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The relationship between salivary flow rate, oral health and malnutrition in elderly; a cross-sectional study

Yaşlılarda tükürük akış hızı, ağız sağlığı ve malnütrisyon arasındaki ilişki; kesitsel bir çalışma

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Abstract

Purpose: This study aimed to evaluate the association between salivary flow rate (SFR), oral health and nutritional status in the elderly.

Materials and methods: The study included 63 elderly people (20 men, 43 women, age: 70.83±6.42 years) who applied to a private dental clinic. Data were collected by face-to-face interview, and participants' sociodemographic characteristics, employment status information and lifestyle habits were recorded in the questionnaire. To determine nutritional status, 3-day food consumption records were taken, the Mini Nutritional Assessment Test (MNA) was performed and anthropometric parameters were measured. To assess oral health, the decayed teeth (DMFT) index and oral health impact scale (OHIP-14) were used, and unstimulated SFR was measured.

Results: According to MNA, 23.8% of the elderly were malnourished or at risk of malnutrition. The mean SFR of the elderly was 0.40±0.31 mL/min and 15.9% of them had low SFR. The mean SFR of the elderly with normal body weight was higher than that of the obese (p<0.05). There was a negative correlation between SFR and Body Mass Indexs (r=-0.291, p=0.021), calf circumference (r=-0.260, p=0.014), Mid-Upper Arm Circumference (r=-0.254, p=0.044) and body fat percentage (r=-0.308, p=0.014), and a negative correlation between energy (r=0.345, p=0.006), carbohydrate (r=0.251, p=0.047), protein (r=0.326, p=0.009), fat (r=0.354, p=0.006) and phosphorus (r=0.287, p=0.023) intake.

Conclusion: No significant evidence was found regarding to a direct association between SFR, DMFT index, and OHIP-14 scores with malnutrition. However, an assaciation was found between low SFR and obesity. This suggests that there might be a potential link between SFR and nutritional status, which requires further investigation. To gain a better understanding of the relationship between SFR and malnutrition in the elderly, it is recommended to conduct multicenter clinical trials.

Keywords: Elderly, salivary flow rate, oral health, malnutrition.

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Öz

Amaç: Bu çalışmanın amacı; yaşlılarda tükürük akış hızı, ağız sağlığı ve beslenme durumu arasındaki ilişkinin değerlendirilmesidir.

Gereç ve yöntem: Çalışmaya, özel diş hekimi kliniğine başvuran 63 (20 erkek, 43 kadın, yaş: 70,83±6,42 yıl) yaşlı dahil edildi. Veriler yüz yüze görüşme yöntemiyle toplanmış olup katılımcıların sosyodemografik özellikleri, çalışma durumuna ilişkin bilgileri ve yaşam tarzı alışkanlıkları ankete kaydedildi. Beslenme durumu saptanması için 3 günlük besin tüketim kaydı alındı, Mini Nütrisyonel Değerlendirme Testi (MNA) uygulandı; antropometrik ölçümler yapıldı. Ağız sağlığını değerlendirmek için çürük dişler indeksi (DMFT) ve ağız sağlığı etki ölçeği (OHİP-14); tükürük akış hızını saptamak için uyarımsız tükürük akış hızı hesaplaması kullanıldı.

Bulgular: MNA'ya göre yaşlıların %23,8'inin malnutrisyonlu veya malnütrisyon riski altında olduğu belirlenmiştir. Yaşlıların tükürük akış hızı ortalamaları 0,40±0,31 mL/dk olarak bulunmuş olup %15,9'unun düşük tükürük akış hızına sahip olduğu saptanmıştır. Normal vücut ağırlığına sahip yaşlıların tükürük akış hız ortalaması obezlerden daha yüksektir (p<0,05). Tükürük akış hızı ile beden kütle indeksi (r=-0,291, p=0,021), baldır çevresi (r=-0,260, p=0,014), üst orta kol çevresi (r=-0,254, p=0,044) ve vücut yağ oranı (r=-0,308, p=0,014) arasında negatif yönlü, diyetle enerji (r=0,345, p=0,006), karbonhidrat (r=0,251, p=0,047), protein (r=0,326, p=0,009), yağ (r=0,354, p=0,006) ve fosfor (r=0,287, p=0,023) alımı arasında pozitif yönlü anlamlı ilişki mevcuttur.

