

<https://helda.helsinki.fi>

Relationship between Fried's frailty phenotype and oral frailty in long-term care residents

Hiltunen, Kaija

2021-11

Hiltunen , K , Saarela , R K T , Kautiainen , H , Roitto , H-M , Pitkälä , K H & Mäntylä , P
2021 , ' Relationship between Fried's frailty phenotype and oral frailty in long-term care
residents ' , Age and Ageing , vol. 50 , no. 6 , pp. 2133-2139 . <https://doi.org/10.1093/ageing/afab177>

<http://hdl.handle.net/10138/339804>

<https://doi.org/10.1093/ageing/afab177>

cc_by_nc

publishedVersion

Downloaded from Helda, University of Helsinki institutional repository.

This is an electronic reprint of the original article.

This reprint may differ from the original in pagination and typographic detail.

Please cite the original version.

RESEARCH PAPER

Relationship between Fried's frailty phenotype and oral frailty in long-term care residents

KAIJA HILTUNEN¹, RIITTA K.T. SAARELA², HANNU KAUTIAINEN^{3,4}, HANNA-MARIA ROITTO^{2,5}, KAISU H. PITKÄLÄ⁶, PÄIVI MÄNTYLÄ^{7,8}

¹Department of Oral and Maxillofacial Diseases, University of Helsinki, Helsinki, Finland

²City of Helsinki, Department of Social Services and Health Care, Oral Health Care, Helsinki, Finland

³Primary Health Care Unit, Kuopio University Hospital, Kuopio, Finland

⁴Folkhälsan Research Center, Folkhälsan, Helsinki, Finland

⁵Health Care, Geriatric Clinic, Helsinki Hospital, Helsinki, Finland

⁶Department of General Practice, University of Helsinki, Helsinki, Finland

⁷Institute of Dentistry, University of Eastern Finland, Kuopio, Finland

⁸Oral and Maxillofacial Diseases, Kuopio University Hospital, Kuopio, Finland

Address correspondence to: Kaija Hiltunen, Department of Oral and Maxillofacial Diseases, P.O. Box 41, University of Helsinki 00014, Finland. Tel: 358407280202. Email: kaija.hiltunen@helsinki.fi

Abstract

Background: oral frailty (OFr) may be called a syndrome lacking a consensus on its definition.

Objective: the aim was to prove the relationship between OFr to the phenotype of frailty, general health and nutrition in long-term care.

Design: the FINnish ORAL Health Study in Long-Term Care study is a cross-sectional clinical research comprising findings on oral and general health and nutrition.

Setting: participants were divided into groups according to the number of OFr signs: Group 1 (0–1 sign), Group 2 (2–4 signs) and Group 3 (5–6 signs).

Subjects: the study includes data on 349 older residents of long-term care facilities in Helsinki, Finland.

Methods: frailty status was defined according to Fried's frailty phenotype. OFr was evaluated with six signs: dry mouth, diet of pureed or soft food, residue of food on oral surfaces, unclear speech, inability to keep mouth open during the clinical oral examination and pain expression during the examination.

Results: a significant linear relationship across the OFr groups with Fried's frailty phenotype was found (P for linearity = 0.008, adjusted by gender and age). A linear trend existed between OFr groups and general health; prevalence of dementia and malnutrition increased from Group 1 to Group 3. The need for help with eating and oral hygiene procedures increased from Group 1 to Group 3. Moreover, OFr had a linear relationship with chewing and swallowing difficulties.

Conclusions: OFr is related to Fried's frailty phenotype, general health, nutrition and need for help with daily activities.

Keywords: long-term facilities, older adults, oral frailty, frailty, older people

Key Points

- Oral frailty (OFr) was evaluated with six signs.
- We may conclude that selected signs can be used to describe OFr and its severity.
- OFr is related to Fried's frailty phenotype, general health, nutrition and need for help with daily activities.
- OFr can be considered as a syndrome

Introduction

The geriatric syndrome of frailty is characterised by decreased physiological reserves and increased vulnerability, and it has been associated with an increased risk for disability, falls, hospitalisation and death [1]. It is also associated with malnutrition, impaired health-related quality of life and poor oral health among older adults [2–4]. However, no consensus exists on whether frailty should be defined as a physical phenotype or as an accumulation of deficits (Frailty Index) [5, 6]. These two explanations partly overlap but share a similarly poor prognosis [7].

