Decline in Oral Function and Its Management

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ABSTRACT

With the renewed focus on eating abilities in the ageing population, new concepts referred to as oral frailty and oral hypofunction have been introduced in Japan. We aimed to provide an overview of (i) the evaluation and management of oral function in ageing populations according to oral frailty and oral hypofunction and (ii) recent scientific evidence of the associations of poor oral function with physical function and nutritional status. Both oral frailty and oral hypofunction are multidimensional concepts that describe poor oral function. In epidemiologic and/or clinical settings, they are defined as the accumulation of factors leading to poor oral status. Oral hypofunction is a core component of oral frailty. To date, there are no systematic strategies for addressing oral frailty or oral hypofunction. Nevertheless, recent randomised controlled trials revealed that several components of oral function can be improved through appropriate training. On the other hand, multiple observational studies published in recent years have demonstrated that oral frailty and oral hypofunction are associated with physical function (gait performance, frailty, and sarcopenia) and nutritional status (low protein intake, poor dietary diversity, and malnutrition) in community-dwelling older adults. Moreover, studies have reported a significant association between insufficient participation in social networks and poor oral function. However, most of the studies conducted to date have utilised a cross-sectional design, which does not permit assessment of the temporal association between comprehensive oral function and general health. Maintaining good oral function may be key to longevity. However, evidence is limited thus far, and comprehensive oral function has not been studied in detail; thus, additional high-quality studies are needed.

Introduction

Oral health is integral to general health and social well-being. Oral health refers not only to the number of teeth present and the level of oral hygiene but also to functions such as mastication, tongue and lip motor skills, and salivary secretion.

The 8020 Campaign (having more than 20 teeth at the age of 80), which originated in 1989 in Japan, developed a dynamic national kinesiology initiative and created a foundation for dramatically improving the oral health of older adults. Table 1 shows the results of national surveys of Japanese oral health during 1981 to 2016. The percentage of adults with more than 20 teeth at age 80 exceeded 50% in 2016.[1]

The oral health treatment needs of the older population have changed. In addition to the morphologic approach to teeth affected by dental caries and periodontal diseases, methods focused on adequate functioning of the remaining morphologies are now required.

In response to these changes, "oral frailty," a new model that visualises the process by which decreases in oral function lead to functional impairment, has been proposed in Japan. This model has a focus on decreases in the multifaceted aspects of function in the oral cavity, especially in regard to minor decreases in oral functions, which tend to be neglected (Figure).[2] Although research on oral frailty has recently begun, high-quality evidence has been produced through epidemiologic studies.[3-8]

By promoting discussions on the concept of oral frailty, the third level of oral frailty (Figure) was covered by the Japanese National Health Insurance in 2018. The third level of oral frailty was defined as "oral hypofunction,"[9] which was a 7-component clinical phenotype based on oral health. Since the procedures related to oral hypofunction have been covered by insurance, oral function assessments are accessible to the public in Japan.

The importance of oral function in the ageing population has been receiving more attention from clinicians, researchers, and citizens than ever before. The aim of this review is to

Abbreviations: DRI, Dietary Reference Intake; KCL, Kihon Checklist; MNA®-SF, Mini Nutritional Assessment®-Short Form; oral DDK, oral diadochokinesis; TP, tongue pressure

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Table 1 – Proportion of adults with more than 20 teeth present at age 80.

Survey year	1981	1987	1993	1999	2005	2011	2016
Total sample	362	481	444	417	492	565	543
Proportion of adults with more than 20 teeth present at age 80	7.2%	8.3%	11.5%	17.3%	25.0%	40.2%	51.2%

Survey of Dental Diseases, Japan (1981 to 2016).

provide an overview of (i) the evaluation and management of oral function in ageing populations according to oral frailty and oral hypofunction and (ii) recent scientific evidence on the associations of poor oral function with physical function (frailty and sarcopenia) and nutritional status (malnutrition). Additionally, we critically review the concepts of oral frailty and oral hypofunction.

