

The Relationship Between Number of Teeth, Chewing Function and Nutritional Status in Patients Over 55 Years of Age

Elli Beş Yaş Üzeri Hastalarda Diş Sayısı, Çiğneme Fonksiyonu ve Beslenme Durumu Arasındaki İlişki

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ABSTRACT Objective: To investigate a possible relationship between the number of teeth and chewing function and nutritional status of patients over 55 years of age. **Material and Methods:** A total of 145 patients who were hospitalized for the treatment of non-malignant diseases were included in the study. On the first two days of hospitalization, mini nutritional assessment (MNA), body mass index (BMI) and laboratory analysis (albumin, prealbumin, transferrin and total protein, vitamin B₁₂ and folic acid, and serum iron) were used to assess the nutritional status of patients. Dental examination of the patients was made by two dentists at bedside using a mobile light source and the number of teeth was recorded to classify the patients into two categories as having more or less than 20 teeth. Patients were interviewed and for each patient a questionnaire related to general health and nutritional/dental status was filled out. **Results:** Chewing efficacy was inversely correlated with the number of missing teeth ($\chi^2= 15.753$, $p= 0.001$). There was a significant relationship between MNA scores and number of missing teeth ($\chi^2= 6.231$, $p= 0.044$). Patients assessed as malnourished according to MNA scores also had low levels of albumin and prealbumin ($\chi^2= 10.856$, $p= 0.004$ and $\chi^2= 8.653$, $p= 0.013$, respectively). No significant relationship was found between albumin, prealbumin, transferrin, total protein, vitamin B₁₂, folic acid, serum iron levels and the number of teeth and chewing function ($p> 0.05$). **Conclusion:** Patients with ≥ 20 teeth were not malnourished. The correlations between the MNA scores, the number of teeth and chewing function were significant.

Key Words: Nutrition assessment, malnutrition, tooth

ÖZET Amaç: Elli beş yaş üstü hastalarda diş sayısı, çiğneme fonksiyonu ve beslenme durumu arasındaki muhtemel ilişkiyi araştırmaktır. **Gereç ve Yöntemler:** Çalışmaya, habis olmayan hastalıkların tedavisi için hastaneye başvuran ve yatışı yapılan 145 hasta dahil edilmiştir. Hastaneye yatış yapıldıktan sonraki ilk iki günde hastaların beslenme durumlarını değerlendirmek için mini nutrisyonel değerlendirme (MND), beden kitle indeksi (BKİ) ve laboratuvar analizleri (albümin, prealbümin, transferrin ve total protein, vitamin B₁₂ ve folik asit ve serum demiri) kullanılmıştır. Hastaların dental muayeneleri yatakta iki diş hekimi tarafından mobil ışık kaynağı ile yapılmış ve diş sayıları, 20 dişten fazla ve az olacak şekilde kategorize edilmiştir. Hastalarla görüşme yapılmış ve her hasta için genel sağlık ve beslenme durumu/dental durum ile ilgili anket doldurulmuştur. **Bulgular:** Çiğneme fonksiyonu eksik diş sayısı ile ters orantılıdır ($\chi^2= 15.753$, $p= 0.001$). MND puanları ve eksik diş sayısı arasında anlamlı bir ilişki vardır ($\chi^2= 6.231$, $p= 0.044$). MND puanları ile değerlendirildiğinde, kötü beslendiği belirlenen hastaların albümin ve prealbümin seviyeleri düşük olarak tespit edilmiştir (sırasıyla $\chi^2= 10.856$, $p= 0.004$ ve $\chi^2= 8.653$, $p= 0.013$). Albümin, prealbümin, transferrin, toplam protein, vitamin B₁₂, folik asit ve serum demiri düzeyleri ile diş sayıları ve çiğneme fonksiyonu arasında anlamlı bir ilişki bulunmamıştır ($p> 0.05$). **Sonuç:** Diş sayısı 20 ve daha fazla olan hastalar iyi beslenmiştir. MND puanları, diş sayısı ve çiğneme fonksiyonu arasında anlamlı bir ilişki tespit edilmiştir.