The definition of oral frailty (OFr) has been extensively discussed worldwide, but consensus has not been reached. OFr has been considered poor oral health or oral hypofunction, with the signs, symptoms and methods of diagnosis undergoing debate [8–11]. To reflect physical frailty [5] OFr should present weakness/poor function of muscles, fatigue and/or risk of weight loss. Various researchers have proposed the following as potential signs of OFr: (i) a dietary change to more pureed or soft foods, (ii) residue of food in the oral cavity (oral clearance), (iii) unclear speech, (iv) inability to keep mouth open, (v) hypersensitivity to oral procedure and (vi) dry mouth [8, 10, 12–14]. In addition, such symptoms as chewing and swallowing problems, difficulties in jaw or tongue movements, difficulties in speaking or pronunciation and difficulties in facial expression have been considered. Attempts have been made to form a diagnostic tool for OFr based on these various signs or symptoms [10, 15, 16].

Frailty and oral health may be linked through several pathways such as losing teeth or their occlusal area, deterioration of oral musculature or their kinetics [8–10, 16–19]. Losing teeth is independently associated with the risk of malnutrition as well as with weakening and deteriorating of oral muscles [20]. Currently, we do not have a commonly accepted definition of the signs of OFr or whether the severity can be determined by the number of signs/symptoms. Moreover, we do not know how OFr signs are related to frailty or to overall health and functioning of older residents of long-term care facilities. The main aim of this study was to explore the relationship between selected OFr signs and Fried's frailty phenotype. Furthermore, we examined how OFr signs are associated with general health, nutrition and functioning in the older people living in long-term care facilities.

We hypothesised that OFr and its severity can be determined based on the signs presented in this study, and OFr is associated with frailty phenotype, overall health and nutrition.

Materials and methods

The Ethics Committee of the Hospital District of Helsinki and Uusimaa approved the protocols for the nutritional status and oral healthcare studies and the merging of the data, including patient medical records. The project adhered

to the guidelines set forth in the Declaration of Helsinki and the Belmont Accord to ensure the safety of human research subjects.

This research was originally a developmental project to improve the nutritional care of older long-term care residents in the capital area of Helsinki, Finland [21]. Older residents (N = 550) participated in detailed frailty, health and nutrition assessments [22], and a random sample of these residents or their legal guardians gave consent for further participation in the detailed clinical oral health study (FINORAL, FINnish ORAL Health Study in Long-Term Care). Individuals needing prophylactic antibiotics were excluded from the study (N = 47). In addition, 75 participants died before the start of the oral health study and a further 35 residents were excluded due to refusals or for logistic reasons. Between September 2017 and January 2019, we conducted a comprehensive clinical oral examination (N = 393).

The nursing staff was thoroughly trained to collect background information. They filled out a structured questionnaire that included residents' demographics and diagnoses. The number of continuously used medications was retrieved from medical records. Charlson comorbidity index was calculated as described elsewhere [23]. Participant's height and weight were measured and body mass index (BMI) was calculated (weight in kilogrammes/squared height in metres). The mini-mental state examination (MMSE) was used to measure cognitive impairment [24]. Of the maximum score of 30 points, 24 points or more indicate normal cognition, whereas 19–23 points indicate mild, 10–18 points moderate, and ≤ 9 points severe cognitive impairment. Residents' nutritional status was assessed with the Mini Nutritional Assessment (MNA) and categorised as good nutrition (24–30 points), being at risk of malnutrition (17–23.5 points) or being malnourished (<17 points) [25]. The nurses most familiar with the resident disclosed whether the resident had difficulty in chewing and swallowing, whether he/she needed help in oral hygiene, and whether he/she was able to eat independently (all yes/no).