Evaluation and management of oral function in ageing populations from the viewpoint of oral frailty and oral hypofunction

Definition of oral frailty

In the Kashiwa study, oral frailty was first operationally defined as the presence of 3 or more of the following components: (i) low number of remaining teeth, (ii) low masticatory performance, (iii) low articulatory oral motor skill, (iv) low tongue pressure (TP), and subjective difficulties in (v) eating and (vi) swallowing.[9] The detailed criteria for each component are presented in Table 2.

Amongst these 6 oral frailty components, assessments of masticatory performance, articulatory oral motor skill, and TP required special devices.

Masticatory performance was evaluated using Masticatory Performance Evaluating Gum (XYLITOL, 70 mm × 20 mm × 1 mm, 3.0 g; Lotte). Participants were asked to chew a piece of gum for 1 minute as they usually chew food. When dentures were typically used, they were left on for the measurement. The colour of the chewed gum was evaluated in the L*a*b* colour system with a CR-13 colour reader (Konica Minolta Holdings, Inc. The L*a*b* colour system was developed by the Commission Internationale de l' Eclairage. The 3 basic coordinates represent the lightness of the colour (L*), its position between red/magenta and green (a*), and its position between yellow and blue (b*). Since the Masticatory Performance Evaluating Gum gains redness after mastication, a*

