Journal of Aging Research & Clinical Practice©
Volume 2, Number 1, 2013

CALF CIRCUMFERENCE AND BODY MASS INDEX ARE MORE USEFUL PREDICTORS OF HOSPITALIZATION THAN THE MINI NUTRITIONAL ASSESSMENT IN INSTITUTIONALIZED JAPANESE ELDERLY

C. Momoki[1], F. Hayashi[1], R. Tanaka[1], S. Miyata[1], Y. Hayashi[1], A. Otuka[2], M. Nakahira[2], K. Yamagishi[2], S. Hirata[2], S. Ohfuji[3], W. Fukushima[3], Y. Hirota[3], D. Habu[1]

Abstract: *Objective:* The objective of this study was to determine independent nutritional assessment factors affecting hospitalization due to deteriorating symptoms and to examine nutritional assessment when these factors were substituted for MNA in institutionalized elderly Japanese people. *Methods:* Eighty subjects (21 men and 59 women, 81.4±9.2 years) were enrolled. Multivariate logistic regression analysis was used to determine independent factors influencing hospitalization during a follow-up period of approximately 1 year. Associations between nutritional assessment using these factors, MNA and anthropometric variables, and dietary intakes were assessed. *Results:* Twenty-two subjects were hospitalized during the 1-year follow-up period. Body mass index (BMI) < 22kg/m^2 (OR=5.68, 95%CI 1.31-24.7), calf circumference (CC) < 29cm (OR=5.75, 95%CI 1.64-20.2), arm muscle area (AMA) ≤ 36cm^2 (OR=4.39, 95%CI 1.25-15.4), and arm muscle circumference (AMC) ≤ 21cm (OR=3.00, 95%CI 0.87-10.4) were associated with hospitalization in multivariate analysis. MNA was not associated with hospitalization (malnutrition group OR = 3.69; 95% CI 0.48–28.6). In CC and BMI groups, all anthropometric variables were significantly different such as MNA groups . In BMI groups, anthropometric variables without activities of daily living (ADL) were different. Cumulative hospitalization was only significantly different in 2 CC groups. *Conclusion:* These results show that CC and BMI are more useful predictors of hospitalization than MNA and are useful as independent nutritional assessment variables in this study.

Key words: Calf circumference, MNA, nutritional assessment, hospitalization, institutionalized elderly.

Introduction

In Japan, the aging rate reached 23.1% in 2010, and it is estimated to increase to 40.5% by 2055. The number of people requiring care (care levels 1–5) under the Long-term Care Insurance System was approximately 4.5 million in 2008 and continues to grow steadily. Thus, in order to control social security costs, maintenance of health and ability to engage in activities of daily living (ADL) are necessary for elderly people who require assistance.

Malnutrition is a serious problem in the elderly. It reduces ADL and the quality of life (QOL); additionally, it impairs immune function and prognosis (1-3). In acute care units and institutions, malnutrition prevalence is high (30%–60%) (4), necessitating early nutritional assessment and care.

The Mini Nutritional Assessment (MNA) (4) and short form (5) were created by Guigoz et al. There are widely used for the assessment of nutritional status of the elderly. MNA is a specific assessment sheet for elderly people, and reported that it can be used to evaluate the risk of malnutrition before the deterioration of albumin and body weight, reflecting the prognosis in foreign countries (6). However, its use in Japan is complicated; there is insufficient evidence regarding its useful for institutionalized elderly Japanese people (7-10). Therefore, we verified whether simple anthropometric variables are appropriate predictors and if they correlate with other nutritional indices in the institutionalized elderly.

The aim of this study was to determine the independent nutritional assessment factors affecting hospitalization due to deteriorating symptoms and to

1. Department of Medical nutrition, Graduate School of Life Science, Osaka City University, Osaka 558-8585, Japan; 2. Geriatric health services facilities Tachibana; 3. Department of Public Health, Graduate School of Medicine, Osaka City University, Osaka 545-8585, Japan

Corresponding Author: Chika Momoki, RD, Department of Medical nutrition, Graduate School of Life Science, Osaka City University, 3-3-138 Sugimoto, Sumiyoshi-ku, Osaka city, Osaka 558-8585, Japan, momoki@life.osaka-cu.ac.jp-, Telephone: +81-6-66052882, Fax: +81-6-66052882

Received August 23, 2012
Accepted for publication October 26, 2012

examine whether nutritional assessment using these factors is an appropriate substitute for MNA in institutionalized elderly Japanese people.

