J Nutr Health Aging. 2019;23(10):973-978

BURDEN OF PREMORBID CONSUMPTION OF TEXTURE MODIFIED DIETS IN DAILY LIFE ON NUTRITIONAL STATUS AND OUTCOMES OF HOSPITALIZATION

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Abstract: *Objectives:* Due to the water-rich cooking process required to soften texture modified diets (TMDs), TMDs may have poorer nutrition. The aim of this study was to investigate the associations between daily premorbid TMD consumption and nutritional status at the time of hospitalization, and its burden on hospitalization outcomes. *Design:* Retrospective observational study. *Setting:* An academic hospital. *Participants:* The cohort comprised 3,594 older adult patients aged ≥65 years admitted to the hospital. *Measurements:* Patients were interviewed on admission using a premorbid daily consumption meal form to determine whether the patient ate a TMD. Nutritional status was examined using nutritional screening tools (Mini-Nutritional Assessment Short Form [MNA-SF], Malnutrition Universal Screening Tool [MUST], Geriatric Nutritional Risk Index [GNRI]) and the European Society of Clinical Nutrition and Metabolism (ESPEN)-defined criteria of malnutrition at admission. Length of hospital stay (LOS) and in-hospital mortality were considered outcomes of hospitalization. Multivariate analyses were performed to detect associations between premorbid TMD consumption and nutritional status and outcomes. *Results:* The mean age of the subjects was 75.9±7.0 years, including 58% males. Overall, 110 (3.1%) patients consuming a premorbid TMD were identified. They were older ($p<0.001$), had poor nutritional status (lower MNA-SF score [$p<0.001$] and GNRI value [$p<0.001$], higher MUST score [$p<0.001$], and more prevalent ESPEN-defined malnutrition [61.8% vs. 14.0%, $p<0.001$] than did patients without a TMD. The mortality rate and LOS of patients with TMD was higher (7.3% vs. 2.9%, $p=0.017$) and longer (19 days vs. 8 days, $p<0.001$) than those without TMD. Multivariate analyses showed that TMD consumption was independently associated with poor nutritional status and prolonged LOS after adjusting confounders. *Conclusion:* Daily consumption of a TMD during the premorbid period affects nutritional status at the time of hospitalization and outcomes. Further studies are necessary to investigate whether nutritional intervention can improve outcomes for people on a TMD.

Key words: Older adults, malnutrition, swallowing difficulty, texture modified food.

Abbreviations: CCI: Charlson Comorbidity Index; DRM: disease-related malnutrition; ESPEN: European Society of Clinical Nutrition and Metabolism; FFMI: fat-free mass index; GNRI: Geriatric Nutritional Risk Index; MNA-SF: Mini-Nutritional Assessment Short Form; LOS: length of stay; MUST: Malnutrition Universal Screening Tool; TMD: texture modified diet.

Introduction

In the field of geriatrics and gerontology, malnutrition in older adults is being actively investigated. Hospitalized malnourished older patients are predicted to have worse outcomes, such as mortality (1), prolonged hospital stay (2), decline of activities of daily living (3), and poor quality of life (4). Causes of malnutrition vary with disease-related malnutrition (DRM) with/without inflammation and non-DRM (5). Undernutrition is recognized as one condition of non-DRM and swallowing difficulty is one condition associated with DRM without inflammation. Therefore, older people with swallowing difficulties may be undernourished, presenting with reduced food intake due to swallowing problem. Sarcopenia, known as a systematic decline of skeletal muscle mass and strength, is also driven by undernutrition (6) and is an important factor for the diagnosis of malnutrition (7). Furthermore, based on recent studies, advanced sarcopenia can be considered as a cause of swallowing difficulty, named sarcopenic dysphagia (8–10). Therefore, when it comes to geriatric malnutrition, undernutrition, sarcopenia, and swallowing difficulty are interactively associated with each other.