Anahtar Kelimeler: Nutrisyon değerlendirmesi, yetersiz beslenme, diş

Oral health has an interrelationship with general health. A well-balanced and adequate nutrition is among the principal contributors to health. Food and fluid intake is significantly influenced by oral health status, which is dependent on the chewing ability and function.¹ The dental status of older people was suggested to have an impact on their ability to eat, affecting food choice.² Poor oral health is associated with limited dietary variety and lower nutrient intake.³

Nutritional status is generally determined by the patient's nutritional history such as diet, recent weight change and laboratory tests (serum albumin, serum transferrin, serum transthyretin).¹ In the community of clinical nutrition, there is no single accepted method for assessing nutritional status. Thus, biochemical and dietary intake indicators and the clinical judgment of the evaluator are used to classify nutritional status such as subjective global assessment (SGA) and mini nutrition assessment (MNA).⁴ Initially, MNA was developed for and was validated in relatively healthy elders to assess nutritional status.⁵

The number of teeth in occlusion (the teeth that make biting or chewing contact with one another) is a major determinant for chewing function. The preservation of a healthy, natural, functioning dentition comprising not less than 20 teeth has been described as a goal for oral health by the World Health Organization (WHO).⁶ The number of teeth is the most influential factor on the masticatory function. In patients with less than 20 teeth, the biting pressure is remarkably higher than in patients with 20 or more teeth. The number of teeth appears to be a critical factor in maintaining the biting ability of an individual.⁷

Elderly people usually suffer from inadequate chewing and nutrition. Indeed, a certain amount of mastication is required to promote saliva and gastric flow to facilitate swallowing. In addition, the acts of chewing, tasting and mastication help to give pleasure and emotional satisfaction and consequently underline the need for functional dentures.⁸ Dental status has an impact on food choice and on the intake of nutrients.⁹ Poor oral health is asso-

ciated with limited dietary variety and lower nutrient intake. Preventive oral health care to maintain natural dentition throughout life and regular dental care to ensure adequate denture fit and function may decrease nutritional risk in elderly people.³

In light of these observations, the purpose of the present study was to find out the relationships between the number of teeth, chewing function and nutritional status of patients over 55 years of age.

MATERIAL AND METHODS

The study was carried out with 145 patients who were admitted to the General Surgery, Cardiology, Physical Therapy and Rehabilitation Clinics of a University Hospital for the treatment of non-malignant diseases. For a three months period, all patients admitted to the clinics were included in the study. The mean age of the study group comprising 65 (44.8%) men and 80 (55.2%) women was 66.6 (55-88) years. The patients were fully informed on the study protocol and participation was based solely on volunteering. Patients were interviewed and for each patient a questionnaire related to general health and nutritional/dental status was filled out; the details were presented in Table 1. On the first two days of hospitalization, mini nutritional assessment (MNA), body mass index (BMI) and laboratory analysis for albumin (normal= 3.0-5.1 g/dL), prealbumin (normal= 0.2-0.4 g/L), transferrin and total protein, vitamin B₁₂ and folic acid, and serum iron were carried out to assess the nutritional status of patients. BMI was calculated by dividing body weight (kg) by height (m²).¹⁰ The MNA was calculated according to criteria stated before¹⁰ and was classified as good (24 >), medium (17-23.5) and poor (17 <). All procedures were carried out by three experienced dietitians.

The dental examination of patients was made by two dentists at bedside using a mobile light source. Patients were also asked to fill in the dental status section of the questionnaire set out in Table 1. Data related to the number of missing and available teeth, prosthesis usage, problems interfering

TABLE 1: Questionnaire used in the study.