Sonuç: Tükürük akış hızı, DMFT indeksi ve OHİP-14 skorları ile malnütrisyon arasında doğrudan bir ilişki olduğuna dair anlamlı bir kanıt bulunmamıştır. Bununla birlikte, düşük SFR ile obezite arasında bir ilişki tespit edilmiştir. Bu durum, SFR ile beslenme durumu arasında daha fazla araştırma gerektiren potansiyel bir bağlantı olabileceğini düşündürmektedir. Yaşlılarda tükürük akış hızı ve malnütrisyon arasındaki ilişkinin daha iyi anlaşılması için çok merkezli klinik çalışmaların yapılması önerilmektedir.

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Anahtar kelimeler: Yaşlı, tükürük akış hızı, ağız sağlığı, malnütrisyon.

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Introduction

Malnutrition is a condition in which a deficiency or excess (or imbalance) of energy, protein, and other nutrients has adverse effects on body/tissue structure and function and clinical course [1, 2]. Malnutrition is a common problem in the elderly, and the prevalence of malnutrition has been reported to vary from 13% to 54% [3, 4]. Malnutrition is associated with several adverse health outcomes, including deterioration of functional and cognitive abilities and increased morbidity and mortality [5]. The causes of malnutrition in the elderly are multifactorial. It has been reported that many factors such as age-related physiological changes, inadequate nutrient intake, mental and physical illness, substance use, economic problems, and social isolation can lead to malnutrition in the elderly [6].

Good oral health refers to healthy oral tissues without sores, inflammation, or other painful conditions, well-functioning teeth, adequate saliva, and no oral cavity or masticatory disorders [7]. Oral health problems such as tooth loss, dry mouth, periodontal disease, dental caries, painful mucosal disease, and decreased masticatory function are common in the elderly [7]. It has also been found that salivary glands degenerate with age and therefore salivary flow rate (SFR) decreases in the elderly [8].

Saliva is a physiological fluid that plays an important role in normal oral functions such as swallowing, chewing, and food taste perception [9]. Saliva plays an important role in the acceptance of food and beverages by altering the perception of mouthfeel and the release of flavors. It also converts food into a form that can be safely swallowed. In addition, it dilutes and removes substances from the oral cavity after swallowing [9]. Decreased SFR (hyposalivation), mouth sores, and poorly functioning dentition can affect appetite as well as chewing and swallowing function. It has been reported that this condition can alter food choices and reduce the consumption of balanced foods, increasing the risk of malnutrition [10]. Therefore, it is suggested that impaired oral health may be a factor in the pathogenesis of malnutrition [10]. In a study of the elderly, it was found that the prevalence of malnutrition increased steadily with the increase in oral health problems (oral pain, chewing problems, dryness, and difficulty swallowing) [10]. Another study reported that there was no association between decreased SFR and malnutrition in community-dwelling elderly [11]. Considering the high prevalence of malnutrition in the elderly and the negative consequences of malnutrition on the health of the elderly, studies investigating the relationship between malnutrition and oral health are needed.

In Türkiye, there is no study investigating the association between SFR, oral health status, and malnutrition in the elderly. Therefore, the main objective of this study was to investigate the relationship between SFR, Oral health impact scele-14 (OHIP-14), Decayed, Missing, and filled teeth (DMFT) index and nutritional status. In addition, the relationship between SFR, DMFT, and OHIP scores by Body Mass Index (BMI) groups was investigated. The first null hypothesis states that there are no significant differences in SFR, the DMFT, and (OHIP-14) between older people with normal nutritional status and those with malnutrition or at risk of malnutrition. The second null hypothesis is that there is no association between SFR, DMFT, OHIP-14, and BMI.

