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# Oral health and its relationship with frailty, sarcopenia risk and nutritional status in middle-aged and older adults undergoing dental treatment

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## ABSTRACT

**Objective:** Middle-aged and older adults with poor oral health may be at higher risk of being frail during dental treatment. This study aimed to investigate the associations between oral health status and frailty, as well as their relationships with malnutrition and sarcopenia risk, in middle-aged and older adults undergoing dental treatment.

**Methods:** This cross-sectional study included adults aged ≥55 years receiving dental care for restorative or prosthetic treatment. Nutritional status, sarcopenia risk, and frailty were assessed using the Mini Nutritional Assessment, the SARC-F questionnaire, and the FRAIL scale, respectively. Oral health status was assessed using the Geriatric Oral Health Assessment Index (GOHAI).

**Results:** A total of 90 adults were included in the study, of whom 58 (64.4%) were classified as pre-frail/frail. Participants in the pre-frail/frail group were significantly older and showed higher rates of malnutrition risk/malnutrition and sarcopenia risk compared with those with non-frailty. The pre-frail/frail group had lower GOHAI scores, greater tooth loss, different dental treatment profiles, and more frequent weight loss after dental treatment. GOHAI scores were associated with frailty, sarcopenia risk and nutritional status.

**Conclusion:** Poor oral health was associated with higher frailty, malnutrition and sarcopenia risk among middle-aged and older adults receiving dental care. These findings underscore the importance of incorporating comprehensive nutritional assessments into dental treatment to identify older adults and support multidisciplinary care approaches.

**Keywords:** frailty, oral health, sarcopenia, malnutrition, geriatric dentistry

## Introduction

Oral health is a fundamental component of overall health and functional well-being in older adults.[1] Its importance has become increasingly evident as the global prevalence of oral diseases continues to rise. Oral diseases represent some of the most common non-communicable diseases worldwide and include both inflammatory and non-inflammatory conditions such as dental caries, periodontal disease, tooth loss, oral cancer, xerostomia, and dysphagia, all of which disproportionately affect older populations.[2] Age-related physiological changes, the cumulative burden of chronic diseases, and declining oral hygiene practices further increase older adults' susceptibility to dental problems.[3,4]

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Malnutrition, sarcopenia, and frailty, which are nutrition related disorders highly prevalent among community-dwelling older adults and share common etiological factors, including chronic inflammation, inadequate food intake, reduced physical activity, age-related hormonal changes, and multiple sociodemographic, behavioral, and disease-related factors.[5-7] These conditions are associated with adverse health outcomes, such as functional decline, increased fall risk, reduced quality of life, hospitalization, and mortality.[8] Importantly, suboptimal oral health, including functional problems such as broken or missing teeth or ill-fitting dentures, can compromise nutritional intake by limiting food choices and impairing chewing and swallowing, thereby contributing to deteriorations in nutritional status among older adults.[9] A recent meta-analysis demonstrated that in older adults, fewer teeth, chewing or swallowing difficulties, dry mouth, and the absence of removable dentures were significantly associated with malnutrition, highlighting the close interplay between oral health and nutritional status in aging populations.[10] Emerging evidence indicates that nutritional status is closely associated with both dental status and frailty, highlighting that maintaining oral health alongside adequate nutrition is a key strategy to prevent or delay frailty in older adults.[11]

Current evidence supports a significant relationship between oral health and frailty. Poorer self-rated oral health is consistently associated with higher frailty in community-dwelling middle-aged and older adults.[12,13] Furthermore, recent systematic reviews indicate that a broad spectrum of oral health indicators, including dental-related measures, oral hygiene practices, oral functional parameters, and comprehensive oral health assessment scores are significantly associated with frailty in older adults.[14] Despite increasing recognition of these associations, studies specifically examining the interrelationships between oral health, frailty, sarcopenia, and nutritional status in older adults undergoing dental treatment remain limited. Given the high demand for dental treatments in aging populations, clarifying the relationship between oral health, nutritional assessment and functional status is essential for integrated dental care. Specifically, clarifying the impact of treatment-induced alterations in oral function on nutritional disorders is of importance in older adults, a population inherently vulnerable to malnutrition, sarcopenia, and frailty. Therefore, this study aimed to examine the associations between oral health status and frailty, as well as its relationships with malnutrition and sarcopenia risk, in middle-aged and older adults undergoing dental treatment.

**Main Points**

- Nutrition related disorders are a common problem during dental treatment.
- Perceived poor oral health is associated with higher frailty, sarcopenia risk, and malnutrition in middle-aged and older patients undergoing dental treatment.
- Frailty is associated with treatment parameters such as number of missing teeth, number of fillings, and type of treatment.

