Influence of Dental Status on Nutritional Status of Geriatric Patients in a Convalescent and Rehabilitation Hospital

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Purpose: To investigate 6 dental statuses as risk factors for malnutrition in geriatric patients admitted to a convalescent and rehabilitation hospital. ***Materials and Methods:*** One hundred twenty (59 men and 61 women) geriatric patients admitted to a convalescent and rehabilitation hospital were recruited. Three biochemical and hematologic parameters (albumin, hemoglobin, and lymphocyte count) were used for analysis. Malnutrition was defined as Body Mass Index (BMI) below 18.5 and albumin level under 35 g/L. The number of natural or prosthetic teeth in the dentate patients, and the presence of one or both dentures in the edentate patients, were recorded. Risk factors associated with malnutrition were investigated, namely: *(1)* edentulism among all patients, *(2)* edentulism without a set of complete dentures among all patients, *(3)* edentulism without a set of complete dentures among the edentate patients, *(4)* decreased number (< 6) of occluding pairs of natural or prosthetic teeth among the dentate patients, *(5)* decreased number (< 5) of posterior occluding pairs of natural or prosthetic teeth among the dentate patients, and *(6)* absence of posterior occluding pairs of natural or prosthetic teeth among the dentate patients. One-way ANOVA and Bonferroni multiple comparisons were used to determine if significant differences in the anthropometric, biochemical, and hematologic parameters existed between the patients with different dental statuses. The odds ratio and significance of 6 dental statuses as risk factors of malnutrition were calculated ($P = .05$). ***Results:*** BMI, albumin, and hemoglobin levels of the malnourished patients were significantly lower than those of nourished patients ($P < .05$). Lymphocyte count was not significantly different between the 2 patient groups ($P > .05$). The status of edentate patients without a set of complete dentures compared with other edentate and dentate patients was the only independent risk factor ($P < .05$) in the 6 statuses studied. ***Conclusion:*** Primary healthcare workers caring for hospitalized geriatric patients should identify edentate patients without a set of complete dentures for the possibility of malnutrition. *Int J Prosthodont 2006;19:244–249.*

Protein energy malnutrition is not uncommon in hospitalized geriatric patients.[1–3] It is well documented that malnutrition increases the risk of mortality and adverse clinical events for hospitalized patients.[3] Furthermore, the Cochrane review on nutritional supplementation found that nutritional intervention could lead to improvement of anthropometric and biochemical measures and/or functional status[4] and positively impact certain clinical outcomes, such as decreasing the incidence of acquired hospital infections.[5]

Multiple factors influence the nutritional status of elderly patients in addition to medical condition. Examples of such factors are mental depression,[6–8] self care abilities,[9–11] and impaired cognitive function.[10–12] The extent to which tooth loss contributes to malnutrition has also received much attention. Concomitant with tooth loss is compromised masticatory function. Several studies documented that edentate or partially dentate in-

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Table 1 Methodology of Anthropometric Assessment

Parameter	Measurement unit/resolution	Methodology
Height	Nearest 1 cm	Converted from knee height.
Weight	0.1 kg	Wearing patient's uniform and without shoes standing on an upright scale (Detecto); for bed-bound or chair-bound patients, a chair scale (Detecto) was used.
Body Mass Index (BMI)[31]	Weight (kg)/squared height (m^2)	Normal range = 18.5–22.9; < 18.5 = underweight, > 23 = overweight.
Knee height[32,33]	Nearest 1 cm	Recorded at recumbent position with a knee-height caliper and converted to body height. For male body height: 2.24 × knee height + 51.16 For female body height: 2.46 × knee height – 0.12 × age + 46.11

dividuals favor softer food over tougher or more fibrous food such as vegetables and fruits.[13–16] Consequent to this shift in dietary pattern, it was observed that individuals with tooth loss consume inadequate levels of several key dietary elements such as vitamin A, vitamin C, calcium, and dietary fiber[14,17–22] but increased levels of cholesterol and calories obtained from fat.[15,18,19,23–27] Several other studies investigated the relationship between the dental and nutritional status of elderly patients.[28–30] Underweight as measured with Body Mass Index (BMI) was associated with fewer natural teeth in a group of older Thai people.[28] Institutionalized elderly edentulous individuals without dentures or with only one denture reported less pleasure with eating, consumed more mashed food, and had lower scores on Mini-Nutritional Assessment (MNA) compared to edentulous individuals with a pair of complete dentures.[29] In an oral health survey of adults 65 years or older, a general trend was found for better hematologic and biochemical measures of nutritional status, such as blood hemoglobin, plasma iron, and ascorbate among dentate individuals and individuals with the most natural teeth.[30] However, dental status as a risk factor for malnutrition in elderly hospitalized patients has not been studied.