Subjects and Methods

Study Design and Subjects

This was a prospective cohort study at an institution in Osaka, Japan; it was carried out from September 2009 to December 2011, and 80 subjects were enrolled. The total number of residents is 99. As this study is an open cohort study, the participants were 36 (36.4%) in 2009, 37 (37.3%) in 2010, and 7 (7%) in 2011. The subjects or their family were asked to provide written informed consent. We included all subjects if the consent of their own or from their family was obtained, and if their attending physicians gave approval. We excluded subjects with severe dementia who were unable to communicate and those confined to bed. The study was conducted in accordance with the Declaration of Helsinki, and was approved by the ethics committee of Osaka City University.

Anthropometric Measurements

The lead author and a student in charge of this study conducted the measurements.

Body weight (BW) and height were obtained from medical records. BMI was calculated using the following formula: weight (kg)/height (m^2).

Mid-upper arm circumference (MAC) was measured with an Inser-tape (Abbott Japan, Tokyo, Japan). Tricipital skinfold thickness (TSF) was measured with an Adipometer (Abbott Japan). MAC and TSF were measured on the non-dominant arm midway between the tip of the acromion and the olecranon process. Calf circumference (CC) was measured with an Inser-tape on the thickest part of the calf, with subjects sitting with their knees flexed at a right angle. In subjects with paralyzed or disabled extremities, measurements were taken from the healthy extremity. Arm muscle circumference (AMC) and arm muscle area (AMA) were calculated using the following formula:

AMC (cm) =MAC (cm)-π × TSF (mm)/10

AMA (cm2) = (AMC [cm2])/4π

Functional Status and Comorbidities

Functional status was assessed with the Barthel index (score range 0-100) (11). Subjects' ability to perform independent ADL such as eating, body care, and mobility was measured. Score 100 was independence, score 0 was total disability.

Comorbidities were assessed using the Charlson comorbidity index (12). Subjects were evaluated by the acuity of disease, with higher scores indicating more severe comorbidity.

A care level based on the total estimated care minutes is assigned to each applicant under Long-Term Care Insurance system. Certification of long-term care need is classified into six levels (Assistance required, nursing care levels 1-5) by applying time representing time/effort for nursing care to appropriate criteria. Almost total care is required at nursing care level 3 and above.

Dietary Intake

Energy, protein, and water intakes were obtained from medical records. Energy and protein intakes were expressed as a percentage of requirements. Energy and protein requirements were calculated with the following formula:

Energy requirement = basal metabolism rates (using Harris-Benedict formula) × activity coefficient (1.3) × stress coefficient (1.0)

Protein requirement = nitrogenous equilibrium dose (0.85 g/[kg BW·day], using data from Dietary Reference Intakes for Japanese, 2010) × estimated coefficient (1.25) × usual body weight

Ideal body weight percentage (%IBW) was ≤80, with energy and protein requirements calculated for ideal body weight.

Nutritional Status

Nutritional status was assessed using MNA, BMI, and CC. The MNA includes 18 items divided into 4 assessments: anthropometric, global, dietetic, and subjective. The subjects were classified by MNA scores into 3 categories: malnutrition (<17), at risk (17–23.5), and well nourished (>24). BMI and CC were classified into 2 categories according to median: BMI<22 and ≥22, CC <29 and ≥29.

Statistical Analysis

For comparison between independent groups, ANOVA tests and two-way ANOVA tests were performed. Differences between variables were assessed using the $\chi 2$ test or Mantel-extension test. The value of acceptance for statistical significance was set at $P < .05$.

Univariate and multivariate logistic regression modeling were used to obtain crude and adjusted odds ratios (ORs) and 95% confidence intervals (95% CI) for associations between hospitalization due to deteriorating symptoms, anthropometric data, functional status, and dietary intake. Hospitalization defined as adverse event (event) in this study is the condition where the disease condition of the subject aggravated, the attending physician monitoring the health conditions of residents diagnosed that the subject would require to be hospitalized for treatment, and the subject was actually admitted to a medical institution. Other reasons (e.g., regular hospitalization for PEG device replacement) were excluded. The first day of admission to a hospital after enrolled in this study was defined as the day when an event called "hospitalization" occurred. For analysis, continuous variables were classified into 2 categories according to median . Charlson comorbidity index and care level were categorized into 2 groups by acuity. Energy (%) and protein (%) were categorized into 3 groups: insufficient intake, suitable intake, and excess intake. The following variables were included in multivariate regression model using the result of univariate ORs: sex, age, MNA, ADL, charlson comorbidity index, BMI, CC, AMA, AMC and %Energy. MNA, BMI, CC, AMA and AMC showed strong colleration, therefore, were not included in the same model.