The study assistants evaluated frailty according to Fried's phenotype criteria: (i) Unintentional weight loss >5% during the preceding 3 years (yes/no), (2) Exhaustion—based on nurse-reported or self-reported low energy level most or all the time in the last 4 weeks, (iii) Low physical activity—the question inquired whether the residents exercised regularly weekly (yes/no)—'no' was taken to denote low physical activity, (iv). Slowness—based on walking speed in the Short Physical Performance Battery test (<0.85 m/s) and (v) Physical weakness—based on self-reported difficulty (not at all = 0) carrying or lifting a grocery bag. Residents who met one or two of the above criteria were classified into the prefrail groups, and residents meeting three or more criteria were classified into the frailty groups [5]. None of the residents was classified into the robust group (fulfilling none of the above criteria).

Two qualified, and according to study protocol, calibrated dentists conducted the oral clinical examinations of residents in long-term care facilities. They were equipped with loupes (Merident Optergo MO Ultralight Flip-up), an attached headlamp (Merident Optergo DeLight LED) and normal sets of sterile dental instrumentation. Participants of the oral health study were lying in bed or sat in a chair during the oral examination.

Apart from the clinical oral examination variables in the FINORAL study, we further determined the number of teeth, number of occlusal contacts, edentulousness and removable dentures and need for their repair between the OFr groups.

Of the previously suggested various OFr signs [8, 10, 12, 14, 15, 26], we used the following: (i) salivation as normal or dry mouth (mirror sticks to buccal mucosa or tongue, frothy saliva, glassy appearance of oral palate lobulated/fissured tongue) [27], (ii) presence of food residues (on surface of teeth, on surface of oral mucosa or on surface or under removable dentures), (iii) inability to keep mouth open during the examination (opens when persuaded but then closes during examination, opposes or refuses the examination in its entirety), (iv) unclear speech (not understandable, does not speak), (v) pureed or soft food diet and (vi) painfulness (expression of pain during oral examination: general pain, palpation pain and periodontal probing pain with dentate subjects). For OFr categorisation, all of the forementioned signs were dichotomized as yes/no. The sum of the OFr signs determined study group allocation. Participants with none or one OFr sign were assigned to Group 1 ($N = 52$), participants with 2–4 OFr signs to Group 2 (moderate OFr) ($N = 235$) and participants with 5–6 signs to Group 3 (severe OFr) ($N = 62$).

The data sets from nutritional study, medical records and oral health studies were combined. At this point, because of incorrect or misinterpreted entries, the data of 46 subjects had to be rejected. After the aggregation of the data sets, we had cross-sectional data containing oral health, frailty status, general health status, nutrition and functioning of 349 older participants.

Statistical analysis

The descriptive statistics were presented as means with standard deviation (SD) or counts with percentages. The linearity across the three groups of signs of OFr was evaluated using the Cochran–Armitage test, ordered logistic regression and analysis of variance with an appropriate contrast (orthogonal). The bootstrap method was used when the theoretical distribution of the test statistics was unknown or in the case of violation of assumptions (e.g. non-normality). The normality of variables was evaluated graphically and using the Shapiro–Wilk test. All reported P values are two-sided, and statistical significance (α level) was set at 0.05 for all tests. All analyses were performed using STATA software, version 16.1 (StataCorp LP, College Station, TX, USA).

Results

Characteristics of study participants are shown in Table 1. Of the participants, 52 had 0–1 OFr signs (Group 1), 235 had 2–4 signs (Group 2) and 62 had 5–6 signs (Group 3). Participants' mean age (82 years) did not differ between the OFr groups, but the proportion of females increased from Group 1 to Group 3. The BMI decreased linearly and the proportion of malnourished residents according to the MNA increased across OFr Groups 1–3. The proportion of those suffering from dementia increased and MMSE points decreased linearly from OFr Groups 1 to Group 3, whereas the mean number of medications decreased. Need for help with oral hygiene procedures increased and being able to eat independently decreased across Groups 1–3.

Of all participants, 166 (48%) were frail according to Fried's frail phenotype criteria; the proportion increased significantly from Group 1 to Group 3 (31% and 60%, respectively). After adjustment for age and sex, a significant linear relationship remained between the number of OFr signs and Fried's frailty phenotype (P for linearity < 0.001) (Figure 1). We further grouped the participants into six groups according to the number of signs. There was a similar linear relationship between the accumulation of signs and frailty phenotype (P for linearity 0.006).