Materials and methods

Study design and participants

This cross-sectional study was conducted in independently living individuals over 60 years of age who applied to a private dental clinic in Balıkesir between October 2021 and June 2022. To determine the relationship between SFR and MNA for d=0.4, effect size, 90% power, and 5% type 1 error, the sample size was calculated to be 67 using G power software. Before data collection, 5 volunteers aged 60 years and older underwent a pretest (the results of the pretest were not analyzed) to check the comprehensibility of the questionnaire, and

after the pretest, a total of 63 elderly people were included in the study. The inclusion criteria were as follows: Applying to the dental clinic, being 60 years of age or older, agreeing to participate in the study and signing the informed consent form, answering the research questions completely, and using a telephone. Individuals younger than 60 years of age, individuals who could not answer all research questions, and individuals who had a disease that could affect SFR (sjögren's syndrome, rheumatoid arthritis, systemic lupus erythematosus, parkinson's disease, diabetes mellitus, and other endocrine diseases, crohn's disease, inflammatory bowel disease, periodontitis, mucositis), as well as subjects who received radiotherapy to the head and neck region and subjects who were fasting were not included in the study [12]. The Non-Interventional Clinical Research Ethics Committee of Izmir Katip Celebi University approved the study.

Data collection

Between October 2021 and June 2022, participants who applied to a private dental clinic in Balıkesir, and met the inclusion criteria received general information about the content and purpose of the study, and each participant who agreed to participate in the study was read and signed the informed consent form.

Data for the study were collected by face-to-face interview using a questionnaire. Each interview lasted approximately 30 minutes. In the questionnaire, participants were asked questions about sociodemographic characteristics and information about diseases; a three-day food consumption record was taken to determine nutritional status, and the Mini Nutritional Assessment (MNA) was used. Anthropometric parameters [(body weight, height, mid-upper arm circumference (MUAC), calf circumference, triceps skinfold thickness (TST) were measured. All anthropometric measurements, MNA, and food consumption record were evaluated by a standardized investigational dietitian who had been trained on this topic.

The OHIP-14 was used to assess the oral health problems of the eldery and their impact on nutritional status [13]. The World Health Organization (WHO) criteria for decayed (D), missing (M), and filled (F) teeth (DMFT) were used to assess caries in the permanent dentition [14]. A dentist performed the clinical examinations of the oral cavity using dental mirrors, artificial light, and WHO dental probes, and the participants' teeth were cleaned before the examination. The "unstimulated SFR calculation" was used to determine the SFR.

Anthropometric measurements and bioelectrical impedance analysis

The body weights and body fat percentage of the subjects participating in the study were measured using the bioelectrical impedance analyzer "TANITA BC532 InnerScan" (Tanita, Amsterdam, The Netherlands). The height of the participants was measured with a stadiometer, with the feet side by side and the head in the Frankfort plane. BMI was calculated by dividing body weight (kg) by height squared (m^2). Participants were classified as "obese (≥30 kg/m^2)", "overweight (25-29.9 kg/m^2)", or "normal weight (<25 kg/m^2)" according to BMI [15].

For the TST measurement, the right arm was bent at the elbow 90° and the midpoint between the acromion (shoulder) and olecranon (elbow) was sought and marked in the upright position. The arm was released, and the layer was held with the index finger and thumb of the left hand. The marked area was measured with the right hand using a Holtain caliper [15]. Calf circumference was determined by measuring the widest part of the lower leg between the patella and Achilles tendon with a tape measure [15].

Dietary intake

Each participant was informed about the recording of food consumption in the first interview, in which they were asked the questions of the questionnaire, and participants were asked to take notes so as not to forget the foods they consumed. Another interview was scheduled for the fourth day after the first interview with the participants. For three days, participants were called by telephone at the end of each day after the first interview, and notes were taken on when and in what quantities they had consumed which foods during the day. At the second interview, participants were given the foods and quantities noted in the records as measurements in the book "Food and Nutrition Photo Catalogue: Measurements and

Quantities" and calculated by asking participants to choose the portion they consumed [16]. After determining the amount of food consumed daily by the participants, daily energy, macro- and micronutrient intakes were determined using the "Nutrition Information Systems Package Programme" 9 (Ebispro for Windows, Stuttgart, Germany; Turkish version, BEBIS 9) [17].