A texture modified diet (TMD) is a daily meal form for people with swallowing difficulty, and daily consumption of a TMD indicates the presence of some degree of an eating/swallowing problem. To soften the food, a TMD is generally cooked with a relatively large amount of water, which may result in a low density of nutrition per volume. Our previous

Received May 23, 2019
Accepted for publication June 4, 2019
Published online August 5, 2019, http://dx.doi.org/10.1007/s12603-019-1237-3

study revealed that a TMD contained a relatively poor amount of nutrients, and older inpatients consuming TMDs could not eat all food served during the meal time (11). Subsequently, patients on a TMD showed lower nutritional intake than patients with a regular diet in the study. Furthermore, patients on a TMD showed less skeletal muscle mass than those without a TMD (11). However, little is known about the association between TMD consumption and malnutrition and the burden of a TMD on following medical treatment. The present study aimed to investigate whether daily consumption of a TMD could be related to malnutrition at the time of hospitalization and its influence on outcomes during hospitalization at an acute hospital.

Materials and Methods

Participants

The present retrospective, observational study examined consecutive patients aged ≥65 years who were admitted to, and discharged from, an academic hospital between December 2017 and March 2018. The 900-bed hospital provides acute medical care as a university hospital. Routine nutritional screening is performed on admission by trained nurses using validated screening tools (12). In this study, patients who answered to be restricted to ingest meal orally by home doctor before the onset of the acute disease which resulted in hospitalization were excluded. Patients who did not undergo nutritional screening were also excluded. The study was approved by the ethics committee of the hospital (approval ID: 2018-H177). Since this study was retrospective, we could not obtain written informed consent prior to the study; therefore, the ethics committee approved the waiving of written informed consent, alternatively, an opt-out procedure was conducted to give all patients an opportunity to remove themselves from the study by informing patients of the study protocol on the hospital homepage.

Texture modified diet

All patients or their guardians were interviewed by trained nurses regarding daily, usual, and premorbid texture of food on the day of admission to the hospital. Usually, nurses asked whether patients eat normal, soft, minced, puree, or liquidized rice for the main source of carbohydrates, and normal, soft, minced, puree, or liquidized other food. In the study, minced, puree, or liquidized rice and food consumption was considered as a TMD, because dysphagia would be prevalent among patients eating modified textures of food (13). We classified patients into two groups, the TMD group and the regular diet group, based on the definition of a TMD described above.

To verify the study, we also adapted another criterion to classify patients by diet texture in the secondary analyses. We divided patients into two groups: the regular texture of rice and food group and the non-regular diet group, which included soft texture in addition to TMDs.

Nutritional variables

The nutritional status of all analyzed patients was evaluated using three validated nutritional screening tools and malnutrition was assessed using diagnosing criteria (14) defined by the European Society of Clinical Nutrition and Metabolism (ESPEN). The Mini Nutritional Assessment-Short Form (MNA-SF) (15) consists of an ordinal scale with values ranging from 0-14 points after evaluating six subitems. Scores of 0–7, 8–11, and 12–14 represent malnourished, at risk of malnutrition, and intact of nutrition, respectively. The Malnutrition Universal Screening Tool (MUST) (16) also consists of an ordinal scale ranging from 0–6 points after evaluating three categories. Scores of 2 or more, 1, and 0 represent severe, moderate, and little risk of malnutrition, respectively. The Geriatric Nutritional Risk Index (GNRI) (17) is calculated using actual body height and weight, estimated ideal body weight, and serum albumin concentration. In this study, the ideal body weight was estimated based on the Lorentz formula. Diagnosis based on ESPEN-defined malnutrition requires a two-step evaluation (14). First, a validated nutritional screening tool should be applied. We used the MNA-SF as a screening tool, and patients with MNA-SF score ≤11 were considered at risk of malnutrition using the ESPEN-defined malnutrition criteria in the study. Eventually, using the ESPEN-defined malnutrition, we also assessed information on body mass index (BMI), decline of body weight during the last 6 months, and fat-free mass index in screened patients. BMI was calculated with actual body weight divided by height [m] squared. Fat-free mass was calculated using reported formulas (18). Fat-free mass index (FFMI) was consequently estimated using the mass [kg] divided by squared height [m2].

Other variables

Disease information regarding hospitalization were obtained from the records of the International Classification of Diseases 10th Revision (ICD-10) from the medical chart of each patient, and diseases at admission were classified into categories based on ICD-10 codes. Furthermore, information of comorbidities was evaluated using the Charlson Comorbidity Index (CCI) based on the recorded ICD-10 codes on the medical charts. Survival status at discharge from the hospital and length of stay (LOS) [day] at the hospital were also collected from the medical chart. Further, mobility was assessed using three categories: 1) patient goes out, 2) patients able to get out of bed/chair, but does not go out, and 3) patient is bed/chair bound.