Table 2 shows the oral examination findings according to OFr groups. The clinical oral examination revealed that the number of teeth or contact units between the opposing jaws did not differ between the groups. Nor was there a significant difference in edentulousness or need for denture repair between the groups. The use of removable dentures decreased linearly from OFr Group 1 to Group 3. There was also a linear relationship in increasing chewing and swallowing problems from OFr Group 1 to Group 3.

Of the signs of OFr, unclear speech, food residue in the oral cavity or on denture surfaces, and dry mouth were the most common (Table 2).

Discussion

A significant linear relationship emerged between OFr according to six selected signs and Fried's frailty phenotype. Furthermore, participants with more signs of OFr had more often dementia, malnutrition, lower BMI and swallowing and chewing difficulties, and they needed more often help with eating and managing oral hygiene. Our hypothesis was confirmed; OFr and its severity may be determined by the number of specific oral signs, which are also related to Fried's frailty phenotype, overall health, functioning and nutritional status.

Our study supports a strong link between Fried's phenotype criteria and signs of OFr. Our goal was to find simple signs which could be used both at the dentist's office and in clinical settings. The results showed that frailty was significantly associated with selected signs of OFr, which indicates a close association between these two syndromes

Table 1. Characteristics of older residents of long-term care facilities in Helsinki, Finland according to the number of signs of Oral Frailty

	Group 1 0–1 sign N = 52	Group 2 2–4 signs N = 235	Group 3 5–6 signs N = 62	P for linearity
Demographics				
Mean age, years, mean (SD)	82 (9)	82 (8)	82 (9)	0.92
Females, <i>n</i> (%)	32 (62)	169 (73)	51 (82)	0.014
Education <8 years, <i>n</i> (%)	27 (57)	99 (47)	27 (47)	0.34
Nutritional status				
BMI, mean (SD)	28.6 (5.4)	25.8 (5.1)	24.3 (4.5)	<0.001
MNA <i>n</i> (%)				<0.001
24–30 (well nourished)	19 (39)	44 (21)	2 (4)	
17–23 (at risk of malnutrition)	29 (59)	138 (66)	39 (68)	
<17 (malnutrition)	1 (2)	26 (13)	16 (28)	
Health status				
Charlson morbidity index, mean (SD)	2.2 (1.3)	2.0 (1.2)	1.8 (1.2)	0.15
Diabetes, <i>n</i> (%)	17 (33)	40 (17)	5 (8)	<0.001
Coronary heart disease, <i>n</i> (%)	4 (8)	44 (19)	5 (8)	0.89
Dementia, <i>n</i> (%)	35 (67)	171 (73)	55 (89)	0.007
Number of regular medications, mean (SD)	10.0 (3.5)	9.1 (3.6)	7.3 (3.6)	<0.001
MMSE, mean (SD)	16.5 (6.5)	13.7 (7.2)	8.7 (6.7)	<0.001
Physical functioning				
Eats independently, <i>n</i> (%)	45 (90)	115 (51)	10 (16)	<0.001
Manages oral hygiene independently, <i>n</i> (%)	23 (46)	34 (16)	1 (2)	<0.001
Frailty				
Frailty phenotype (fulfilling 3–5 Fried's criteria), <i>n</i> (%)	16 (31)	113 (48)	37 (60)	0.002

SD standard deviation, BMI body mass index, MNA Mini Nutritional Assessment, MMSE Mini Mental State Examination.

Table 2. Findings of oral clinical examination according to number of signs of Oral Frailty among older adults living in long-term care facilities in Helsinki, Finland