## Materials and Methods

### Study design and population

This cross-sectional study, conducted between July 2025 and October 2025, involved individuals aged 55 years and older who consecutively applied to the dental clinic. The exclusion criteria were severe cognitive impairment preventing reliable responses, neurological disease (e.g., recent stroke, parkinson disease), current chemotherapy/radiotherapy or immunosuppression and terminal-stage cancer, active oral disease or recent oral/maxillofacial surgery that prevents oral examination and hearing or speech disorders. The study was approved by the Ethics Committee of Sivas Cumhuriyet University. All participants were informed about the study, and each provided written voluntary consent in accordance with the principles of the Declaration of Helsinki.

### Measurements

The sociodemographic and clinical variables recorded included age, sex, marital status, smoking status, the presence of chronic disease, and regular medication use. Oral health related variables comprised the type of dental treatment, treatment initiation date, and treatment duration. Participants were also asked about weight loss prior to dental treatment, pain or discomfort while eating due to dental problems, changes in eating habits after treatment, and changes in chewing function following treatment. Further clinical variables included the number of missing teeth, number of dental fillings, and the presence of a teeth-clenching habit. The patients' data

was obtained through the administration of a structured questionnaire and from their medical records.

### Oral health assessment

The Geriatric Oral Health Assessment Index (GOHAI) was used to determine the oral health status of older adults.[15]The scale consists of 12 items and assesses oral health problems across three domains: physical function, psychosocial function, and pain or discomfort. Each item is scored on a 5-point Likert-type scale, yielding a total score ranging from 12 to 60, with higher scores indicating better oral health. Based on cut-off values used in previous studies, patients with GOHAI scores of 12–50 and 51–56 were classified as having low and moderate perceived oral health, respectively, whereas those with scores ≥ 57 were considered to have high perceived oral health.[16,17] The Turkish version of GOHAI is valid and reliable.[18]

### Frailty assessment

Frailty was evaluated using the FRAIL scale, which consists of five components: fatigue, resistance, ambulation, illnesses, and weight loss. The total score ranges from 0 to 5, with higher scores indicating greater frailty. According to standard cut-off points, a score of 0 indicates robustness, scores of 1–2 indicate pre-frailty, and scores >2 indicate frailty.[19] The Turkish version of the FRAIL scale has been validated and shown to be reliable in older adults.[20] In the present study, participants were categorized into two groups: normal and pre-frailty/frailty.

### Nutritional assessment

Anthropometric measurements were performed, including weight and height, from which body mass index (BMI, kg/m$^2$) was calculated. Weight was measured to the nearest 0.1 kg and height to the nearest 0.1 cm using a standardized stadiometer, with participants wearing light clothing and no shoes. Calf circumference was measured at the widest point of the calf. Nutritional status was assessed using the Mini Nutritional Assessment (MNA), a reliable tool widely used to evaluate the nutritional status of older adults.[21] According to the total MNA score, a score of ≥24 indicates "normal nutritional status," scores between 17 and 23.5 indicate "risk of malnutrition," and a score of <17 indicates "malnutrition".

### Sarcopenia risk assessment

Sarcopenia risk was assessed using the SARC-F (The Simple Questionnaire for Rapidly Diagnose of Sarcopenia), which consists of five parameters evaluating the following components: strength, assistance in walking, rising from a chair, climbing stairs, and falls. The total score ranges from 0 to 10, and a score of ≥4 indicates an increased risk of sarcopenia.[22]

### Statistical analysis

Statistical analyses were performed using SPSS (version 23, IBM). Normality of the variables was assessed using Kolmogorov–Smirnov test. Non-normally distributed variables were summarized using medians (Q1–Q3), normally distributed variables were presented as means ± standard deviations, and categorical variables were reported as frequencies and percentages. Comparisons between the normal and pre-frail/frailty groups were performed using the independent samples t-test for normally distributed variables and the Mann–Whitney U test for non-normally distributed variables. Categorical variables were compared using the chi-square test or Fisher's exact test, as appropriate. Associations between oral health status and nutritional and functional outcomes were assessed using Spearman's rank correlation analysis, with correlation coefficients (r) and p values reported. A p-value of $< 0.05$ was considered statistically significant.