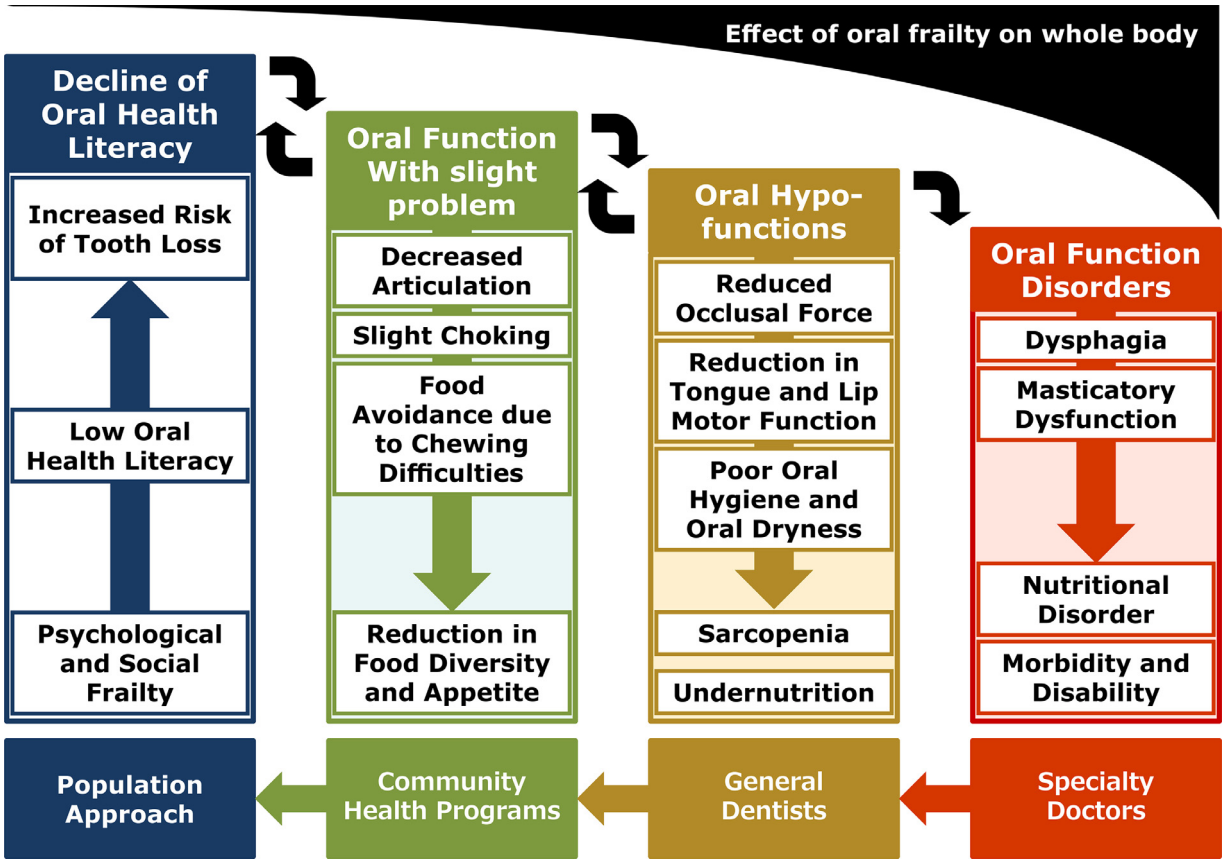

Figure – Oral frailty diagram.[2]

Table 2 – Six components of oral frailty as assessed in the Kashiwa study.[9]

Components	Criteria
(i) Lower number of remaining teeth	Number of remaining teeth: <20
(ii) Low masticatory performance	Spectrophotometric measurement of red photogenesis of colour-changing chewing gum after masticating (a* value) in the lowest quintile according to sex (men: <14.2; women: <10.8)
(iii) Low articulatory oral motor skill	Oral DDK: /ta/; men: <5.2 times/s; women: <5.4 times/s
(iv) Low tongue pressure	Men: <27.4 kPa; women: <26.5 kPa
(v) Difficulties eating hard foods	Answering "yes" to the question "Do you have any difficulties eating tough foods compared to 6 months ago?"
(vi) Difficulties swallowing tea or soup	Answering "yes" to the question "Have you choked on your tea or soup recently?"

Oral DDK, oral diadochokinesis.

values were used to represent masticatory performance. Lower a* values indicated lower masticatory performance.[10]

Articulatory oral motor skill was evaluated by the measurement of the repetitive articulatory rate or oral diadochokinesis (oral DDK) using an oral function measuring device (KENKOU-KUN handy; Takei Scientific Instruments Co., Ltd.).[11] The number of repetitions of the monosyllable /ta/ per second was recorded.

TP was measured using a JMS TP measuring device (TPM-01; JMS Co., Ltd.).[12] This device consists of a probe, connecting tube, and main body. The probe has a balloon that is 25 mm long and 15 mm wide. The part of the probe that participants grip has a plastic cylinder that allows them to hold the probe in the correct position. For the TP measurement, study participants were asked to sit in a relaxed position, place the balloon in their mouth, and hold the plastic cylinder at the midpoint of the central incisors with the lips closed. The examiners also held the probe to keep it in the correct position. Participants were then asked to raise their tongue and compress the balloon against the hard palate for 7 seconds at maximum voluntary effort. The maximum pressure value was recorded in kPa. Dentures, when typically worn, were left on for the measurement. Measurements were carried out 3 times at 1-minute intervals, and the average value of the 3 measurements was used in this assessment.

Diagnosis of oral hypofunction

Older adults were diagnosed with oral hypofunction if they had 3 or more of the following 7 aspects of oral health and functions: (i) poor oral hygiene, (ii) oral dryness, (iii) low occlusal force, (iv) low articulatory oral motor skill, (v) low TP, (vi) low masticatory performance, and (vii) compromised swallowing function. The detailed criteria for each item are summarised in Table 3.

Management of oral function

To date, there are no systematic strategies for addressing oral frailty or oral hypofunction. Nevertheless, epidemiologic studies have investigated the effects of interventions in older adults with poor oral function. In one cluster-randomised controlled trial,[21] a total of 219 older adults from 30 dental clinics, who were defined as having oral frailty, were randomly allocated to either the intervention group or the control group and were followed for 12 weeks. The programme involved oral exercises, mouth-opening training, TP training, articulation training, and masticatory training and was implemented in the intervention group. The control group received no intervention during the same period. Details of the programme menu are summarised in Table 4. Oral function assessment was performed at baseline and at the 12-week follow-up. Overall, 51 adults in the intervention group and 32 adults in the control group completed the study. Significant improvements in oral DDK, TP, repetitive saliva swallowing test results, and gum test results were observed in the intervention group (Table 5).