	Group 1 0–1 sign N = 52	Group 2 2–4 signs N = 235	Group 3 5–6 signs N = 62	P for linearity
Oral findings				
Number of teeth, mean (SD)	9.7 (9.4)	9.2 (9.3)	11.0 (8.9)	0.40
Number of occlusal contact units, mean (SD)	3.6 (4.7)	3.6 (4.6)	4.0 (4.6)	0.68
Edentulousness, <i>n</i> (%)	13 (28)	72 (32)	9 (15)	0.080
Removable denture, <i>n</i> (%)	19 (61)	64 (38)	7 (16)	<0.001
Denture in need of repair, <i>n</i> (%)	4 (22)	33 (46)	1 (17)	0.45
Signs of OFr				
Dry mouth, <i>n</i> (%)	18 (35)	175 (75)	58 (94)	<0.001
Diet of pureed or soft food, <i>n</i> (%)	0 (0)	94 (43)	54 (89)	<0.001
Residue of food on oral surfaces, <i>n</i> (%)	13 (28)	114 (52)	43 (73)	<0.001
Unclear speech, <i>n</i> (%)	0 (0)	174 (74)	62 (100)	<0.001
Inability to keep mouth open, <i>n</i> (%)	4 (9)	53 (23)	50 (81)	<0.001
Painfulness, <i>n</i> (%)	0 (0)	10 (5)	5 (9)	0.037
Masticatory function ^a				
Chewing problems, <i>n</i> (%)	5 (11)	60 (28)	23 (38)	0.002
Swallowing difficulties, <i>n</i> (%)	1 (2)	47 (22)	17 (29)	0.001

^aInformation from the structured nursing staff questionnaire, SD standard deviation.

[1, 5, 14, 16]. Considering our findings, we agree with the earlier statement that OFr should be included as a geriatric syndrome [14]. In addition, our findings verified a significant increase in chewing difficulties, dysphagia and malnutrition with increasing severity of OFr. Healthcare staff, who knew the older residents well, observed that swallowing and chewing problems were most common among participants with severe OFr.

The purpose of this study was to test previously proposed signs of OFr. OFr is a multifactorial syndrome with several signs for which international research has not yet reached a consensus [8, 14, 16, 28–30]. Masticatory muscle weakness and associated signs are related to muscle size, accuracy of function and maintaining muscle strength for the intended function activity [31–34]. In our study protocol, measurements for occlusal force, muscle thickness or kinetics were

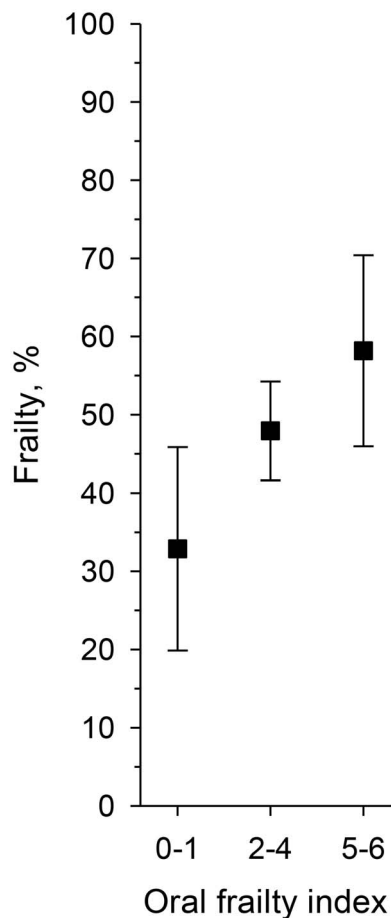


Figure 1. Proportion (%) of frail participants according to Fried's frailty phenotype criteria (5) in each study group. Group 1: signs of OFr 0–1, Group 2: signs of OFr 2–4, Group 3: signs of OFr 5–6. Adjusted by gender and age, *P* for linearity <0.001.

not possible; it was challenging for participants to cooperate and understand the importance of such examinations [32, 35, 36]. Instead, we evaluated the weakness of masticatory muscles (masseter, temporalis, medial pterygoid and lateral pterygoid) or the tongue with four surrogate signs: degree of food softness, inability to keep mouth open, unclear speech, residue of food on surface of teeth, mucosa or dentures. Our results suggest that these signs may be used as signs of OFr (i.e. surrogates for oral muscle weakness). However, the summary of OFr signs should also be tested in future studies using other groups, such as home-dwelling or hospitalised older people.

Furthermore, we used dry mouth as a potential sign of OFr. The subjective sensation of dry mouth becomes increasingly common in old age [37]. Dry mouth is considered a sign of general fatigue, and it is associated with dehydration, dementia, difficulty in chewing and swallowing, and unclear speech [38, 39]. FINORAL findings are in line with this. In addition, to the best of our knowledge only subjective pain has earlier been tested as a sign of OFr [40–42]. In this study, we used general pain, palpation pain and periodontal probing pain (in dentate subjects) expressed by participants [43]. We observed the pain expressions of

sounds, turning the head and partial or total refusal of further examination that the 'Orofacial Pain Scale for Non-Verbal Individuals' has recommended [44, 45]. According to the results, pain expressions increased linearly towards severe OFr.