## Results

Baseline characteristics and nutritional status of the participants are presented in Table 1. The study included a total of 90 adults, of whom 58 (64.4%) were classified as pre-frail/frail. The mean age of the participants was 59.6 ± 4.1 years, and individuals in the pre-frail/frail group were significantly older than those in the normal group (60.7 ± 4.3 vs. 57.6 ± 3.0 years, $p = 0.001$). There was no significant difference between the groups in sex, marital status, smoking habits and anthropometric measurements ($p > 0.05$). Malnutrition status and sarcopenia risk were significantly associated with pre-frailty/frailty, with higher proportions observed in the pre-frail/frail group compared with the normal group ($p < 0.01$).

Table 2 presents oral health characteristics according to frailty status. The pre-frail/frail group had significantly lower median GOHAI scores than the normal group ($p = 0.011$), whereas GOHAI categories did not differ

**Table 1.** Sociodemographic, clinical, and nutritional characteristics of participants according to frailty status

| | Normal | Pre-frail/frailty | p | Total |
|---|---|---|---|---|
| **Age, year, mean±SD** | 57.6±3.0 | 60.7±4.3 | 0.001 | 59.6±4.1 |
| Sex, n (%) | | | | |
| Female | 12 (37.5%) | 32 (55.2%) | 0.108 | 44 (48.9%) |
| Male | 20 (62.5%) | 26 (44.8%) | | 46 (51.1%) |
| **Education** | | | | |
| Primary/secondary school | - | 12 (20.7%) | 0.007 | 12 (13.3%) |
| High School/university | 32 (100%) | 46 (79.3%) | | 78 (86.7%) |
| **Marital status, n (%)** | | | | |
| Single/widowed/divorced | 7 (21.9%) | 12 (20.7%) | 0.895 | 19 (21.1%) |
| Married | 25 (78.1%) | 46 (79.3%) | | 71 (78.9%) |
| **Smoking, n (%)** | | | | |
| Yes | 19 (59.4%) | 28 (48.3%) | 0.313 | 47 (52.2%) |
| No | 13 (40.6%) | 30 (51.7%) | | 43 (47.8%) |
| **Chronic illness, n (%)** | | | | |
| Yes | 15 (46.9%) | 42 (72.4%) | 0.016 | 57 (63.3%) |
| No | 17 (53.1%) | 16 (27.6%) | | 33 (36.7%) |
| BMI, kg/m$^2$, mean±SD | 25.3±3.0 | 25.6±4.1 | 0.708 | 25.5±3.7 |
| **BMI classification, kg/m$^2$** | | | | |
| 18.5-24.9 | 14 (43.8%) | 25 (43.1%) | | 39 (43.3%) |
| 25-29.9 | 16 (50.0%) | 26 (44.8%) | 0.664 | 42 (46.7%) |
| ≥30 | 2 (6.2%) | 7 (12.1%) | | 9 (10.0%) |
| Calf circumference, mean±SD | 36.5±3.2 | 35.6±4.2 | 0.328 | 35.9±3.8 |
| **Malnutrition status, n (%)** | | | | |
| Normal nutrition | 32 (100%) | 39 (67.2%) | <0.001 | 71 (78.9%) |
| Malnutrition risk | - | 14 (24.2%) | | 14 (15.5%) |
| Malnutrition | - | 5 (8.6%) | | 5 (5.6%) |
| **Sarcopenia risk, n (%)** | | | | |
| Normal | 32 (100%) | 43 (74.1%) | 0.002 | 75 (83.3%) |
| Sarcopenia risk | - | 15 (25.9%) | | 15 (16.7%) |

significantly between groups ($p > 0.05$). There was a significant association between frailty status and dental treatment types, the number of missing teeth, and the number of filled teeth ($p < 0.05$). Weight loss after initiation of dental treatment was more frequently reported in the pre-frail/frail group ($p = 0.035$), while oral pain during eating did not differ between groups ($p > 0.05$).

As shown in Table 3, there was a negative correlation between GOHAI and FRAIL, SARC-F scores, and a positive correlation with MNA scores ($p < 0.01$). There is a positive correlation between FRAIL and SARC-F scores, and a negative correlation between FRAIL and MNA scores ($p < 0.001$).