Thus, the aims of the present study were to test the hypotheses that the risk of malnutrition is not increased by *(1)* edentulism among all patients, *(2)* edentulism without a set of complete dentures among all patients, *(3)* edentulism without a set of complete dentures among edentate patients, *(4)* decreased number (< 6) of occluding pairs of natural or prosthetic teeth among dentate patients, *(5)* decreased number (< 5) of posterior occluding pairs (PoPs) of natural or prosthetic teeth among dentate patients, and *(6)* absence of PoPs of natural or prosthetic teeth among dentate patients.

Materials and Methods

This cross-sectional study included patients at least 65 years old who were transferred to the geriatric wards of a convalescent and rehabilitation hospital, Tung Wah Eastern Hospital (TWEH), Hong Kong, between December 2002 and March 2003. These patients had previously been admitted into the medical wards of a general hospital, Pamela Youde Nethersole Eastern Hospital, Hong Kong, through its Accident and Emergency Department. Twelve patients admitted through the same channel in a pilot study conducted in August 2002 were also included. The application of the Chinese version of the MNA as a screening tool and the association of depressed mood, impaired cognitive functions, functional impairment, polypharmacy, residence before admission, or mobility as risk factors of malnutrition for this group of patients were reported elsewhere.[31]

Exclusion criteria of the present study included:

1. Patients admitted into the geriatric ward via specialist outpatient clinics or government outpatient clinics but not for convalescence or rehabilitation
2. Patients with amputated limbs because the normal range of BMI was not applicable
3. Patients with terminal cancer
4. Patients readmitted within the study period
5. Patients (or their relatives) unable or unwilling to give written informed consent
6. Patients suffering from severe contracture, which would not allow accurate measurement of body weight or knee height

Baseline demographic data, including age, sex, marital status, smoking status, alcohol consumption, and education levels of the patients, were obtained upon admission to the ward. Anthropometric parameters were recorded as outlined in Table 1.[32–34] Routine blood tests including complete blood pictures with differential counts and liver and renal function tests were taken within 1 day after admission into TWEH as part of the standard hospital care. Three biochemical and hematologic parameters—albumin (g/L), hemoglobin (g/dL), and lymphocyte count (10^9/L)—were used for analysis. Malnutrition was defined as BMI below 18.5 kg/m^2 for

Table 2 Baseline Demographic Data of Patients

Demographic data	No. (%)
Age (y)	
60–69	9 (8%)
70–79	46 (38%)
≥ 80	65 (54%)
Gender	
Female	61 (51%)
Male	59 (49%)
Marital status	
Single	4 (3%)
Married	52 (44%)
Widowed	63 (53%)
Smoking status	
Nonsmoker	59 (49%)
Former smoker	46 (38%)
Current smoker	15 (13%)
Alcohol consumption	
Nondrinker	79 (66%)
Former drinker	10 (8%)
Social drinker	29 (24%)
Chronic drinker	2 (2%)
Education level	
Illiterate	54 (45%)
Primary	47 (39%)
Secondary	14 (12%)
Tertiary	5 (4%)

both genders (normal range: 18.5 to 22.9) and albumin level under 35 g/L (normal range: 35 to 50 g/L).[35] Six risk factors in association with malnutrition were investigated: *(1)* edentulism among all patients, ie, edentate patients with or without dentures were compared to dentate patients with or without dentures; *(2)* edentulism without a set of complete dentures among all patients, ie, edentate patients without a set of complete dentures were compared to both edentate patients with dentures and dentate patients; *(3)* edentulism without a set of complete dentures among edentate patients, ie, edentate patients without a set of complete dentures were compared to edentate patients with both dentures; *(4)* decreased number (< 6) of occluding pairs of natural or prosthetic teeth among dentate patients, ie, dentate patients with fewer than 6 occluding pairs of natural or prosthetic teeth were compared to dentate patients with 6 or more occluding pairs of natural or prosthetic teeth; *(5)* decreased number (< 5) of PoPs of natural or prosthetic teeth among dentate patients, ie, dentate patients with 4 or fewer PoPs of natural or prosthetic teeth were compared to those with 5 or more PoPs of natural or prosthetic teeth; and *(6)* absence of PoPs of natural or prosthetic teeth among dentate patients, ie, dentate patients with no PoPs of natural or prosthetic teeth were compared to dentate patients with 1 or more PoPs of natural or prosthetic teeth.