"Mini nutritional assessment" (MNA)

In the study, the Turkish version of the MNA was used as a screening test for the nutritional status of the elderly. In this context, the participants were asked questions under the titles "anthropometric assessment," "general assessment," "food intake assessment," and "subjective assessment" in the MNA and the necessary measurements were taken. After completion of the assessment test, participants' total scores were calculated. Participants' nutritional status was categorised as "no nutritional problem" with a score above 23.5, "at risk of malnutrition" with a score between 23.5-17.0, and "malnutrition" with a score below 17.0 [18].

"Oral health impact scale-14" (OHIP-14)

Oral health-related quality of life is an individual's personal perception of how oral health affects their quality of life and overall health. The OHIP-14 is a scale that assesses this perception with two questions about functional limitations, physical pain, psychological discomfort, physical, psychological, and social disability and handicap. Because the scale is concerned with patient problems, high scores indicate patients with oral health-related problems and low scores indicate healthy individuals. An increase in the total score means that the severity of the problem increases and the quality of life decreases [13]. The severity of oral problems and quality of life related to the condition of the elderly who participated in the study were assessed with this scale. The validity and reliability of the scale was determined by Basol et al. [13] in 2014.

SFR

To eliminate the risk that interventional procedures might not be accepted and might reduce the sample size, especially in frail elderly, a nonstimulated SFR measurement was performed in this study.

SFR measurements were performed between 09:00 and 11:00 am, and participants were asked not to eat breakfast on the day of measurement and not to drink water for 2 hours before measurement. Participants rested for a few minutes before the measurement. Participants were asked to swallow 1 time before starting the measurement. Unstimulated saliva samples were collected in cylindrical tubes calibrated from 0 mL to 10 mL by placing subjects with their heads in front of them for 5 minutes and allowing only saliva to flow into the tube in front of the lips without making a spitting motion. The obtained mL value was divided by 5 and the saliva flow rate per minute was calculated. Of the calculated values, the range of 0.3-0.4 mL was considered normal and values below 0.1 mL were considered low salivary flow rate (hyposalivation) [19-21].

DMFT index

Clinical examinations of the elderly were performed by a dentist to determine the number of teeth affected by caries and their results. The sum of the 28 permanent teeth (excluding teeth 18, 28, 38, 48) of the participants and the number of decayed (Decayed-D), missing (Missing-M) and filled (Filled-F) teeth resulted in the DMFT values of the participants [14].

Statistical analysis

Data were analysed with the programme "IBM SPSS Statistics 25.0 (IBM Corp., Armonk, New York, USA)". Descriptive statistics are reported as number (n), percentage (%), mean ± standard deviation, median, and IQR. Normal distribution of quantitative data was analysed using the Kolmogorov-Simirnov test. Parametric tests were used for numerical variables that had a normal distribution, and nonparametric methods were used for variables that did not have a normal distribution. Intergroup comparisons for numeric variables were evaluated with the independent t test for two groups when data were normally distributed and with the Mann-Whitney U test when data were not normally distributed. The ANOVA test was used to determine whether there was a difference in SFR by BMI groups, and the difference in DMFT and OHIP-14 scores was determined with the Kruskal Wallis test. Pearson's or Spearman's correlation analysis was used to evaluate the relationships between continuous variables. In

all analyses, a *p* value of less than 0.05 was considered statistically significant.

Results

Table 1 shows the general characteristics of the elderly. A total of 63 elderly people, 20 men (32%) and 43 women (68%), participated in the study. The mean age was 70.83±6.42 years, 87.3% of the elderly did not consume alcohol, and 61.9% did not smoke. Of all the elderly, 76.2% had normal nutritional status and 23.8% were malnourished or at risk of malnutrition. Most of the elderly were overweight and 38.1% of them did 150 minutes of moderate exercise per week. The mean SFR of the elderly was 0.40±0.31 mL/min and 15.9% of them had low SFR.