**Table 2.** Oral health status, dental treatment characteristics, and eating-related outcomes according to frailty status

| | Normal | Pre-frail/frailty | p | Total |
|---|---|---|---|---|
| **GOHAI, median (Q1-Q3)** | 49.5 (42-53) | 42.5 (32.8-51) | 0.011 | 44.5 (34-52) |
| **GOHAI classification, n (%)** | | | | |
| Low oral health | 18 (56.2%) | 42 (72.4%) | 0.119 | 60 (66.7%) |
| Moderate oral health | 14 (43.8%) | 16 (27.6%) | | 30 (33.3%) |
| **Type of dental treatment, n (%)** | | | | |
| Implant | 15 (46.9%) | 35 (60.3%) | 0.002 | 50 (55.6%) |
| Endodontic and restorative treatment | 17 (53.1%) | 13 (22.4%) | | 30 (33.3%) |
| Dental prosthesis | - | 10 (17.2%) | | 10 (11.1%) |
| **Number of filled teeth, mean±SD** | 3.8±2.0 | 2.7±2.1 | 0.010 | 3.1±2.1 |
| **Number of missing teeth, mean±SD** | 4.8±3.6 | 10.6±8.4 | <0.001 | 8.6±7.6 |
| **Weight loss after initiation of dental treatment, n (%)** | | | | |
| Yes | 4 (12.5%) | 19 (32.8%) | 0.035 | 23 (25.6%) |
| No | 28 (87.5%) | 39 (67.2%) | | 67 (74.4%) |
| **Oral pain or discomfort while eating, n (%)** | | | | |
| Yes | 30 (93.8%) | 511 (87.9%) | 0.381 | 81 (90%) |
| No | 2 (6.2%) | 7 (12.1%) | | 9 (100%) |
| **Improved eating habits after treatment, n (%)** | | | | |
| Yes | 9 (28.1%) | 33 (56.9%) | 0.009 | 42 (46.7%) |
| No | 23 (71.9%) | 25 (43.1%) | | 48 (53.3%) |

**Table 3.** Relation between oral health scale and nutritional disorders score

| | FRAIL | | MNA | | SARC-F | |
|---|---|---|---|---|---|---|
| | r | p | r | p | r | p |
| GOHAI | -0.399 | <0.001 | 0.590 | <0.001 | -0.322 | 0.002 |
| FRAIL | - | - | -0.598 | <0.001 | 0.721 | <0.001 |
| MNA | -0.598 | <0.001 | - | - | -0.564 | <0.001 |
| SARC-F | 0.721 | <0.001 | -0.564 | <0.001 | - | - |

## Discussion

This study demonstrated an association between oral health status, as assessed by the GOHAI, and frailty, sarcopenia risk, and nutritional status among middle aged and older adults receiving dental treatment. In the present study population, participants in the pre-frail/frail group had lower GOHAI scores compared with non-frail participants, indicating poorer perceived oral health. Moreover, GOHAI scores were negatively correlated with FRAIL and SARC-F scores and positively correlated with MNA scores, suggesting that declines in oral health are associated with increased frailty and sarcopenia risk as well as poor nutritional status.

In this study, the prevalence of sarcopenia risk and malnutrition status among participants is consistent with previous systematic reviews and epidemiological studies conducted on community-dwelling older adults.[23-25] In contrast, a relatively high prevalence of pre-frailty/frailty (64.4%) was observed in the present study. A large meta-analysis including over 40,000 community-dwelling

adults aged ≥60 years reported a wide prevalence range of frailty (8–80%), with a pooled prevalence of 42%, highlighting that frailty is common but heterogeneous across populations.[26]The higher prevalence observed in the present study may be partially explained by the inclusion of individuals receiving dental treatment, who may represent a more vulnerable subgroup with underlying functional limitations and health problems.

Oral health status in the present study was assessed using the GOHAI, a widely validated instrument that evaluates physical and psychosocial functioning, pain, and discomfort as core components of oral health related quality of life, which are closely associated with dietary intake and functional capacity in both older and adult populations.[27,28] In the current study, GOHAI scores were negatively correlated with FRAIL and SARC-F scores and positively correlated with MNA scores, indicating that poor perceived oral health is associated with higher frailty and sarcopenia risk as well as poor nutritional status. Our results are consistent with previous studies reporting an association between poor self-rated oral health, as measured by GOHAI, and pre-frailty/frailty status[29], as well as findings from hospitalized older adults showing that poor self-reported oral health is independently associated with higher frailty scores, even after adjusting for nutritional status and comorbidities.[17] Likewise, oral health status has been widely reported to be associated with nutrition related disorders, including malnutrition, sarcopenia, and frailty, particularly among community-dwelling older adults.[30-32] Oral diseases may contribute to these conditions through multiple pathways such as pain, tooth loss, impaired mastication, infection, and chronic inflammation, all of which can lead to reduced dietary intake and exacerbate age-related pathophysiological changes.[33,34]

In recent years, oral frailty has received increasing attention and has been defined as an age-related decline in oral structure and function.[35,36] Previous studies have shown that oral frailty is associated with nutritional status and muscle function.[37,38] Although oral frailty was not specifically assessed in this study, the evaluation of overall oral health using GOHAI provides partial insight into oral status, encompassing some physical, functional, and psychosocial aspects. Further studies using specific oral frailty indices are needed to clarify these relationships.