All data were collected by a single investigator within 48 hours after patient admission. Written consent was obtained from patients or their relatives. The research protocol was approved by the Ethics and Research Committee of the Tung Wah group of hospitals. Patients who presented with BMI below 18.5 or albumin level under 35 g/L were referred to dietitians for dietary counseling. Conversely, overweight patients were advised to lose weight.

Data were analyzed using the Statistical Package for the Social Sciences (SPSS, Version 11.5). Student *t* tests were used to compare the anthropometric, biochemical, and hematologic parameters of malnourished and nourished subjects ($P = .05$). One-way analysis of variance (ANOVA) and Bonferroni multiple comparisons were used to determine whether significant differences existed between the anthropometric, biochemical, and hematologic parameters of patients with different dental statuses. Analyses of the dentate patients according to the total number of occluding pairs of teeth and number of occluding posterior teeth were performed separately. The dichotomous distributions of dental status as risk factors between the malnourished and nourished subjects were subjected to risk estimation and reported as the odds ratio with a confidence interval at 95%. For any dental status identified as a risk factor, multivariate analysis was performed with age and gender to determine whether these 2 independent variables might contribute to the findings.

Results

Within the study period, 108 patients gave informed consent to participate in the study. Together with 12 more subjects from a pilot study, the total number of patients was 120 (59 men and 61 women). The length of stay of patients in the medical ward before transfer to TWEH was 4.2 ± 3.7 days (mean ± SD). The overall mean age was 80.3 (SD = 7.4) while the women, on average, were older than the men (81.8 ± 7.9 versus 78.7 ± 6.5) but the difference was not statistically significant ($P > .05$). Approximately a quarter of the patients were residing in old-age homes, and a majority of institutionalized residents (20 of 31) were aged 80 or above. Other demographic data are summarized in Table 2.

According to BMI (< 18.5 kg/m^2) and albumin level (< 35 g/L), the prevalence rate of malnutrition in this study was 16.7%. BMI, albumin, and hemoglobin levels of the malnourished patients were significantly lower than those of nourished patients ($P < .05$). Lymphocyte counts were not significantly different between the 2 patient groups ($P > .05$) (Table 3).

Comparison of the anthropometric, biochemical, and hematologic parameters between patients of different dental status showed that there were no significant differences in albumin level, hemoglobin level, and lymphocyte count among the patient groups ($P >$

.05) (Tables 4 and 5). A significant difference existed between age and BMI among the patient groups ($P <$ .05) (Tables 4 and 5). For example, edentate patients without a set of complete dentures were significantly older and had significantly lower BMI than dentate patients with 6 or more occluding pairs of natural or prosthetic teeth, or those dentate patients with 1 or more PoPs (natural or prosthetic).

The dichotomous distributions of dental status as risk factors between the malnourished and nourished subjects are shown in Table 6. Among the 6 dental statuses studied, only the status of edentate patients without a set of complete dentures among all patients emerged as an independent risk factor ($P <$ .05). Among the edentate patients without a set of complete dentures (n = 35), 1 patient wore only a single maxillary denture. To determine whether age and gender were confounding factors of malnutrition, the status of malnutrition (BMI $<$ 18.5 kg/m^2 and albumin level $<$ 35 g/L) was used as the dependent variable, and 3 independent variables—age (below 75 versus 75 and above), gender (male versus female), and dental status (edentate patients without a set of complete dentures versus others)—were selected for multivariate statistical analysis using logistic regression. The categorization of the 3 independent variables was based on the results of preliminary analyses, which showed that showed classification of variables had the greatest impact on the outcome. The isolation of variable(s) with significant impact on malnutrition was done according to a process of forward stepwise selection of significant variable (Wald) ($P <$ .05) using SPSS. The result showed that edentate patients without a set of complete dentures were a significant variable ($P =$ .025), while age ($P =$ .056) and gender ($P =$ 0.369) were not.