Other signs of OFr have also been suggested in the literature. In fact, most previous publications link OFr to oral health and, in particular, to the number of remaining teeth [8–11, 16, 18, 31, 46, 47]. Our results do not confirm the latter. The mean numbers of remaining teeth and occlusal contact units between opposite jaws were quite similar in the study groups, suggesting that among our subjects the number of teeth does not determine the severity of OFr. Furthermore, several studies have suggested dysphagia as a sign of OFr [16, 27, 30]. In accord with this, swallowing difficulties showed a linear relationship with the severity of OFr as defined in our sample.

Our findings for the three OFr groups are further strengthened by the associations with dementia, malnutrition and need for help with daily functioning. However, the mean value of the Charlson morbidity index showed no difference between the study groups [23]. According to previous findings, age, dentition or morbidity alone does not explain the change in the severity of OFr in long-term care residents [16, 47]. We can assume that OFr is a more complex entity, and it is also dependent on issues other than dental or oral health. This contradicts the earlier consensus that the number of teeth is a decisive factor in OFr [8–11, 18, 31].

This study is unique in analysing the relationships between signs of OFr and frailty phenotype, overall health, nutrition and functioning in long-term care facilities. To our knowledge, such extensive and multidisciplinary research is rare. In the FINORAL study, oral health was comprehensively assessed, including the number of teeth and the occlusal contact units between opposing jaws. In addition, the use of dentures and their condition were examined. The strength of the FINORAL study is the fairly large sample size of long-term care residents, the data of detailed nutrition and health and the comprehensive oral health examination. The participants were older adults in long-term care facilities and in need of constant care, which inevitably affects the execution of the oral examination.

A limitation of the study is its cross-sectional nature, which does not allow us to determine causal relationships between signs of OFr, nutrition, morbidity and Fried's frailty phenotype criteria. Furthermore, the relationship between this definition of OFr and frailty phenotype should be tested in other populations. In addition, future studies should explore the prognostic value of OFr.

Conclusions

Our results suggest that the selected six simple oral signs (diet of pureed or soft food, residue of food on surface of teeth, mucosa, or dentures, inability to keep mouth open, unclear speech, dry mouth, painfulness) may be used to determine

OFR syndrome, which in turn is significantly associated with Fried's frailty phenotype. OFr was confirmed to have an association with health, nutrition, functioning and chewing and swallowing difficulties. Further studies are needed to explore the relationship of OFr with oral biofilm-related diseases, other geriatric syndromes and in other older populations. Regular oral examinations are highly recommended for the early diagnosis of OFr and its closely related syndromes in long-term care facilities.

Declaration of Sources of Funding: This study was supported by Sohlberg Foundation, Helsinki City and Helsinki University Hospital VTR funding, The Finnish Dental Society Apollonia, and The Finnish Society of Female Dentists.

Declaration of Conflicts of Interest: None.