Survival curves for hospitalization during the 1-year follow-up period were described using the Kaplan-Meier method. Follow-up started at first measurement and end at censoring. Censoring was hospitalization due to deteriorating symptoms. Statistical analysis was performed with SAS 9.1 software (SAS Institute Inc., Cary, NC, USA).

Results

The characteristics of the study subjects are shown in Table 1. The mean age (SD) of the subjects was 81.4 (9.2) years. On an average, the men were younger than the women (P < .0001) and had lower ADL levels. Care levels and charlson comorbidity index scores were higher among men. The major anamnesis was cerebrovascular disease (34 subjects, 42.5% of total).

Table 1
Characteristics of the study subjects

Characteristics		Male (n=21)	Female (n=59)	p value
Age(years)		74.1±6.5	84.0±8.7	<0.0001
Body weight(kg)		52.5±7.9	43.0±8.2	<0.0001
Body mass index(kg/m2)		20.6±2.9	20.5±3.7	0.918
Care levels	1	2(9.5%)	6(10.2%)	0.026
	2	1(4.8%)	18(30.5%)	
	3	6(28.6%)	14(23.7%)	
	4	6(28.6%)	16(27.1%)	
	5	6(28.6%)	5(8.5%)	
Charlson comorbidity index	0	0	8(13.6%)	0.024
	1	6(28.6%)	24(40.7%)	
	2	6(28.6%)	11(18.6%)	
	3	5(23.8%)	12(20.3%)	
	4	4(19.1%)	4(6.8%)	
MNA score(points)		18.4±2.9	19.9±3.3	0.073
Basic ADL(points)		41.4±25.3	63.3±22.2	0.0003

Data were expressed as n(%) or mean±SD.T-test for continuous variables and Mantel-extension test for categorical variables were performed.

Results of Logistic Regression Analysis

Among the 80 subjects, 22 were hospitalized due to deteriorating symptoms during the 1-year follow-up period. Table 2 shows the univariate and multivariate logistic regression analysis used to elucidate independent factors affecting hospitalization. Unadjusted univariate analysis suggested that 4 factors were significantly associated with hospitalization: BMI < 22, CC < 29, AMA ≤ 36, and AMC ≤ 21. Charlson comorbidity index and energy (%) were not significantly associated, however, included in multivariate analysis because these were basic and important variables in the field of nutrition. In the multivariate logistic regression analysis included for sex, age, basic ADL, charlson comorbidity index, BMI, and energy (%), BMI < 22 was associated with hospitalization (OR, 5.68; 95% CI, 1.31–24.7). The multivariate logistic regression analysis included for anthropometric variables (CC, AMA, and AMC) was significantly associated with hospitalization in univariate analysis. In the analysis included for CC, AMA, AMC as a substitute for BMI, odds ratios of CC (<29) was 5.75 (1.64–20.2), AMA (≤36) was 4.39 (1.25–15.4), and AMC(≤21) was 3.00 (0.87–10.4) (AMC data not shown). CC and AMA were associated with hospitalization as was BMI. In the analysis included for MNA (<17) as a substitute for anthropometric variables, odds ratio of the malnutrition group (<17) was 3.69 (0.48–28.6) and of the at-risk group (17–23.5) was 0.93 (0.15–5.80).

Association Between Nutritional Status Assessed by MNA, CC, BMI, and Other Variables

The association between nutritional status as assessed by MNA, CC, BMI, and other variables are shown in Table 3 (A, MNA; B, CC; C, BMI). For nutritional status assessed with MNA and CC, all variables were significantly different. For nutritional status assessed using BMI, anthropometric variables were significantly different in 2 groups without ADL.

Dietary Intake

The dietary intake results are shown in Table 4 (A, MNA; B, CC; C, BMI). Among the 80 subjects, 2 underwent percutaneous endoscopic gastrostomy. A small number of subjects had irregular intakes, but the energy and protein requirements were met, with intake levels at approximately 100% in all groups.