Similar results were observed in another randomised controlled trial.[26] There were significant improvements in oral function, including oral DDK with /pa/, /ta/, and /ka/ (ie, the number of repetitions of the monosyllables /pa/, /ta/, and /ka/ per second), TP, and chewing ability, following an 8-month oral function training amongst community-dwelling older adults with mild cognitive impairment. A single-arm intervention study[27] to investigate the change in oral function after implementation of a 3-month isometric tongue lifting exercise programme revealed improvements in not only oral function, including TP and oral DDK, but also physical function, including open-eyed one-leg standing time, sit-to-stand motion time, and 3-minute timed up and go test results. Based on the results of these intervention studies, several components of oral function can be improved through appropriate training.

A unique approach to the treatment of oral hypofunction[28] has been reported. Adults aged ≥65 years were randomly allocated to either the intervention group or the control group and were followed for 12 weeks. The programme consisted of comprehensive oral and physical exercises and munchy lunch gatherings, was named the "COPE-TeL programme," and was implemented for the intervention group. The munchy lunch was a packaged lunch box meal consisting of cooked rice, a main dish, and 2 side dishes. The lunch boxes provided increased masticatory load by means of the following preparation principles: (i) using hard or textured food ingredients, (ii) cutting ingredients into larger pieces, (iii) shortening cooking time for vegetables and root vegetables, and (iv) using less water. In addition, the lunches were designed to have specified amounts of calories (≥600 kcal), protein (≥25 g), vitamin D (≥2.75 μg), and sodium (≤2.5 g) based on the Dietary Reference Intakes (DRIs) for Japanese individuals. The control group received only a physical exercise regimen during the same period. At the 12-week follow-up assessment, the prevalence of oral hypofunction was significantly decreased in the intervention group. This study demonstrated that comprehensive programmes including oral and physical exercises and munchy lunch gatherings

Table 3 – Seven components of oral hypofunction.[13]

Components	Criteria	Description
(i) Poor oral hygiene	TCI ≥ 50%	Oral hygiene was assessed using the TCI, which quantifies the tongue-coating status as a percentage and reflects the total number of anaerobic bacteria present on the dorsum area of the tongue.[14]
(ii) Oral dryness	Oral moisture checker value < 27	Oral dryness was assessed using an oral moisture checker (Mucus; Life Co., Ltd.) that measures mucosal wetness on the central dorsum of the tongue. Measurements were performed 3 times, and the median value of the 3 measurements was used in this analysis.
	Saxon test ≤2 g/2 min	The Saxon test,[15] which measures saliva production with a gauze sponge, was proposed as an alternative method to diagnose oral dryness.
(iii) Low occlusal force	Occlusal force < 500 N	Occlusal force was measured using pressure-sensitive sheets (Dental Prescale II; GC Corporation) with an image scanner and analysis software (Bite force analyzer; GC Corporation). Older adults were asked to clench their jaws with maximum force in the intercuspal position for 3 seconds with pressure-sensitive sheets placed between the upper and lower dental arches.
	Number of remaining teeth: <20	Dentures, when used, were left on for measurement. The maximum occlusal force was calculated after the sheet was scanned. Determination of number of teeth was set as alternative method to diagnose low occlusal force.
(iv) Low articulatory oral motor skill	Any of the oral DDK with /pa/, /ta/, and /ka/ < 6 times/s	Articulatory oral motor skill was evaluated by the oral DDK. The number of repetitions of the monosyllables /pa/, /ta/, and /ka/ per second was recorded.
(v) Low tongue pressure	Tongue pressure < 30 kPa	Tongue pressure was measured using a JMS tongue pressure measuring device (TPM-01; JMS Co., Ltd.).[12] Measurements were carried out 3 times at 1-minute intervals, and the average value of the 3 measurements was used for the diagnosis.
(vi) Low masticatory performance	Glucose concentration obtained by chewed gummy jelly < 100 mg/dL.	Glucose concentration obtained from the chewed gummy jelly was measured to assess masticatory function. Individuals were asked to chew 2 g of gummy jelly, after which time the amount of eluted glucose was measured using a masticatory ability testing system (Gluco Sensor GS-II; GC Corporation).[16]
	Masticatory ability test score using gummy jelly < 3	Visual inspection score of the degree of fracture in the chewed gummy jelly (Test Gummy Jelly for Evaluating Masticatory Performance; UHA Mikakuto Co., Ltd.) was proposed as an alternative method to assess masticatory performance. Older adults were asked to chew a gummy jelly for 30 strokes, similar to the manner in which they usually chew food. The degree of fracture in the chewed gummy jelly was evaluated as a comparison with the visual reference material and was assigned a score ranging from 0 to 9, whereby lower scores indicated poorer masticatory performance.[17]
(vii) Compromised swallowing function	Total EAT-10 score ≥ 3	Swallowing function was assessed using the 10-item eating assessment tool EAT-10.[18] The EAT-10 is a self-administered 10-item questionnaire for dysphagia screening, with each item scored from 0 to 4 (total score range, 0 to 40). An EAT-10 total score ≥ 3 is indicative of dysphagia.[19]
	Rated as "A" in any of the 15 components of the Seirei questionnaire of swallowing	Another questionnaire, the Seirei Questionnaire of Swallowing,[20] can be used either as subjective (via self-report) and objective (via observation) assessments. This can be used as an alternative method to assess swallowing function.