References

1. Strandberg TE, Pitkala KH. Frailty in elderly people. *Lancet* 2007; 369: 1328–9.
2. Buckinx F, Reginster JY, Petermans J *et al.* Relationship between frailty, physical performance and quality of life among nursing home residents: the SENIOR cohort. *Aging Clin Exp Res* 2016; 28: 1149–57.
3. Kanwar A, Singh M, Lennon R, Ghanta K, McNallan SM, Roger VL. Frailty and health-related quality of life among residents of long-term care facilities. *J Aging Health* 2013; 25: 792–802.
4. Salminen KS, Suominen MH, Kautiainen H, Pitkälä KH. Associations between nutritional status, frailty and health-related quality of life among older long-term care residents in Helsinki. *J Nutr Health Aging* 2020; 24: 319–24.
5. Fried LP, Tangen CM, Walston J *et al.* Frailty in older adults: evidence for a phenotype. *J Gerontol A Biol Sci Med Sci* 2001; 56: M146–56.
6. Mitnitski AB, Mogilner AJ, Rockwood K. Accumulation of deficits as a proxy measure of aging. *Sci World J* 2001; 1: 323–36.
7. Perttinen NM, Pitkala KH, Kautiainen H, Tilvis R, Stranberg T. Various diagnostic measures of frailty as predictors for falls, weight change, quality of life, and mortality among older Finnish men. *J Frailty Aging* 2017; 6: 188–94.
8. Azzolino D, Passarelli PC, De Angelis P, Piccirillo GB, D'Addona A, Cesari M. Poor oral health as a determinant of malnutrition and sarcopenia. *Nutrients* 2019; 11: 2898.
9. Ramsay S, Papachristou E, Watt R *et al.* Influence of poor oral health on physical frailty: a population-based cohort study of older British Men. *J Am Geriatr Soc* 2018; 66: 473–9.
10. Tanaka T, Takahashi K, Hirano H *et al.* Oral frailty as a risk factor for physical frailty and mortality in community-dwelling elderly. *J Gerontol A Biol Sci Med Sci* 2018; 73: 1661–7.
11. Matsuo K, Kito N, Ogawa K, Izumi A, Masuda Y. Effects of textured foods on masticatory muscle activity in older adults with oral hypofunction. *J Oral Rehabil* 2020; 47: 180–6.
12. Nicosia MA, Hind JA, Roecker EB *et al.* Age effects on the temporal evolution of isometric and swallowing pressure. *J Gerontol A Biol Sci Med Sci* 2000; 55: M634–40.
13. Ono T, Kumakura I, Akimoto M *et al.* Influence of bite force and tongue pressure on oro-pharyngeal residue in the elderly. *Gerodontology* 2007; 24: 143–50.
14. Woo J, Tong C, Yu R. Chewing difficulty should be included as a geriatric syndrome. *Nutrients* 2018; 10: 1997.
15. Choi JH, Kang JH, Koh SB, Kim NH, Kho HS. Development of an oral and maxillofacial frailty index: a preliminary study. *J Oral Rehabil* 2020; 47: 187–95.
16. Komatsu R, Nagai K, Hasegawa Y *et al.* Association between physical frailty subdomains and oral frailty in community-dwelling older adults. *Int J Environ Res Public Health* 2021; 18: 2931.
17. Barbe AG, Schmidt P, Bussmann M, Kunter H, Noack MJ, Röhrig G. Xerostomia and hyposalivation in orthogeriatric patients with fall history and impact on oral health-related quality of life. *Clin Interv Aging* 2018; 13: 1971–9.
18. Hakeem FF, Bernabé E, Sabbah W. Association between oral health and frailty: a systematic review of longitudinal studies. *Br Dent J* 2019; 227: 803.
19. Hasegawa Y, Sakuramoto A, Sugita H *et al.* Relationship between oral environment and frailty among older adults dwelling in a rural Japanese community: a cross-sectional observational study. *BMC Oral Health* 2019; 19: 23.
20. Zhang Y, Ge M, Zhao W *et al.* Association between number of teeth, denture use and frailty: findings from the west China health and aging trend study. *J Nutr Health Aging* 2020; 24: 423–8.
21. Saarela RKT, Savikko NM, Soini H *et al.* Burden of oral symptoms and health-related quality of life in long-term care settings in Helsinki, Finland. *Nutr Health Aging* 2019; 23: 1021–5.
22. Roitto HM, Kautiainen H, Laurila J, Laurila J, Pitkälä KH. Severity of both neuropsychiatric symptoms and dementia is associated with quality of life in nursing home residents. *Eur Geriatr Med* 2019; 10: 793–800.
23. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis* 1987; 40: 373–83.
24. Folstein MF, Folstein SE, McHugh PR. "Mini-mental state." A practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res* 1975; 12: 189–98.
25. Vellas B, Guigoz Y, Garry PJ *et al.* The mini nutritional assessment (MNA) and its use in grading the nutritional state of elderly patients. *Nutrition* 1999; 15: 116–22.
26. Clark HM, Henson PA, Barber WD, Stierwalt JA, Sherrill M. Relationships among subjective and objective measures of tongue strength and oral phase swallowing impairments. *Am J Speech Lang Pathol* 2003; 12: 40–50.
27. Osailan SM, Pramanik R, Shirlaw P, Proctor GB, Challacombe SJ. Clinical assessment of oral dryness: development of a scoring system related to salivary flow and mucosal wetness. *Oral Surg Oral Med Oral Pathol Oral Radiol* 2012; 114: 597–603.
28. Feng Z, Lugtenberg M, Franse C *et al.* Risk factors and protective factors associated with incident or increase of frailty among community-dwelling older adults: a systematic review of longitudinal studies. *PLoS One* 2017; 12: e0178383.
29. Kossioni AE, Karkazis HC. EMG study on the effect of ageing on the human masseteric jaw-jerk reflex. *Gerodontology* 1994; 11: 30–8.