Statistical analyses

Categorical variables are expressed as the number of patients (percentage). Quantitative variables, including parametric and nonparametric values, are expressed as the mean ± standard deviation and median (interquartile range), respectively. Comparisons between groups were made using the chi-square test, Student's t-test, or Mann–Whitney U test in case of categorical, parametric, or non-parametric variables,

respectively. Multivariate linear regression analyses were performed to determine whether TMD consumption could be related to nutritional variables (MNA-SF, GNRI, and MUST). Multivariate logistic regression analyses were also performed to identify association between TMD consumption and ESPEN-defined malnutrition and between TMD consumption and in-hospital mortality. Covariates adjusted in the multivariable analyses were determined using a directed acyclic graph, resulting in the following covariates for multivariable analyses: age, sex, mobility, and CCI for nutritional variables, and those plus a nutritional variable and disease on admission for in-hospital mortality and length of hospital stay. P-values <0.05 were considered statistically significant. Statistical analyses were performed using SPSS 23.0 software (IBM Japan, Tokyo, Japan).

Results

The study examined the eligibility of 3,728 patients aged ≥65 years admitted to the hospital during the study period. One hundred thirty-four patients were excluded due to premorbid restricted daily oral intake (104 cases, 2.8%) and incomplete nutritional screening (30 cases, 0.8%). Finally, 3,594 patients with mean age of 75.9 years and 58% males, were analyzed in the study. Based on the ICD-10 codes for the reason for hospital admission, neoplasms (26.6%), circulatory diseases (21.2%), and digestive diseases (13.2%) were the major diseases for admission (Table 1). We identified 110 patients (3.1%) consuming a premorbid TMD daily in this cohort.

Table 1
Baseline characteristics of studied patients

	All (n=3,594)
Age, years	75.9±7.0
Sex, n (%)	
male	2,097 (58.3)
female	1,497 (41.7)
Premorbid consumption of texture modified diet, n (%)	
no	3,484 (96.9)
yes	110 (3.1)
Charlson Comorbidity Index, points	2 (0-3)

Table 2 shows the differences between the TMD and regular diet groups. Patients consuming a TMD for their premorbid daily meals were older (mean age: 81.1 years vs. 75.7 years, p<0.001), thinner (mean BMI: 19.0 kg/m2 vs. 22.4 kg/m^2, p<0.001), higher malnutrition risk (mean MNA-SF: 6.8 points vs. 11.6 points, p<0.001), and higher prevalence of malnutrition (ESPEN-defined malnutrition: 61.8% vs. 14.0%). Table 3 shows the results of multivariable analyses of different models on malnutrition. TMD consumption was associated with nutritional risk and malnutrition at admission after adjusting for confounders.

One hundred and eight patients died in the cohort. Mortality rate of the patients in the TMD group was higher than those in the regular diet group (7.3% vs. 2.9%, p=0.017). Moreover, in survival cases, LOS was longer in the TMD group than in the regular diet group (median days: 19 days vs. 8 days, p<0.001), whereas the LOS of patients who died did not differ between groups (median days: 11.5 vs. 9 days, p=0.737) (Table 4). Logistic regression analysis failed to detect an independent association between TMD consumption and mortality (adjusted odds ratio = 0.59, 95% confidence interval [CI] = 0.26–1.36, p=0.215). However, there was a positive relationship between premorbid TMD consumption and prolonged hospital stay in survival cases after adjusting for confounders (Table 5).

In the secondary analyses, 319 patients were included in the non-regular diet group. Consumption of a non-regular diet was associated with nutritional risk (for MNA-SF, coefficient = -1.73, 95% CI = -1.96 to -1.50, p<0.001; for GNRI, coefficient = -6.23, 95% CI = -7.40 to -5.06, p<0.001; for MUST, coefficient = 1.04, 95% CI = 0.91–1.18, p<0.001) and malnutrition at admission (adjusted odds ratio = 3.57, 95% CI = 2.72–4.68, p<0.001) after adjusting for confounders. This was similar to the results from the primary analyses. Furthermore, interpretation of the results from multivariate analyses for mortality (adjusted odds ratio = 0.94, 95% CI = 0.54–1.65, p=0.935) and LOS in survival cases (coefficient = 3.53, 95% CI = 2.05–5.02, p<0.001) was also similar to those of the primary analyses.