Discussion

Using a combined criterion of BMI ($<$ 18.5 kg/m^2) and albumin level ($<$ 35 g/L), the prevalence of malnutrition of hospitalized patients in this study was 16.7%. This value is comparable to previous reports of simi-

Table 3 Comparisons of Anthropometric, Biochemical, and Hematologic Parameters Between Malnourished and Nourished Patients (Means and SDs)

Parameter	Malnourished (n = 20)	Nourished (n = 100)	*P*
Anthropometric			
Age (y)	86.2 ± 7.0	79.1 ± 6.9	.0001
BMI (kg/m^2)	16.4 ± 1.5	23.0 ± 3.9	.0001
Biochemical and hematologic			
Albumin (g/L)	28.0 ± 4.0	36.0 ± 5.0	.0001
Hemoglobin (g/dL)	10.5 ± 1.4	11.8 ± 1.9	.0031
Lymphocyte ($\times 10^9$/L)	1.3 ± 0.5	1.5 ± 0.8	.1490

Table 4 Comparisons of Anthropometric, Biochemical, and Hematologic Parameters Between Patients of Different Dental Status: Analysis According to Total No. of Occluding Pairs of Teeth (Means and SDs)

Parameters	Edentate patients without a set of complete dentures (n = 35)	Edentate patients with both dentures (n = 20)	Dentate patients with $<$ 6 occluding pairs of natural or prosthetic teeth (n = 22)	Dentate patients with 6 ≥ occluding pairs of natural or prosthetic teeth (n = 43)	*P*
Age (y)	84.89 ± 7.02[a]	80.10 ± 4.59	79.05 ± 8.04[a]	77.21 ± 6.63[a]	$<$ .0001
BMI (kg/m^2)	20.31 ± 3.91[b]	20.14 ± 3.19[c]	20.97 ± 3.23[d]	24.37 ± 4.72[b,c,d]	$<$ .0001
Albumin (g/L)	32.86 ± 4.88	34.40 ± 5.39	34.00 ± 5.79	35.79 ± 6.03	.146
Hemoglobin (g/dL)	11.40 ± 1.85	11.45 ± 1.46	11.47 ± 2.33	11.88 ± 1.85	.668
Lymphocyte ($\times 10^9$/L)	1.40 ± 0.66	1.45 ± 0.82	1.48 ± 0.86	1.58 ± 0.71	.765

[a,b,c,d]Bonferroni multiple comparison, $P <$ .05.

Table 5 Comparisons of Anthropometric, Biochemical, and Hematologic Parameters Between Patients of Different Dental Status: Analysis According to No. of Occluding Pairs of Posterior Teeth (Means and SDs)

Parameters	Edentate patients without a set of complete dentures (n = 35)	Edentate patients with both dentures (n = 20)	Dentate patients with $<$ 6 occluding pairs of natural or prosthetic teeth (n = 22)	Dentate patients with 6 ≥ occluding pairs of natural or prosthetic teeth (n = 43)	*P*
Age (y)	84.89 ± 7.02[a]	80.10 ± 4.59	81.47 ± 7.81	76.74 ± 6.61[a]	$<$ .0001
BMI (kg/m^2)	20.31 ± 3.91[b]	20.14 ± 3.19[c]	20.76 ± 2.37	23.95 ± 4.79[b,c]	$<$ .0001
Albumin (g/L)	32.86 ± 4.88	34.40 ± 5.39	33.87 ± 3.78	35.58 ± 6.46	.174
Hemoglobin (g/dL)	11.40 ± 1.85	11.45 ± 1.46	11.27 ± 2.39	11.88 ± 1.90	.554
Lymphocyte ($\times 10^9$/L)	1.40 ± 0.66	1.45 ± 0.82	1.21 ± 0.61	1.65 ± 0.77	.173

[a,b,c,d]Bonferroni multiple comparison, $P <$ .05.