In the present study, weight loss following the initiation of dental treatment was more frequently found among participants in the pre-frail/frail group. Although dental treatment is generally expected to improve oral function over time, short-term factors such as postoperative discomfort, adaptation to dental prostheses, and functional limitations associated with prosthetic rehabilitation may adversely affect dietary nutrient intake.[39,40] It should be noted that the weight loss data were obtained based on patient self-report, which may introduce bias. Despite this situation, these findings highlight the importance of integrating nutritional assessment and close monitoring into dental care, particularly for older adults with pre-existing frailty or sarcopenia risk.

A large population-based longitudinal study demonstrated that tooth loss was associated with a more rapid progression of frailty over time.[41] Similarly, previous studies have shown that progressively severe tooth loss, edentulism, and periodontal disease are associated with a higher risk of developing frailty, whereas a greater number of natural teeth is associated with a lower frailty risk.[42,43] These findings suggest that impaired oral health and functional limitations observed during dental treatment may be closely linked to frailty-related outcomes and could contribute to the accelerated frailty progression reported in longitudinal studies. This need is further supported by qualitative evidence indicating that, although general dental practitioners recognize the importance of providing dietary advice, its routine implementation in primary dental care is constrained by unclear professional roles, time pressures, and inadequate remuneration.[44] In this context, greater involvement of dietitians may help support individualized medical nutrition therapy for dental patients. Furthermore, systematic reviews suggest that combining dietary interventions with dental care can improve both masticatory function and nutritional outcomes.[45] These findings underscore the importance of addressing both oral function and nutrition concurrently to optimize health outcomes in older adults receiving dental treatment.

There are some limitations in the study. First, this study employed a cross-sectional design and recruited patients from a single dental clinic; therefore, causal inferences cannot be drawn. Second, this study enrolled individuals aged 55 and above, while most previous studies on oral health and frailty have focused on older adults, although some included participants starting from 40 years of age[13,46], which may affect the generalizability of the results. Third, sarcopenia risk was assessed using the SARC-F questionnaire, without direct measurements of muscle mass or function. Another limitation of this study is that oral health status was assessed using the GOHAI,

which is primarily based on self-reported symptoms and may not fully reflect objective clinical evaluations conducted by dental professionals. Therefore, there is potential reporting bias. Fourth, weight loss data during dental treatment were also based on patient self-report and were not documented in medical records, making them inherently subjective and limiting their reliability. Also, the relatively small sample size and the limited number of participants in certain subgroups restricted the ability to perform multivariate regression analyses. It is important to note that the absence of multivariate regression analysis is a significant limitation because it restricts consideration of potential confounding factors. Finally, due to the relatively small sample size and the cross-sectional nature of the study, the interpretation of the associations between oral health status, frailty, sarcopenia risk, and nutritional status during dental treatment should be made with caution.

In conclusion, oral health status had a significant association with frailty, nutritional status, and sarcopenia risk in older adults receiving dental treatment, with poorer perceived oral health linked to higher frailty and sarcopenia risk as well as nutritional impairment. Integrating routine nutritional screening and frailty assessment into dental care settings may enable dietitians to identify older adults at increased risk and facilitate early, multidisciplinary interventions. Future longitudinal and multicenter studies are warranted to clarify causal relationships, enhance the generalizability of findings, and determine whether targeted oral and nutritional interventions reduce the progression of frailty and improve overall health outcomes.

## Author contributions

Conception and design: M.K., E.B.T.; Data acquisition: E.B.T.; Data analysis: M.K.; Data interpretation: M.K.; Drafting of the manuscript: M.K.; Critical revision of the manuscript: M.K. All authors reviewed the results, approved the final version of the manuscript, and agreed to be accountable for all aspects of this study.

## Ethical approval

This study was approved by the Sivas Cumhuriyet University Health Sciences Research Ethics Committee (Date: July 10, 2025 (July 10, 2025), Decision/Protocol No: 2025-07/46). Informed consent was obtained from all participants involved in this study.

## Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

## Conflict of interest

The authors declare that this study was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## Generative AI statement

The authors declare that no generative AI or AI-assisted technologies were used in the writing or preparation of this study.

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