Discussion

We conducted a large size retrospective cohort study to determine the influence of daily TMD consumption prior to the onset of disease on nutritional status and outcomes during hospitalization in older patients. Two significant findings were identified in this study. One was that older people consuming a TMD during the premorbid period were likely to be diagnosed as malnourished at the time of hospital admission compared with older people consuming a regular diet. The other was that TMD consumption may negatively affect discharge from hospital.

The study showed that patients consuming a TMD during the premorbid period were malnourished at the time of hospital admission. To our knowledge, there are few studies reporting an association between TMDs and malnutrition at hospitalization. Malnutrition at admission is recognized as a significant predictor for poor outcomes, such as mortality (1, 19), extended LOS (2), and poor quality of life (4). A systematic review revealed that only usage of TMD would fail to improve nutritional status (20). Therefore, preventive nutritional care for older adults consuming TMDs would be necessary. Some favorable intervention strategies have been considered. Individually optimized TMDs for dysphagic patients might improve nutritional status. Zanini et al. reported

Table 2
Nutritional variables at hospitalization between groups

	TMD	Regular diet	p value
Age, years	81.1±8.7	75.7±6.9	<0.001
BMI, kg/m^2	19.0±3.8	22.4±3.5	<0.001
FFMI, kg/m^2			
male	16.3±1.7	17.9±1.5	<0.001
female	13.0±1.7	14.3±1.6	<0.001
MNA-SF, score	6.8±2.5	11.6±2.2	<0.001
MNA-SF, n (%)			<0.001
intact	1 (0.9)	2,040 (58.6)	
at risk	40 (36.4)	1,231 (35.3)	
malnutrition	69 (62.7)	213 (6.1)	
GNRI, score	79.0±11.3	94.4±10.7	<0.001
MUST score	2 [2-4]	0 [0-2]	<0.001
MUST, n (%)			<0.001
0 point	13 (11.8)	2,236 (64.2)	
1 point	3 (2.7)	343 (9.8)	
≥2 points	94 (85.5)	905 (26.0)	
ESPEN-defined malnutrition, n (%)			
no	42 (38.2)	2,997 (86.0)	<0.001
yes	68 (61.8)	487 (14.0)	
Reason for hospital admission			
Neoplasm	18 (16.4)	939 (27.0)	0.004
Circulatory diseases	17 (15.5)	745 (21.4)	
Digestive diseases	13 (11.8)	462 (13.3)	
Others	62 (56.4)	1,400 (40.2)	
Charlson Comorbidity Index, points	1 [0-3]	2 [0-3]	0.771
Mobility, n (%)			
Goes out	18 (16.4)	2,792 (80.1)	<0.001
Able to get out of bed/chair, but does not go out	26 (23.6)	437 (12.5)	
Bed/chair bound	66 (60.0)	255 (7.3)	

Abbreviations: TMD, texture modified diet; BMI, body mass index; FFMI, fat-free mass index; MNA-SF, Mini Nutritional Assessment Short Form; GNRI, Geriatric Nutritional Risk Index; MUST, Malnutrition Universal Screening Tool; ESPEN, European Society of Clinical Nutrition and Metabolism

the effectiveness of a personalized program focusing on the level of density, viscosity, texture, and particle size of TMDs on dysphagic older adults without nutritional supplementation in nursing homes (21). They found that there was almost 7% weight gain and improvement of other nutritional parameters during the 6-months intervention. Reyes-Torres et al. also reported that focusing greater attention to food texture could lead to an increase in nutritional intake, body weight, and hand-grip strength in a randomized controlled trial (22). Increasing the nutritional density of TMDs would be another possible intervention. A study among healthy adults reported that high density TMDs could increase nutritional intake without an influence on fullness, hunger, and desire to eat (23). However, high nutritional density of TMDs may result in a decline in taste (23). Another possible intervention is multimodal feeding care. We recently reported that a comprehensive approach to facilitating oral intake, using a 13-item assessment tool, could increase nutritional intake and body weight in older patients with disability (24). The tool focuses on medical, cognitive, swallowing, physical, and texture of food condition during periodic intervals and practitioners share the information routinely.