EAT-10, 10-item eating assessment tool; oral DDK, oral diadochokinesis; TCI, tongue coating index.

Table 4 – Details of oral functional training programme.[21]

Items	Criteria	Contents
Oral exercises	All individuals in intervention group participated in oral exercises.	Abdominal breathing and oral functional exercises.[22,23] Oral functional exercises consisted of short facial muscle gymnastics and a tongue gymnastics programme.
Mouth-opening training	Individuals with an RSST score <3 in 30 seconds participated in mouth-opening training.	The mouth is opened as wide as possible and held open for 10 seconds, followed by 10 seconds of rest.[24]
Tongue-pressure training	Individuals with a tongue pressure of <30 kPa participated in tongue-pressure training.	A tongue-strengthening training tool (Pecopanda; JMS Inc.) is pushed upwards with the tongue in a crushing motion; 5 times per set.[25]
Articulation training	Individuals with oral DDK with /ta/ <6.0 times/s participated in articulation training.	Nonsense syllable chain training was performed. Specifically, a simple pattern of sounds produced using the lips (/ma/or /ba/), the tip of the tongue (/ta/ or /te/), and the back of the tongue (/ka/) was produced. Ten different nonsense words containing 3 sounds each were articulated. A complex pattern was produced by changing 2 of the 3 sounds simultaneously. The syllable chain was designed to maximise lip and tongue movement, with the requirement of rapid and clear pronunciation and loud vocalisations.
Masticatory training	Individuals with a gum test score <3 participated in masticatory training.	Chewing gum (rhythmic chewing for 2 minutes followed by free chewing for 3 minutes) twice daily, in the morning and at night. The individuals were instructed to close their lips and chew alternately and equally on both sides. In addition, they had to maintain an erect posture during this training.

Oral DDK, oral diadochokinesis; RSST, repetitive saliva swallowing test.

had the potential to improve oral function in older adults with oral hypofunction.