A. Personal Data	
1. Name-surname	
2. Birth place & year	
3. Gender	
B. General Health Status	
4. Do you have any disease(s)?	
a. Yes	
b. No	
5. Do you use any drug(s)?	
a. Yes	
b. No	
C. Nutritional Information	
6. Do you have a prescribed diet?	
a. Yes	
b. No	
7. Are you complying with your diet?	
a. Yes	
b. No	
8. Biochemical measurements	
9. Body mass index	
D. Dental Status	
10. Is there any problem in your mouth that makes your chewing difficult?	
a. Yes	
b. No	
11. If the answer is yes to the question 10, which of the problems below?	
a. Bad restoration	i. Unhealed wound in mouth
b. Caries	j. Difficulty in the sense of taste
c. Missing teeth	k. Sound and pain on the temporomandibular joint
d. Toothache	l. Difficulty on swallowing
e. Sensitivity to cold and heat	m. Become tired during chewing
f. Difficulty on chewing	n. Eating speed
g. Fissures on lips	o. Prosthesis
h. Tongue ache	
12. Last dental visit	13. How frequently do you brush your teeth?
a. Never	a. Never
b. 1 month ago	b. 1/day
c. 1-6 months ago	c. 2/day
d. 6 months-1 year ago	d. 3 and +/day
e. 1-5 years ago	
f. Other	
14. Reason of dental visit	g. Missing teeth
a. Regular control	h. Gingival bleeding
b. Prosthetic rehabilitation	i. Scaling and root planing
c. Sensitivity to cold and heat	j. Orthodontic treatment
d. Restoration	k. Orofacial pain
e. Root canal treatment	
f. Tooth extraction	
15. Do you use mouth-rinse?	16. Do you use dental floss?
a. Yes	a. Yes
b. No	b. No
c. Sometimes	
17. How would you describe your oral health maintenance?	18. How would you describe your chewing function?
a. Good	a. Good
b. Average	b. Average
c. Poor	c. Poor

with chewing function, and tooth-brushing habits were recorded in a standard form. The number of available teeth and number of teeth with prosthesis were recorded separately. The total number of teeth was evaluated by the addition of the number of available teeth and number of missing teeth restored with prosthesis. Third molars were not included. The patients were classified into two categories as having more or less than 20 teeth (total number of teeth).

Data related to oral health and nutritional status of patients, were statistically analyzed using the Statistical Package for the Social Sciences (SPSS) V.11.5 (SPSS Inc. Chicago, IL, USA) on a personal computer. Cross-tabulations and chi-square statistics were computed. Statistical significance was assumed for $p < 0.05$.

RESULTS

The patients who self-evaluated their oral hygiene and their chewing function as good were 44.8% and 51%, respectively. In general, more women tended to self-evaluate their chewing function and oral hygiene as good than men did (58.8% and 53.8%, respectively). Nearly half of the patients evaluated their eating speed as slow. In addition, most of them brushed their teeth twice a day. None of them used dental floss and only a few used mouth rinses (9.7%). The last dental visits had mostly taken place in the last 1 to 5 years (28.3%). Dental habits and patients' self-evaluation of their dental status were presented in Table 2.

Diagnosis of the patients was as follows: goiter (9 patients), peptic ulcer or gastritis (33 patients), anemia (5 patients), osseous and joint disorders (3 patient), asthma (3 patients), hemorrhoids (2 patients), cardiac disorders (80 patients) and none (21 patients).

The prevalence of malnutrition was 62% (MNA), 50.3% (albumin) and 40% (prealbumin), respectively. No significant relationship was found between albumin, prealbumin, transferrin, total protein, vitamin B₁₂, folic acid and serum iron levels and the number of teeth and chewing func-

TABLE 2: Dental habits.

		n	%
Self evaluation of oral hygiene	Good	65	44.8
	Average	58	40
	Poor	22	15.2
Self evaluation of chewing function	Good	74	51
	Average	51	35.2
	Poor	20	13.8
Eating speed	Quick	44	30.3
	Average	42	29
	Slow	59	40.7
Last dental visit	Never	5	3.4
	1 month	13	9
	1-6 months	16	11
	6 months-1 year	22	15.2
	1-5 years	41	28.3
	Other	48	33.1
Tooth brushing frequency	Never	21	14.5
	1 per day	36	24.8
	2 per day	46	31.7
	3/+ per day	42	29
Dental floss use	Yes	0	0
	No	145	100
Oral rinse use	Yes	2	1.4
	No	131	90.3
	Sometimes	12	8.3

on. Results based on the laboratory analysis according to the number of teeth were presented in Table 3. Number of teeth was not affected by sex and BMI ($p > 0.05$). Chewing ability decreased with the number of missing teeth ($\chi^2 = 15.753$, $p = 0.001$). There was a significant relationship between MNA scores and the number of missing teeth ($\chi^2 = 6.231$, $p = 0.044$) (Table 4), which indicates a relationship between the number of teeth and malnutrition. Even in patients who scored their chewing function as good, 58.1% were malnourished or at risk of malnutrition when assessed with MNA; MNA assessment revealed that 40% of patients who scored their chewing function as poor were moderately malnourished. Patients who were assessed as malnourished with MNA scores had also low levels of albumin and prealbumin, respectively ($\chi^2 = 10.856$, $p = 0.004$ and $\chi^2 = 8.653$, $p = 0.013$) (Table 5).