Association with Cumulative Hospitalization

Figure 1 shows Kaplan-Meier survival curves illustrating the association between MNA, CC, and BMI

Table 2
Odds ratios for hospitalization

		Total number	n(%)	Univariate Odds ratio (95%CI)	Multivariatea Odds ratio (95%CI)	Multivariateb Odds ratio (95%CI)	Multivariatec Odds ratio (95%CI)	Multivariated Odds ratio (95%CI)
sex	male	21	7(33)	1	1	1	1	1
	female	59	15(25)	0.68(0.23-2.01)	1.10(0.25-4.79)	0.65(0.16-2.60)	0.61(0.15-2.50)	0.49(0.12-2.04)
age(years)	≦85	52	14(27)	1	1	1	1	1
	86-100	28	8(28)	1.09(0.39-3.02)	0.91(0.26-3.15)	0.83(0.24-2.85)	0.65(0.17-2.50)	0.90(0.26-3.13)
Basic ADL(points)	50<	45	11(24)	1	1	1	1	1
	≦50	35	11(31)	1.42(0.53-3.80)	0.99(0.29-3.38)	1.10(0.33-3.65)	0.73(0.21-2.58)	0.97(0.29-3.24)
Charlson comorbidity index	0-2	55	18(33)	1	1	1	1	1
	3-4	25	4(16)	0.39(0.12-1.31)	0.510(0.13-1.96)	0.56(0.15-2.15)	0.49(0.13-1.90)	0.63(0.15-2.59)
Carelevel	1-2	27	7(26)	1				
	3-5	53	15(28)	1.13(0.40-3.22)				
MNA(points)	24≦	8	2(25)	1	1			
	17-23.5	54	11(20)	0.77(0.14-4.34)	0.93(0.15-5.80)			
	<17	18	9(50)	3.00(0.47-19.0)	3.69(0.48-28.6)			
					p for trend: p=0.09			
Body mass index(kg/m2)	22≦	28	3(11)	1		1		
	<22	52	19(37)	4.80(1.28-18.0)		5.68(1.31-24.7)		
Mid-arm circumference(cm)	23<	47	10(21)	1				
	≦23	33	12(36)	2.11(0.78-5.72)				
Triceps skinfold thickness(cm)	8<	40	9(23)	1				
	≦8	40	13(33)	1.66(0.61-4.48)				
Calf circumference(cm)	29≦	45	7(16)	1			1	
	<29	34	15(44)	4.29(1.50-12.3)			5.75(1.64-20.2)	
Arm muscle area(cm)2	36<	40	6(15)	1				1
	≦36	40	16(40)	3.78(1.29-11.1)				4.39(1.25-15.4)
Arm muscle circumference(cm)	21<	44	8(18)	1				
	≦21	36	14(39)	2.86(1.04-7.92)				
%Energy	<100	23	8(35)	2.40(0.60-9.56)	1.96(0.44-8.79)	2.79(0.60-12.9)	2.71(0.56-13.1)	2.23(0.48-10.3)
100-110	22	4(18)	1	1	1	1	1	
	110≦	34	10(29)	1.88(0.51-6.95)	1.52(0.34-6.88)	1.52(0.36-6.51)	1.88(0.40-8.83)	1.44(0.33-6.31)
%Protein	≦90	24	8(33)	1.83(0.53-6.33)				
	90-110	28	6(21)	1				
	110≦	27	8(30)	1.54(0.45-5.25)				

CI ; confidence interval.a Model included sex, age, MNA, basic ADL, charlson comorbidity index and %energy.b Model included sex, age, basic ADL, charlson comorbidity index, body mass index and %energy.c Model included sex, age, basic ADL, charlson comorbidity index, calf circumference and %energy.d Model included sex, age, basic ADL, charlson comorbidity index, arm muscle area and %energy.Hospitalization defined as adverse event (event) is the case where the disease conditionof the subject aggravated, the attending physician monitoring the health conditions ofresidents diagnosed that the subject would required to be hospitalized for treatment, andthe subject was actually admitted to a medical institution.

groups and hospitalization (A, MNA; B, CC; C, BMI). There were significant differences in the 2 CC groups, but not difference in the MNA and BMI groups.

Discussion

The results of this study suggest that CC, BMI, and AMA are more useful predictors for hospitalization than MNA in institutionalized elderly Japanese people. CC and BMI are useful as independent nutritional assessment variables in this study.