The association of poor oral function with physical function and nutritional status: a narrative review

Since the concepts of oral frailty and oral hypofunction were introduced, several epidemiologic studies have been carried out, and new findings have been reported. We performed a narrative review and examined papers written in English and published in the past 3 years (ie, between November 2019 and November 2021) that described the association between poor oral function and general health. Because both oral frailty and oral hypofunction have been introduced as multicomponent phenotypes that describe poor oral function,[13,9] studies investigating single/individual components of oral function were out of the scope of our work and were not reviewed. Moreover, the following types of papers were not included in this review: case reports, in vitro studies, animal experiments, letters to the editor, systematic or narrative reviews, guidelines, or comments. Table 6 summarises the author, publication year, setting, participants, study design, measures (exposure and outcome), and results of the included papers. We attempted to present key results from each study in a numeric form that includes estimates of associations and appropriate measures of variability and uncertainty (eg, regression coefficients or odds ratios with confidence intervals).

The associations of oral frailty, defined as the accumulation of objectively assessed low oral function, with other health characteristics, including nutritional status and

Table 5 – Comparison of changes in variable assessing oral function between intervention and control groups.

	Intervention group (n = 51)		Control group (n = 32)		
	Baseline	12 weeks after baseline	Baseline	12 weeks after baseline	*P* value for group × period interaction
Oral DDK /pa/ (times/s)	4.8 (3.4–6.6)	5.8 (3.8–7.2)	5.2 (3.0–6.8)	5.4 (2.2–7.0)	<.01
Oral DDK /ta/ (times/s)	5.0 (3.2–6.6)	5.6 (3.4–6.6)	5.1 (2.8–7.0)	5.4 (2.4–7.0)	Not significant
Oral DDK /ka/ (times/s)	4.8 (3.4–6.4)	5.4 (3.4–6.6)	5.1 (2.4–7.6)	5.4 (1.8–7.4)	<.01
Tongue pressure (kPa)	24.7 (2.6–47.1)	30.9 (14.1–54.5)	28.4 (15.4–42.9)	30.3 (16.4–47.3)	<.01
RSST (times)	4.0 (1.0–7.0)	4.0 (1.0–8.0)	4.0 (1.0–8.0)	4.0 (1.0–7.0)	<.01
Gum test score	4.0 (1.0–5.0)	4.0 (2.0–5.0)	4.0 (2.0–5.0)	4.0 (1.0–5.0)	<.01

Modified from Table 2 of Shirobe et al.[21]
Oral DDK, oral diadochokinesis; RSST, repetitive saliva swallowing test.

Table 6 – Overview of included epidemiologic studies investigating the association of oral frailty and oral hypofunction with physical function and nutritional status.