TABLE 3: Laboratory analysis according to the number of teeth.

		Number of Teeth				χ^2	p
		0-19 Teeth		20/+ Teeth			
		n	%	n	%		
Albumin	Low	33	50	40	50.6	0.006	0.939
	Normal	33	50	39	49.4		
Prealbumin	Low	25	37.9	33	41.8	0.227	0.634
	Normal	41	62.1	46	58.2		
Transferrin	Low	4	6.1	10	12.7	1.794	0.180
	Normal	62	93.9	69	87.3		
Total protein	Low	34	51.5	44	55.7	0.253	0.615
	Normal	32	48.5	35	44.3		
Vit B ₁₂	Low	2	3	8	10.1	2.82	0.093
	Normal	64	97	71	89.9		
Folic Acid	Low	0	0	0	0		
	Normal	66	100	79	100		
Serum iron	Low	21	31.8	20	25.3	0.75	0.387
	Normal	45	68.2	59	74.7		

TABLE 4: Sex, MNA and chewing ability distribution of the patients according to the number of teeth.

		Number of Missing Teeth				χ^2	p
		0-19 Teeth		20/+ Teeth			
		n	%	n	%		
Sex	Men	32	48.5	33	41.8	0.655	0.418
	Women	34	51.5	46	58.2		
	Total	66	100	79	100		
MNA	Good	31	47	25	31.6	6.231	0.044
	Medium	30	45.5	38	48.1		
	Poor	5	7.6	16	20.3		
	Total	66	100	79	100		
Chewing Ability	Good	38	57.6	36	45.6	15.753	0.001
	Medium	17	25.8	34	43		
	Poor	11	16.7	9	11.4		
	Total	66	100	79	100		
BMI	Severe Malnutrition	3	4.5	6	7.6	1.086	0.780
	Moderate Malnutrition	10	15.2	15	19		
	Normal	35	53	39	49.4		
	Obese	18	27.3	19	24.1		
	Total	66	100	79	100		

MNA: Mini Nutritional Assessment, BMI: Body Mass Index.

DISCUSSION

Malnutrition is common among elderly populations throughout the world. Nutritional problems may result from changes associated with the aging

process itself, from disease or other conditions.¹¹ Malnutrition is a serious problem especially among people who are admitted to the hospital.¹² There are a couple of accepted methods for assessing nutritional status such as biochemical, dietary intake

TABLE 5: Albumin and prealbumin distribution according to MNA.

		MNA								χ^2	p
		Good		Medium		Poor		Total			
		n	%	n	%	n	%	n	%		
Albumin	Lower	20	27.4	37	50.7	16	21.9	73	100	10.856	0.004
	Normal	36	50	31	43.1	5	6.9	72	100		
Prealbumin	Lower	14	24.1	33	56.9	11	19	58	100	8.653	0.013
	Normal	42	48.3	35	40.2	10	11.5	87	100		

MNA: Mini Nutritional Assessment.

indicators, SGA and MNA.⁴ Many scales have been proposed for the brief nutritional assessment of older persons.¹³

The MNA is a clinical assessment tool for grading nutritional status and for evaluating the risk of malnutrition among elderly patients and contains composite measures of 18 nutritional related items.¹⁴ It is an overall evaluation method (score) of nutritional state including measures of anthropometry, evaluation of dietary intake and measure of nutritional biological markers.¹⁴ It is a practical, non-invasive, well-validated and cost effective instrument allowing for rapid nutritional evaluation of older persons^{10,13,15-17} and is recommended for early detection of malnutrition risk,¹⁷ with good levels of reliability⁵. The MNA scores were demonstrated to have both high sensitivity (98%) and specificity (96%).¹⁸

MNA was successfully used in the follow-up evaluation of outcome, nutritional intervention, nutritional education programs and physical intervention programs in elderly persons.¹⁷ SGA, on the other hand, has been suggested to be useless for early detection of malnutrition and to be impractical for follow-up and monitoring during nutritional support.¹⁰ Barone et al¹⁹ showed that MNA was a more appropriate nutritional assessment tool for older patients when compared to SGA. MNA was shown to be the first choice for geriatric hospital patients.²⁰ Therefore, in this study MNA was used for grading nutritional status of the patients.