Table 3
Influence of TMD on nutritional variables in different models of multivariable analyses

Dependent variable	Coefficient	95% CI	Standardized error	p value
MNA-SF	-2.36	-2.73–-1.99	0.19	<0.001
GNRI	-7.36	-9.25–-5.47	0.96	<0.001
MUST	1.31	1.09–1.53	0.11	<0.001
	Adjusted odds ratio	95% CI	p value	
ESPEN-defined malnutrition	5.70	3.70–8.79	<0.001	

The values of TMD consumption are depicted as an explanatory variable against dependent variables; Abbreviations: TMD, texture modified diet; MNA-SF, Mini Nutritional Assessment Short Form; GNRI, Geriatric Nutritional Risk Index; MUST, Malnutrition Universal Screening Tool; ESPEN, European Society of Clinical Nutrition and Metabolism; CI, confidence interval

Table 4
Outcomes at discharge

	TMD	Regular diet	p value
Length of stay, days			
All	19 [9-29.75]	8 [3-15]	<0.001
Survival	19 [9-30.25]	8 [3-15]	<0.001
Dead	11.5 [3.25-22.5]	9 [2-20.5]	0.737
Mortality, n (%)			
Survival	102 (92.7)	3,384 (97.1)	0.017
Dead	8 (7.3)	100 (2.9)	

Abbreviation: TMD, texture modified diet

Table 5
Multivariable linear regression analysis for hospital stay of survival cases

Factors	Coefficient	95% CI	Standardized error	p value
Age	0.03	0.01–0.05	0.13	<0.001
Sex (male)	-0.50	-1.26–0.26	-0.02	0.197
Malnutrition	1.91	0.81–3.02	0.04	0.001
CCI	0.71	0.58–0.84	0.17	<0.001
Mobility (reference: goes out)				
Able to get out of bed/chair	5.66	4.49–6.83	0.12	<0.001
Bed/chair bound	7.96	6.50–9.42	0.13	<0.001
Reason for admission	abbreviated			
TMD	2.62	0.29–4.96	0.03	0.028

Abbreviations: CI, confidence interval; CCI, Charlson Comorbidity Index; TMD, texture modified diet

Premorbid daily TMD consumption was associated with prolonged LOS after adjusting for nutritional status. Dysphagic patients may have restricted oral intake during treatment of acute disease. Patients with aspiration pneumonia, which is a common infectious disease in dysphagic older adults, are often nil by mouth to avoid choking. Prolonged nil by mouth status is reported to lead to longer LOS than no restriction or early oral intake in aspiration pneumonia (25). Nil by mouth is also related to a risk of complications. Respiratory infection may occur due to nil by mouth during hospitalization (26). Lack of nutrition during hospitalization is likely associated with prolonged LOS. The fact that TMDs contain less nutrition

compared to regular food (11) implies that hospitalized patients consuming a TMD will consume less nutrition than those without a TMD. It was reported that the mean energy intake of all adult inpatients during hospitalization was 760 kcal/day (27). Older adults consuming a daily TMD are likely to be diagnosed with sarcopenia. Sarcopenic older adults have decreased strength of swallowing muscles (28) related to presbyphagia and sarcopenic dysphagia. Hospitalization will may lead to further deterioration of sarcopenic dysphagia as well as whole body sarcopenia (29) due to inactivity and undernutrition, and may interfere with patients discharge from hospital.

This study has some limitations. First, the study was conducted retrospectively and a causal relationship among premorbid TMD consumption and other variables are not warranted, although we adjusted for age, sex, and comorbidities in multivariable analyses. Second, the information about TMDs obtained from interviews might not be validated. TMD judgement should be performed using a validated scale such as the International Dysphagia Diet Standardisation Initiative framework (30).

In conclusion, the present study provided evidence that, in older patients admitted to hospital, consuming a TMD in daily life was associated with malnutrition during hospitalization and prolonged LOS. Fortifying TMDs and a multimodal approach to facilitate nutritional intake may be necessary to improve nutritional conditions and hospital outcomes in older adults consuming TMDs.

Acknowledgments: The authors thank all the collaborators from our nutrition support teams at Aichi Medical University Hospital for their clinical work. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Disclosure statement: Keisuke Maeda received a grant from the Japan Society for the Promotion of Science (grant number: 18K11142) outside the submitted work. Other authors have no conflicts of interests.

Ethical standards: The study was approved by the ethics committee of Aichi Medical University. This study complies with the Japanese ethical guidelines for epidemiological research.

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