated oral frailty assessment tools. The current review emphasizes that oral functions must be considered in addition to the number of teeth counted in the case of older people. The evaluation of oral function is universal across countries; however, the supply system of medical and dental services, as well as the insurance system, differ. Also, most of the tools are developed in Japan, so the external reliability and validity of the tool is needed to increase its generalizability. The oral frailty assessment tool should be available for screening tailored to our setting. It will provide dentists with an excellent opportunity to detect oral frailty at an early stage and thus prevent or postpone frailty. It is time for the oral health and geriatric communities to collaborate.

An important limitation of the study is that the low number of studies included as data regarding oral frailty is scarce. Although not a limitation, which concerns the design of this review, it is the limit of the study that the validity of the oral frailty tool used in each study was not fully verified.

Conclusion

This comprehensive review of the available literature found only three oral frailty assessment tools. The oral frailty checklist is the only available validated oral frailty assessment tool, despite the disproportionately high prevalence of oral frailty and the projected increase. Due to differences in lifestyle, diet, and other sociodemographic characteristics, there is a need for validation of the tools in another setting. As we need to conduct an oral function examination for the elderly in their 60s to promote effective oral frailty countermeasures, a validated oral frailty risk assessment tool can be integrated as a standard of practice for oral frailty screening at the population level. This approach will help to improve the oral health and physical health of the elderly regardless of the setting.

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Authors' Contributions

Author SKN made significant contributions to the conception and design, data acquisition, analysis, and interpretation of data, drafting the article, critically revising the article for important intellectual content, and the final approval of the version to be published; CJ was involved in the conception, design, and analysis of the article, as well as the critical revision of the article for important intellectual content and final approval of the version to be published.

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