Author [#Ref.]	Year	Setting	Participants		Design	Measures		Results
			N	Age, y		Exposure	Outcome	
Shimazaki et al[29]	2020	Community	978	Range = 65–85	Cross-sectional	Oral hypofunction	Frailty	Study participants with oral hypofunction had significantly higher adjusted ORs for prefrailty (OR, 1.4; 95% CI, 1.1–2.0) and frailty (OR, 2.1; 95% CI, 1.2–3.5).
Iwasaki et al[5]	2020	Community	1054	Mean (SD) = 77.0 (4.8)	Cross-sectional	Oral frailty	MNA®-SF and serum albumin	After adjusting for potential confounders, the study participants with oral frailty had higher odds of more severe malnutrition evaluated using the MNA®-SF (adjusted OR, 2.17; 95% CI, 1.58–2.98) and serum albumin level (adjusted OR, 1.59; 95% CI, 1.10–2.31).
Iwasaki et al[6]	2020	Community	466	Mean (SD) = 76.4 (4.1)	Longitudinal	Oral frailty	MNA®-SF	After adjusting for potential confounders, oral frailty was significantly associated with deteriorating nutritional status evaluated using the MNA®-SF (adjusted OR, 2.24; 95% CI, 1.08–4.63).
Ohara et al[8]	2020	Community	722	Mean (SD) = 79.1 (4.5)	Cross-sectional	Eating alone	Oral frailty	After adjusting for potential confounders, eating alone was significantly associated with oral frailty (adjusted OR, 1.82; 95% CI, 1.14–2.90).
Hironaka et al[3]	2020	Community	682	Mean (SD) = 73.3 (6.6)	Cross-sectional	Social frailty	Oral frailty	The direct path from social frailty to oral frailty was statistically significant (coefficient = 0.14).
Iwasaki et al[7]	2021	Community	1082	Mean (SD) = 77.1 (4.7)	Cross-sectional	Oral frailty	Gait characteristics	After adjusting for potential confounders, participants with oral frailty had slower gait speed, shorter stride and step length, wider step width, and longer double support duration, as well as higher variability in stride length and step length.
Hoshino et al[4]	2021	Community	481	≥65	Cross-sectional	Oral frailty	Dietary variety	After adjusting for potential confounders, pre-oral frailty and oral frailty were significantly associated with low dietary variety (pre-oral frailty, adjusted OR, 1.69; 95% CI, 1.22–2.34; oral frailty, adjusted OR, 2.86; 95% CI, 1.49–5.48).
Yoshida et al[30]	2021	Community	340	Mean = 75.0	Cross-sectional	Oral hypofunction	Frailty	Study participants with oral hypofunction had significantly higher adjusted OR for frailty (OR, 1.5).
Iwasaki et al[31]	2021	Community	715	Mean (SD) = 73.5 (6.6)	Cross-sectional	Oral hypofunction	MNA®-SF	After adjusting for potential confounders, the study participants with oral hypofunction were more likely to have malnutrition evaluated using the MNA®-SF (adjusted RR, 3.00; 95% CI, 1.29–6.98).
Kugimiya et al[32]	2021	Community	878	Mean (SD) = 76.5 (8.3)	Cross-sectional	Oral hypofunction	Sarcopenia	After adjusting for potential confounders, oral hypofunction was significantly associated with sarcopenia (adjusted OR, 1.59; 95% CI, 1.02–2.47).
Nishi et al[33]	2021	Community	1054	Mean (SD) = 67.5 (11.3) in men and 68.8 (10.8) in women	Cross-sectional	Oral hypofunction	Protein intake	After adjusting for potential confounders, oral hypofunction was significantly associated with low protein intake (adjusted OR, 1.70; 95% CI, 1.21–2.35).

MNA®-SF, Mini Nutritional Assessment®-Short Form; OR, odds ratio; RR, relative risk.

physical function, have been examined in 6 studies.[3-8] Oral frailty was associated with malnutrition evaluated using the Mini Nutritional Assessment®-Short Form (MNA®-SF; adjusted odds ratio [aOR], 2.17; 95% confidence interval [CI], 1.58–2.98) and serum albumin levels (aOR, 1.59; 95% CI, 1.10–2.31).[5] Moreover, older adults with oral frailty had a higher risk of nutritional status deterioration evaluated using the MNA®-SF (aOR, 2.24; 95% CI, 1.08–4.63).[6] Another study in community-dwelling older adults revealed a significant association between oral frailty and low dietary diversity.[4] Overall, these studies provide evidence that oral frailty is associated with poor quality of diet and poor nutritional status. Additionally, we found that oral frailty was associated with slower gait speed, shorter stride and step length, wider step width, and longer double support duration, as well as higher variability in stride length and step length.[7] The findings of this study indicated that individuals with oral frailty were at risk of falling and fall-related adverse health events, including disability and death. Unlike other studies that used oral function as an exposure, the study of Ohara et al.[8] used oral frailty as an outcome. They reported that older adults who ate alone were more likely to have oral frailty (aOR, 1.82; 95% CI, 1.14–2.90). Hironaka et al[3] performed path analysis to determine the relationships amongst the different types of frailty: physical, social, and oral. They demonstrated that social frailty had an influence on oral frailty. Overall, these findings suggested that insufficient participation in social networks may lead to poor oral function. Poor social engagement could lower general and oral health literacy and skills, leading to poor oral hygiene, tooth loss, and even declines in oral function.[3] Furthermore, older adults with poor social engagement may have few opportunities for conversation, leading to reduced TP as a result of a decrease in the tongue movements involved in speech intelligibility.[3]