Table 6 Dichotomous Distribution of Dental Status as Risk Factors in Malnourished and Nourished Subjects

Potential risk factor	Distribution of risk factor		Odds ratio (95% CI)	Fisher exact test
	No. of malnourished patients	No. of nourished patients		
Edentate patients with or without dentures	13	42	2.56 (0.94–6.99)	0.085
Dentate patients with or without dentures	7	58		
Edentate patients without a set of complete dentures	10	25	3.00 (1.12–8.06)	0.033*
Edentate patients with both dentures and all dentate patients	10	75		
Edentate patients without a set of complete dentures	10	25	2.27 (0.54–9.43)	0.333
Edentate patients with both dentures	3	17		
Dentate patients with < 6 occluding pairs of natural or prosthetic teeth	2	20	0.76 (0.14–4.27)	1.000
Dentate patients with ≥ 6 occluding pairs of natural or prosthetic teeth	5	38		
Dentate patients with ≥ 4 PoPs of natural or prosthetic teeth	5	35	1.64 (0.29–9.17)	0.70
Dentate patients with ≤ 5 PoPs of natural or prosthetic teeth	2	23		
Dentate patients with no PoPs of natural or prosthetic teeth	2	13	1.39 (0.24–8.00)	0.658
Dentate patients with ≤ 1 PoPs of natural or prosthetic teeth	5	45		

*Statistical significant difference between the malnourished and nourished subjects in the parameter ($P < .05$).

lar patients in this geographic region, wherein the prevalence of malnutrition in institutionalized elderly individuals was 21.6%[12] and that for hospitalized patients was 14.7%.[36]

The present study tested 6 dental statuses as risk factors for malnutrition. Edentulism without a set of complete dentures among all patients emerged as an independent risk factor. Thus, the hypothesis that the risk of malnutrition is not increased by this dental status was rejected and the hypotheses that that the risk of malnutrition is not increased by the other 5 dental statuses were accepted.

Edentulism with or without denture treatment was not found to be a significant risk factor for malnutrition ($P = .085$, n = 120; statistical power > 80%). Taking into consideration the borderline insignificant level and previous findings of poor nutritional status associated with the elderly and institutionalized edentate patients in particular,[29,30,37] one should not disregard edentulism as a potential predictor for malnutrition in hospitalized patients. Although edentate patients without a set of complete dentures were not at significant nutritional risk compared with edentate patients with both dentures ($P = .333$), these patients were at a 3-fold significant risk of malnutrition (odds ratio = 3, $P = .033$) when compared with other patients studied (Table 6). Thus, it is important for primary health care workers to identify edentate patients without a complete set of dentures. These are patients with poor masticatory function and a particular risk of malnutrition. Appropriate measures should be undertaken to assess and improve, if necessary, such patients' nutritional status.

The present study showed that dentate patients with fewer than 6 occluding pairs of natural or prosthetic teeth were not at significant nutritional risk when compared with their dentate counterparts with 6 or more occluding pairs of teeth. The result is different in comparison to that of 324 institutionalized frail older adults in Sweden (mean age 85) in which dentate patients with fewer than 6 occluding pairs of teeth had significantly lower serum albumin.[37] Although the odds ratio of this particular risk was not reported, the authors found that this risk factor presented a significant risk to the cohort when there were more than 3 retained roots and at least 1 tooth with vertical mobility.[37] The difference in results may be explained by a younger (mean age = 80) or less frail cohort in the present study.

It has been commented that in the context of the nutritional status of patients with compromised dentition, the number of occluding pairs of posterior teeth could be a better indication of chewing ability than the total number of teeth.[38] It was also reported that those with 5 to 8 PoPs had a better Healthy Eating Index score compared to those with 4 or fewer PoPs or full dentures.[38] Despite the association between poor nutrition and a fewer number of PoPs, the present study did not show the absence of PoPs of natural or prosthetic teeth as a risk factor for malnutrition (Table 6).

Conclusion

Edentulism without a set of complete dentures among the subjects studied emerged as an independent risk factor. However, such dental status was not a significant nutritional risk factor among the edentate

patients. Edentulism with or without denture treatment was on the borderline but not found to be a significant risk factor of malnutrition. The conditions of fewer than 6 occluding pairs of teeth and absence of PoPs of teeth were not significant risk for malnutrition. Primary healthcare workers caring for hospitalized geriatric patients should identify edentate patients without a set of complete dentures for the possibility of malnutrition.

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