Food selection may be influenced by a complex interaction of social, cultural and behavioral factors.²¹ It may also be affected by the ability of

biting and chewing. Especially in older people, this effect plays a more important role. Reportedly, older people state that their food selection is affected by the number of teeth, the number of occluding pairs they have and the presence of dentures.^{14,21} Older people with a reduced number of teeth have poor quality diet and nutrient intake.^{3,22} The importance of the dental status in relation to the ability of chewing certain food is even more important in institutionalized people.²¹ Among people with teeth, ease of eating was clearly influenced by the number of teeth present, with chewing becoming easier with a greater number of natural teeth. For almost all individuals with more than 20 teeth, the number of foods that could not be managed easily was low.² Chewing function and potentially food choice are affected by oral health, specifically by the number and distribution of natural teeth.²

Good oral health is essential to maintain the quality of life. Because the oral cavity is the gateway to the gastrointestinal system, its biological quality and functional circumstances affect nutrition. Elderly individuals who suffer from mouth pain, chewing and swallowing difficulties, poor dentition or dentures create a risk for developing nutritional problems.²³ Elderly dental patients can be at risk of poor nutrition for a variety of reasons including physiologic, oral, psychosocial, functional and medical factors. Oral impairments can affect diet and nutrition due to changes in the ability of taste, biting, chewing and swallowing foods. Oral health status, especially the number of teeth, affects the ability to eat. However, care must be given to the reality that dietary and nutritional factors al-

so play a role in the etiology of oral diseases that may cause tooth loss.¹¹

In the present study population, dental floss and oral rinse use was very rare and last dental visits mostly took place in the last 1-5 years. Although these findings were not satisfactory, 44.8% of the patients evaluated their oral hygiene as good. Also, 54.5% of the patients had 20/+ missing teeth and 45.6% of them evaluated their chewing function as good, with only 11.4% evaluating their chewing function as poor. Apparently, patients in our study did not care enough to improve their oral hygiene. It seemed that they could easily be satisfied with their oral hygiene and chewing function.

Studies have shown that dental status in older people is associated with perceived ability to eat certain foods. Eating ability and food choice are affected by oral health, specifically by the number of teeth.^{2,9} The loss of teeth with age impairs the masticatory function.²⁴ Decreased number of remaining teeth, edentulism, and poor masticatory function are associated with decreased nutrient intake.³ However, the function and position of the remaining teeth were reported to be a better indicator for chewing ability than the total number of present teeth.²⁵

Studies have shown that poor oral health is associated with limited dietary variety and lower nutrient intake.^{2,3,14} Although Sheiham and Steele² stated that it was difficult to establish a correlation between nutrient intake and the number and distribution of teeth, they also mentioned that people with more than 20 natural teeth consumed more of the nutrients than those with fewer teeth. Griep et al¹⁴ showed by using the MNA that the risk of malnutrition increased with the loss of natural teeth.

Sahyoun et al²⁵ found a positive association between the number of teeth, especially pairs of occlusal posterior teeth and the nutritional status of individuals. They stated that the number of posterior pairs of teeth were more strongly associated with nutritional status than the total number of posterior teeth.

The preservation of a healthy, natural and functioning dentition comprising not less than 20 teeth has been described as a goal for oral health by WHO.⁶ It has been shown that masticatory ability is sufficient with 20 or more "well-distributed" teeth,^{7,26} and elderly people with ≥ 20 teeth appear to have less physical problems than those with ≤ 19 teeth.²⁷ Therefore, we classified our patients as having more or less than 20 teeth.

Tooth loss, by itself, may not cause a nutritional problem, but impaired nutrient intake arises when teeth are not replaced or when denture fit and stability are inadequate.³ Oral status, which was classified according to teeth and prosthesis, was shown to be related to nutritional status. Poor oral status contributes to the higher risk of malnutrition.² Therefore, we counted the total teeth number as the number of teeth and the number of teeth with prosthesis together. In our study, as the number of missing teeth increased chewing ability seemed to decrease. MNA scores indicated a good nutritional state in patients with ≤ 19 missing teeth and a moderate or poor nutritional state in those with ≥ 20 . These results showed a significant relationship between MNA and the number of missing teeth.