Table 1. General characteristics of the elderly

	n	%
Age (year) (x̄±SD)	70.8±6.42	
Alcohol consumption status		
Yes	8	12.7
No	55	87.3
Smoking status		
Yes	9	14.3
No	54	85.7
Doing exercise regularly (150 minutes/week, moderate intensity)		
Yes	24	38.1
No	39	61.9
Nutritional status of the elderly according to MNA		
Normal nutritional status	48	76.2
At risk of malnutrition	12	19.0
Malnourished	3	4.8
BMI group		
Normal body weight	12	19.0
Overweight	29	46.0
Obese	22	34.9
Anthropometric measurements	**x̄±SD**	
Calf circumference (cm)	33.9±4.16	
TST (mm)	20.6±11.36	
MUAC (cm)	29.8±4.88	
Body Fat (%)	35.6±9.20	
Dietary intake		
Energy (kcal)	1501.3±556.49	
Carbohydrate (%)	41.1±10.63	
Protein (%)	17.4±4.06	
Fat (%)	41.1±9.29	
Oral health variables		
OHIP-14 (median (IQR)	6.0 (8.0)	
DMFT (median (IQR)	24.0 (12.0)	
Salivary flow rate (mL/min)	0.40±0.31	
Low salivary flow rate (<0.1 mL/min) n (%)	10 (15.9)	

OHIP 14: Oral Health Impact Profile, DMFT: Decayed, Missing, and Filled Teeth, TST: triceps skinfold thickness
MUAC: Mid-upper arm circumference, SD: standart deviation

The relationship between SFRs, DMFT indices, and OHIP scores of the elderly according to MNA is shown in Table 2. It was found that there was no statistically significant difference in SFRs, DMFT indices, and OHIP-14 scores between the elderly with normal nutritional status and those at risk of malnutrition/ malnourished according to MNA (p>0.05).

Salivary flow rates, DMFT, and OHIP scores of the elderly by BMI group are shown in Table 3. Although there was no statistically significant difference between the DMFT and OHIP-14 scores of elderly people in the different BMI groups, a statistically significant difference was found in the SFR averages (p<0.001). The SFRs of the elderly with normal body weight were higher than those of the elderly with overweight (p<0.001).

The relationship between SFR, OHIP, DMFT, and MNA, anthropometric measurements, and food intake is shown in Table 4. There was a negative correlation between SFR and BMI (r=-0.291, p=0.021), calf circumference (r=-0.260, p=0.014), MUAC (r=-0.254, p=0.044) and body fat percentage (r=-0.308, p=0.014) and a positive correlation between energy (r=0.345, p=0.006), carbohydrate (r=0.251, p=0.047), protein (r=0.326, p=0.009), fat (r=0.354, p=0.006) and phosphorus (r=0.287, p=0.023) intake. There was a significant positive correlation between OHIP and energy intake (r=0.346, p=0.006), carbohydrates (r=0.272, p=0.031), protein (r=0.261, p=0.038), fat (r=0.340, p=0.006), calcium (r=0.343, p=0.006) and phosphorus (r=0.270, p=0.032). There was no statistically significant relationship between DMFT and MNA, anthropometric measurements, and food intake values (p>0.05).

Table 2. Salivary flow rates, DMFT indices and OHIP scores of the elderly according to MNA groups

	Healthy (n=48)	Risk of malnutrition/ malnourished (n=15)	*p*
	x̄±SD or median (IQR)	x̄±SD or median (IQR)	
Salivary flow rate	0.39±0.27	0.43±0.41	0.617[a]
DMFT	25.0 (13.0)	19.0 (12.0)	0.291[b]
OHIP-14	7.0 (7.5)	7.0 (8.0)	0.999[b]

OHIP-14: Oral Health Impact Profile, DMFT: Decayed, Missing, and Filled Teeth · [a]Independent t test, [b]Mann Whitney U test

Table 3. Salivary flow rates, DMFT and OHIP scores of the elderly according to BMI groups

	Normal (n=12)	Overweight (n=29)	Obese (n=22)	*p*
	x̄±SD or median (IQR)	x̄±SD or median (IQR)	x̄±SD or median (IQR)	
Salivary flow rate	0.72±0.48[1]	0.34±0.23[2]	0.30±0.14[3]	<0.001[a], 1>3
DMFT	20.0 (8.0)	25.0 (14.0)	24.0 (11.0)	0.683[b]
OHIP-14	5.5 (4.0)	6.0 (7.0)	6.5 (7.5)	0.677[b]

OHIP-14: Oral Health Impact Profile, DMFT: Decayed, Missing, and Filled Teeth, [a]One Way Anova, [b]Kruskal Wallis Test