Five studies[29–33] explored the association of oral hypofunction, a 7-component clinical phenotype related to oral health, with physical function (frailty and sarcopenia) and nutritional status (malnutrition) in community-dwelling older adults (Table 6). Shimazaki et al[29] found that oral hypofunction was associated with a higher odds of frailty determined by the Kihon Checklist (KCL). Yoshida et al[30] also reported that oral hypofunction was associated with KCL-based frailty. Kugimiya et al[32] reported that older adults with oral hypofunction were more likely to have sarcopenia (aOR, 1.59; 95% CI, 1.02–2.47). The link of oral hypofunction with frailty and sarcopenia is thought to be related to the poor nutrition caused by poor oral function. Iwasaki et al[31] demonstrated that oral hypofunction was associated with malnutrition evaluated using the MNA®-SF (adjusted relative risk, 3.00; 95% CI, 1.29–6.98). Nishi et al[33] examined dietary intake in 1004 Japanese adults. Dietary protein intake not reaching the lower limit of the dietary goal range defined by the DRIs for Japanese individuals was defined as low. They found that oral hypofunction was associated with low protein intake (aOR, 1.70; 95% CI, 1.21–2.35). An inadequate or unbalanced diet can lead to declines in muscle mass, muscle strength, and physical performance and the development of sarcopenia and frailty.[34–36] These findings support the hypothesis that nutrition mediates the association of oral hypofunction with frailty and sarcopenia.

The association between oral hypofunction and sarcopenia may be bidirectional. Sarcopenia is a progressive and generalised skeletal muscle disorder frequently seen in older adults.[37] It is associated with various adverse health outcomes, including physical disability; poor quality of life; increased risks of falls, fractures, and hospitalisation; and higher mortality.[38,39] Because the oral cavity is an organ within the body, sarcopenia, characterised as a generalised loss of skeletal muscle mass, may influence the loss of orofacial muscle mass.[40–44] Recent studies have proposed a path in which a generalised loss of muscle mass and function is associated with a loss of swallowing muscle mass.[42–44] Furthermore, associations of generalised muscle mass with masseter muscle mass, strength, and function have been observed in previous studies.[40,41,45–47]

Challenges for the concepts of oral frailty and oral hypofunction

It should be noted that the concepts of oral frailty and oral hypofunction do not include all possible oral functions. Although each of the oral frailty and oral hypofunction components have been studied in terms of their associations with general health,[13,9] other aspects—such as social communication functions including speaking, smiling, and enjoying meals with others—are also important and have been reported to be associated with mental health in older adults.[48] Furthermore, the number of teeth is included as a diagnostic component of oral frailty and oral hypofunction. Oral frailty and oral hypofunction are potentially reversible conditions. Because the number of teeth is irreversible, the definition/diagnosis of oral frailty and oral hypofunction could be revisited and subjected to further deliberation. In addition, regarding oral hypofunction, the following issues have not yet been resolved, indicating the need for further research: (i) unclear validity of the diagnostic criteria for each component; (ii) inconsistent clinical interpretation of the results of oral function examinations; and (iii) ambiguity in the distinction between oral hypofunction and dysphagia.[13]

Conclusions

Oral frailty and oral hypofunction are multidimensional concepts that describe poor oral function.[13,9] Because individual oral health problems are interrelated and their prevalence increases with age, older adults frequently have multiple oral health problems.[5,49] Therefore, problems related to poor oral function will become more common as the population ages. As more attention is given to the importance of oral function in the ageing population, new concepts referred to as oral frailty and oral hypofunction have been introduced in Japan. We summarised these concepts in this paper. This review also demonstrated that multiple studies published in recent years have reported a significant association between oral function and general health in older adults. However, most of the studies conducted to date have utilised a cross-sectional design, which does not permit the assessment of the

temporal association between comprehensive oral function and general health. Further studies are warranted.

Although oral frailty and oral hypofunction are novel concepts, they possess their own unaddressed challenges. Maintaining good oral function may be key to longevity. However, currently, there is limited evidence, and comprehensive oral function has not been studied in detail, indicating the need for additional high-quality studies.

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