MNA is a nutrition assessment tool for older patients.¹⁹ Our study included patients over 55 years of age because we planned to investigate whether MNA could be used for relatively younger age groups. However, no significant difference was found between the 55-64 years-age group and those over 65 ($p > 0.05$), probably due to the limited sample size of the study population. Studies with larger population size may demonstrate whether MNA can be used for relatively younger age groups.

Serum albumin and prealbumin did not correlate with MNA scores.^{4,5} As mentioned previously, serum albumin concentration is often considered a determinant of the nutritional status.²⁸ In our study, patients assessed as malnourished with MNA showed low levels of albumin and prealbumin.

The dentist's opinion for eating problems significantly correlated with lower MNA scores. Subjects with natural functioning dentition had also higher BMI scores in our study.²⁹ Marcenes et al³⁰

drew attention to patients with 20 or more functioning teeth who had an acceptable body mass index. However, they also mentioned that the association between the number of teeth and BMI was not linear. Our study did not show a significant correlation between the number of teeth and BMI ($p > 0.05$).

Preventive oral health care to maintain natural dentition throughout life and regular dental care to ensure adequate denture fit and function may decrease nutritional risk in elderly people. Dentists should give serious consideration to use implant-retained prosthesis, overdentures and others, not only for elderly patients but also for younger patients, to prevent nutritional risk later in life.³ Prevention of tooth loss is essential and dental health should be considered an integral component of nutritional assessment.²⁵

The present study has various limitations that need to be taken into account. First, the study should have been carried out in a larger sample size. Second, as mentioned previously,²⁵ the number of

occluding posterior teeth is much more important for chewing than the total number of teeth. In the present study, we counted the total number of teeth and teeth with prosthesis. However, despite these limitations, the present study provides valuable information.

Within the limitations of the present study, patients with 20 or more teeth (natural + artificial) were not malnourished and a significant correlation was found between the MNA score, the number of teeth and chewing function. However, further studies with larger sample sizes will be helpful to investigate the mechanism of the correlation between the number of teeth and malnutrition. We suggest MNA to be tested also for relatively younger age groups.