Table 4. Correlations between the variables

	Salivary flow rate		OHIP-14		DMFT	
	r	*p*	r	*p*	r	*p*
Salivary flow rate	-	-	0.225	0.077	0.018	0.886
MNA	-0.007	0.955	0.027	0.836	0.040	0.753
OHIP-14	0.225	0.077	-	-	0.098	0.447
DMFT	0.018	0.886	0.098	0.447	-	-
Body weight (kg)	-0.160	0.211	0.032	0.805	0.147	0.252
BMI (kg/m²)	-0.291	0.021	0.005	0.971	0.066	0.609
Calf circumference (cm)	-0.260	0.014	-0.150	0.240	0.134	0.295
MUAC (cm)	-0.254	0.044	-0.139	0.279	0.123	0.337
TST (mm)	-0.131	0.307	0.034	0.791	0.025	0.848
Body fat (%)	-0.308	0.014	0.082	0.522	0.50	0.700
Energy (kkal)	0.345	0.006	0.346	0.006	0.177	0.165
Carbohydrate (g)	0.251	0.047	0.272	0.031	0.196	0.124
Carbohydrate (%)	-0.158	0.216	-0.166	0.194	-0.012	0.928
Protein (g)	0.326	0.009	0.261	0.038	0.108	0.400
Protein (%)	0.024	0.851	-0.068	0.596	-0.047	0.716
Fat (g)	0.345	0.006	0.340	0.006	0.131	0.306
Fat (%)	0.117	0.360	0.204	0.209	0.009	0.945
Calcium (mg)	0.021	0.873	0.343	0.006	0.140	0.274
Phosphorus (mg)	0.287	0.023	0.270	0.032	0.141	0.269

TST: triceps skinfold thickness, MUAC: Mid-upper arm circumference, MNA: Mini nutritional assessment, OHIP-14: Oral Health Impact Profile DMFT: Decayed, Missing, and Filled Teeth, BMI: body mass index

Discussion

Oral health is an important component of "healthy ageing" as it affects the overall health and quality of life of individuals [22]. Nutritional status is also a key component of overall health in the elderly [23]. Oral problems are likely to contribute to poorer nutritional status, as certain foods are avoided due to chewing or pain problems. However, the relationship between oral health and nutritional status in the elderly is still neglected. The main objective of this study was to investigate the relationship between SFR, OHIP-14, DMFT index, and nutritional status. The first null hypothesis of this work, namely that SFR, DMFT index and OHIP-14 score are not predictors of malnutrition, was accepted. An inverse statistically significant relationship was found between BMI and SFR, and obese elderly were found to have lower SFR in this study. Therefore, the second null hypothesis was rejected.

Insufficient SFR, also known as hyposalivation, has been associated with a number of chronic diseases such as diabetes [24], asthma [25], and obesity [26]. Therefore, screening and early treatment of SFR play an important role in maintaining oral health, especially in people living in a rapidly ageing society [27, 21]. In the literature, older people with reduced SFR have been shown to consume less of certain foods, including vegetables and seafood. Low SFR has been associated with taste perception, food pleasure, food enjoyment, quality of life, and malnutrition problems [28-30]. A meta-analysis by Pina et al. [8] found that the prevalence of unstimulated low SFR in the elderly was 33.3% (n=2425 individuals). In a 6-year follow-up study in Japan that examined the association between anorexia nervosa and low SFR, it was found that approximately 20% of healthy elderly developed decreased SFR [21]. Similarly, in this cross-sectional study,

15.9% of the elderly were found to have a low SFR. Because saliva not only maintains oral cavity health but also plays a role in maintaining overall health, these findings underscore the importance of early screening and management in the elderly [31, 27-29].

SFR varies according to population, age group, or climatic conditions. The mean value of unstimulated SFR for the general population is 0.3-0.5 mL/min [32]. In this study, in accordance with the literature, the mean SFR of the elderly was found to be 0.40±0.31 mL/min. However, in this study, no statistically significant difference was found between the SFRs of elderly at risk of malnutrition or malnutrition and elderly with normal body weight. In addition, no statistically significant difference was found in DMFT and OHIP-14 scores by BMI and MNA. Similarly, in a study conducted in Finland with 157 community dwelling elderly aged 75 years and older, it was shown that there was no assaciation between low SFR and malnutrition [11]. In contrast to these results, low SFR was associated with malnutrition in a study conducted in elderly hospital patients [33]. The absence of an association between malnutrition and SFR in this study may be attributed to the fact that the participants lived in the community and were probably healthier than the hospitalised elderly. At the same time, these results may be related to the small number of malnourished elderly who participated in the study.