30. Morley JE. Editorial: Oral frailty. *J Nutr Health Aging* 2020; 24: 683–4.
31. Watanabe Y, Hirano H, Arai H *et al.* Relationship between frailty and oral function in community-dwelling elderly adults. *J Am Geriatr Soc* 2017; 65: 66–76.
32. Ohara Y, Hirano H, Watanabe Y *et al.* Masseter muscle tension and chewing ability in older persons. *Geriatr Gerontol Int* 2013; 13: 372–7.
33. Gaszynska E, Godala M, Szatko F, Gaszynski T. Masseter muscle tension, chewing ability, and selected parameters of physical fitness in elderly care home residents in Lodz, Poland. *Clin Interv Aging* 2014; 9: 1197–203.
34. Kugimiya Y, Watanabe Y, Igarashi K *et al.* Factors associated with masticatory performance in community-dwelling older adults: a cross-sectional study. *J Am Dent Assoc* 2020; 151: 118–26.
35. Park JS, Jung YJ, Kim MJ. Effects of neuromuscular electrical stimulation synchronized with chewing exercises on bite force and masseter muscle thickness in community-dwelling older adults in South Korea: a randomized controlled trial. *Int J Environ Res Public Health* 2020; 17: 4902.
36. Buckinx F, Landi F, Cesari M *et al.* Pitfalls in the measurement of muscle mass: a need for a reference standard. *J Cachexia Sarcopenia Muscle* 2018; 9: 269–78.
37. Affoo RH, Foley N, Garrick R, Siqueira WL, Martin RE. Meta-analysis of salivary flow rates in young and older adults. *J Am Geriatr Soc* 2015; 63: 2142–51.
38. Hooper L, Bunn D, Jimoh FO, Fairweather-Tait SJ. Water-loss dehydration and aging. *Mech Ageing Dev* 2014; 136-137: 50–8.
39. Ship JA, Pillemer SR, Baum BJ. Xerostomia and the geriatric patient. *J Am Geriatr Soc* 2002; 50: 535–43.
40. Chaudhuri A, Behan PO. Fatigue in neurological disorders. *Lancet* 2004; 363: 978–88.
41. Herr K. Pain assessment strategies in older patients. *J Pain* 2011; 12: S3–13.
42. Kamdem B, Seematter-Bagnoud L, Botrugno F, Santos-Eggimann B. Relationship between oral health and Fried's frailty criteria in community-dwelling older persons. *BMC Geriatr* 2017; 17: 174.
43. Canakci V, Canakci CF. Pain levels in patients during periodontal probing and mechanical non-surgical therapy. *Clin Oral Investig* 2007; 11: 377–83.
44. De Vries MW, Visscher C, Delwel S *et al.* Orofacial pain during mastication in people with dementia: reliability testing of the orofacial pain scale for non-verbal individuals. *Behav Neurol* 2016; 2016: 3123402.
45. Delwel S, Binnekade TT, Perez RS, Hertogh CM, Scherder EJ, Lobbezoo F. Oral health and orofacial pain in older people with dementia: a systematic review with focus on dental hard tissues. *Clin Oral Investig* 2017; 21: 17–32.
46. Shwe PS, Ward SA, Thein PM, Junckerstorff R. Frailty, oral health and nutrition in geriatrics inpatients: a cross-sectional study. *Gerodontology* 2019; 36: 223–8.
47. Miura H, Watanabe S, Isogai E, Miura K. Comparison of maximum bite force and dentate status between healthy and frail elderly persons. *J Oral Rehabil* 2001; 28: 592–5.

Received 22 April 2021; editorial decision 3 July 2021