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REFERENCES

- Haider M, Haider SQ. Assessment of protein-calorie malnutrition. *Clin Chem* 1984;30(8):1286-99.
- Sheiham A, Steele J. Does the condition of the mouth and teeth affect the ability to eat certain foods, nutrient and dietary intake and nutritional status amongst older people? *Public Health Nutr* 2001;4(3):797-803.
- Marshall TA, Warren JJ, Hand JS, Xie XJ, Stumbo PJ. Oral health, nutrient intake and dietary quality in the very old. *J Am Dent Assoc* 2002;133(10):1369-79.
- Langkamp-Henken B, Hudgens J, Stechmiller JK, Herrlinger-Garcia KA. Mini nutritional assessment and screening scores are associated with nutritional indicators in elderly people with pressure ulcers. *J Am Diet Assoc* 2005;105(10):1590-6.
- Bleda MJ, Bolibar I, Parés R, Salvà A. Reliability of the mini nutritional assessment (MNA) in institutionalized elderly people. *J Nutr Health Aging* 2002;6(2):134-7.
- World Health Organization. A review of current recommendations for the organization and administration of community oral health services in Northern and Western Europe. Report of a WHO Workshop. Copenhagen: World Health Organization - Regional Office of Europe; 1982.
- Miyaura K, Matsuka Y, Morita M, Yamashita A, Watanabe T. Comparison of biting forces in different age and sex groups: a study of biting efficiency with mobile and non-mobile teeth. *J Oral Rehabil* 1999;26(3):223-7.
- Ettinger RL. Diet, nutrition, and masticatory ability in a group of elderly edentulous patients. *Aust Dent J* 1973;18(1):12-9.
- Sheiham A, Steele JG, Marcenes W, Lowe C, Finch S, Bates CJ, et al. The relationship among dental status, nutrient intake, and nutritional status in older people. *J Dent Res* 2001;80(2):408-13.
- Omran ML, Morley JE. Assessment of protein energy malnutrition in older persons, part I: History, examination, body composition, and screening tools. *Nutrition* 2000;16(1):50-63.
- Palmer CA. Gerodontology nutrition and dietary counseling for prosthodontic patients. *Dent Clin North Am* 2003;47(2):355-71.
- Walls AW, Steele JG, Sheiham A, Marcenes W, Moynihan PJ. Oral health and nutrition in older people. *J Public Health Dent* 2000;60(4):304-7.
- Delacorte RR, Moriguti JC, Matos FD, Pfrimer K, Marchini JS, Ferrioli E. Mini-nutritional assessment score and the risk for undernutrition in free-living older persons. *J Nutr Health Aging* 2004;8(6):531-4.
- Griep MI, Mets TF, Collys K, Ponjaert-Kristofersen I, Massart DL. Risk of malnutrition in retirement homes elderly persons measured by the "mini-nutritional assessment". *J Gerontol A Biol Sci Med Sci* 2000;55(2):M57-63.
- Soini H, Routasalo P, Lagström H. Characteristics of the Mini-Nutritional Assessment in elderly home-care patients. *Eur J Clin Nutr* 2004;58(1):64-70.
- Vellas B, Guigoz Y, Baumgartner M, Garry PJ, Lauque S, Albarede JL. Relationships between nutritional markers and the mini-nutritional assessment in 155 older persons. *J Am Geriatr Soc* 2000;48(10):1300-9.
- Guigoz Y, Lauque S, Vellas BJ. Identifying the elderly at risk for malnutrition. The Mini Nutritional Assessment. *Clin Geriatr Med* 2002;18(4):737-57.
- Guigoz Y, Vellas B, Garry PJ. Assessing the nutritional status of the elderly: The Mini Nutritional Assessment as part of the geriatric evaluation. *Nutr Rev* 1996;54(1 Pt 2):S59-65.

19. Barone L, Milosavljevic M, Gazibarich B. Assessing the older person: is the MNA a more appropriate nutritional assessment tool than the SGA? *J Nutr Health Aging* 2003;7(1):13-7.
20. Bauer JM, Vogl T, Wicklein S, Trögner J, Mühlberg W, Sieber CC. Comparison of the Mini Nutritional Assessment, Subjective Global Assessment, and Nutritional Risk Screening (NRS 2002) for nutritional screening and assessment in geriatric hospital patients. *Z Gerontol Geriatr* 2005;38(5):322-7.
21. Sheiham A, Steele JG, Marceles W, Finch S, Walls AW. The impact of oral health on stated ability to eat certain foods; findings from the National Diet and Nutrition Survey of Older People in Great Britain. *Gerodontology* 1999; 16(1):11-20.
22. Daly RM, Elsner RJ, Allen PF, Burke FM. Associations between self-reported dental status and diet. *J Oral Rehabil* 2003;30(10):964-70.
23. Saunders MJ. Nutrition and oral health in the elderly. *Dent Clin North Am* 1997;41(4):681-98.
24. Nakata M. Masticatory function and its effects on general health. *Int Dent J* 1998;48(6):540-8.
25. Sahyoun NR, Lin CL, Krall E. Nutritional status of the older adult is associated with dentition status. *J Am Diet Assoc* 2003;103(1):61-6.
26. Elias AC, Sheiham A. The relationship between satisfaction with mouth and number and position of teeth. *J Oral Rehabil* 1998; 25(9):649-61.
27. Akifusa S, Soh I, Ansai T, Hamasaki T, Takata Y, Yohida A, et al. Relationship of number of remaining teeth to health-related quality of life in community-dwelling elderly. *Gerodontology* 2005;22(2):91-7.
28. Pirlich M, Lochs H. Nutrition in the elderly. *Best Pract Res Clin Gastroenterol* 2001;15(6): 869-84.
29. Soini H, Routasalo P, Lauri S, Ainamo A. Oral and nutritional status in frail elderly. *Spec Care Dentist* 2003;23(6):209-15.
30. Marceles W, Steele JG, Sheiham A, Walls AW. The relationship between dental status, food selection, nutrient intake, nutritional status, and body mass index in older people. *Cad Saude Publica* 2003;19(3):809-16.