There are many factors that influence SFR. Many drugs such as anxiolytics, diuretics, antidepressants, antihypertensives, analgesics, and neuroleptics can cause a decrease in SFR. In addition, age, women, and obesity are other known risk factors for low SFR in young patients [26, 34]. In a study conducted in Brazil, a negative correlation was found between BMI and perception of oral health in the elderly [35]. Accordingly, in this study, it was found that the SFR of elderly people with normal body weight was higher than that of obese people, and an inverse statistically significant relationship was found between SFR and BMI. In contrast to the results of the present study, Dormenval et al. [33] showed that the SFR of elderly people with BMI <21 kg/m² was significantly lower than that of people with BMI >21 kg/m². It is well known that the term malnutrition does not only refer to inadequate food intake and/or underweight. Malnutrition is the imbalance between the nutrients consumed (energy, protein and other nutrients) and the coverage of the changing metabolic needs. From this perspective, malnutrition is a concept that includes obesity. In previous studies, SFR has been associated with malnutrition, which is characterised by inadequate nutrition. Based on the results of this study in relation to BMI and considering that obesity is also a form of malnutrition, it can be said that SFR is higher in elderly with normal BMI values than in malnourished elderly. These results suggest that low SFR may influence nutritional status.

Previous studies have reported that nutritional status may also influence SFR. [28, 30]. A study based on frequency of food intake showed that dry mouth affects quantity and quality of food intake and ultimately quality of life, and that dry mouth was associated with low carbohydrate and protein intake [36]. In addition, it was reported that people with dry mouth tend to avoid crunchy, dry, and sticky foods and have lower intakes of cellulose, potassium, vitamin B6, iron, calcium, and zinc [37, 38]. Similarly, in a study in the elderly, dry mouth was associated with lower intake of omega-3 fatty acids, micronutrients (vitamin E, folate, fluorine), and water [39]. Similarly, this study found a statistically significant positive association between SFR and carbohydrate, protein, and fat intake. In addition, a significant positive association was found between OHIP and energy, carbohydrate, protein, fat, calcium, and phosphorus intake. The ESPEN guideline states that these changes in dietary intake in the elderly may put people with dry mouth at risk of malnutrition [40]. In this context, routine consideration of SFR in determining and monitoring the nutritional status of the elderly is expected to play a critical role in preventing malnutrition.

This study has limitations. First, due to the fact that this study was designed as a cross-sectional study, a cause-effect relationship could not be established as a result of the analyzes conducted. Second, the sample consisted of older people living in the community; therefore, they likely represent a healthier proportion of older adults overall. Despite these limitations, the study also has its strengths. This study is the first to examine malnutrition and SFR in community-dwelling older people in Türkiye. Another strength is that

the clinical examinations of the participants are conducted by a professional team that includes a dentist and a dietitian. At the same time, the evaluation of food intake with a three-day consumption protocol instead of consumption frequency in this study allowed a more accurate determination of nutritional status.

In conclusion, no significant evidence was found regarding to a direct association between SFR, dental health as measured by the DMFT index, and oral health-related quality of life as measured by the OHIP-14 scores with malnutrition. However, an association was found between low SFR and obesity. This suggests that there might be a potential link between SFR and nutritional status, which requires further investigation. To gain a better understanding of the relationship between SFR and malnutrition in the elderly, it is recommended to conduct multicenter clinical trials.

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Authors' contributions to the article

G.A. and G.K constructed the main idea and hypothesis of the study. G.A, and G.K developed the theory and arranged/edited the material and method section. G.Y.D. wrote the introduction section. G.A and G.Y.D have done the evaluation of the data in the Results section. Discussion section of the article was written by G.K., G.Y.D and G.K reviewed, corrected and approved. In addition, all authors discussed the entire study and approved the final version.