MNA is a widely used tool that accurately reflects prognosis. In this study, the malnutrition group showed relatively high cumulative hospitalization during the 1-year follow-up period, considering that MNA can predict the prognosis. However, multivariate logistic regression analysis showed CC, BMI, and AMA had higher odds ratios with hospitalization than MNA. These results indicate that CC, BMI, and AMA could be used as independent predictive factors for prognosis. As for reasons MNA did not predict the prognosis, nutritional assessment using MNA is associated with prognosis, however, it was considered it is because nutritional condition alone is not the factor for prognosis. Moreover, similarly to MNA, nutritional assessments using CC and BMI showed differences between the two groups, exhibiting the association between physical measurement index and food intake volume (Tables 3, 4). As for the reasons why the assessment using BMI did not show the association with ADL, it is considered that, unlike CC, BMI at baseline is not greatly associated with ADL in the elderly, similarly to the report of Izawa et al (13).

It has been reported that AC, AMA, TSF, and CC are predictive factors for mortality (14-17). CC is a particularly suitable marker of nutritional assessment as it reflects alteration of muscle mass (17). Moreover, it has been demonstrated through the process of development of MNA that CC and AC show a high correlation with whole-body skeletal muscle (18); CC is particularly closely correlated with degree of autonomy (such as gait motion) and shows great precision as an outcome predictor among elderly people (19). BMI is also very widely used for assessing nutritional status, and it has been demonstrated to accurately predict 1-year mortality (20). In our study, BMI was a strong predictive variable, but it is often difficult to measure height and weight in the elderly with impaired physical function. Additionally, it has been reported that BMI alone does not detect many

Table 3

Assosiation of the variables and nutritional status according to MNA score(3-A), CC value(3-B), BMI value(3-C)

A

Variables	Malnutrition MNAscore<17		At Risk 17≦MNAscore≦23.5		Well nourished MNAscore≧24	p value		
	Male(n=9)	Female(n=9)	Male(n=12)	Female(n=42)	Female(n=8)	MNAgroup	sex	MNAgroup*sex
Age(years)	76.1±6.6	89.3±7.8	72.7±6.2	82.4±8.2	86.5±10.2	0.087	<0.0001	0.440
Body weight(kg)	45.0±3.0	32.6±4.7	58.2±5.1	44.3±7.4	47.5±6.1	<0.0001	<0.0001	0.690
Body mass index(kg/m2)	17.9±1.3	15.8±1.5	22.3±2.0	20.9±3.3	23.5±2.1	<0.0001	0.015	0.780
MNA score(points)	15.5±0.6	15.1±2.3	20.6±1.7	19.9±1.8	25.5±1.2	<0.0001	0.175	0.780
Basic ADL(points)	27.8±17.3	48.9±25.1	51.7±26.0	67.1±20.5	59.4±22.7	0.0003	0.004	0.654
Mid-arm circumference(cm)	22.6±1.2	19.4±1.5	27.0±2.5	24.4±3.4	26.6±2.5	<0.0001	0.001	0.712
Triceps skinfold thickness(cm)	5.7±1.2	5.8±2.8	8.0±2.3	10.0±4.2	11.1±3.9	0.0003	0.144	0.368
Calf circumference(cm)	27.5±1.9	24.5±2.1	32.0±2.4	30.2±3.6	31.6±4.0	<0.0001	0.014	0.554
Arm muscle area(cm)2	33.9±3.3	24.1±2.9	47.5±9.1	36.0±8.4	42.1±7.1	<0.0001	<0.0001	0.694
Arm muscle circumference(cm)	20.8±1.0	17.5±1.12	4.5±2.3	21.3±2.5	23.1±2.0	<0.0001	<0.0001	0.986

B

Variables	CC<29		CC≧29		p value		
	Male(n=8)	Female(n=26)	Male(n=13)	Female(n=32)	CCgroup	sex	CCgroup*sex
Age(years)	78.1±6.2	87.8±7.1	71.7±5.4	80.5±8.4	<0.0001	<0.0001	0.806
Body weight(kg)	46.5±5.4	36.5±5.7	56.2±7.0	48.0±6.1	<0.0001	<0.0001	0.572
Body mass index(kg/m2)	18.1±1.7	18.0±2.7	22.1±2.3	22.3±3.2	<0.0001	0.859	0.864
MNA score(points	)15.8±1.2	18.2±3.5	20.1±2.3	21.2±2.5	<0.0001	0.023	0.359
Basic ADL(points)	24.4±15.0	57.5±23.5	51.9±24.9	68.3±20.5	0.007	<0.0001	0.145
Mid-arm circumference(cm)	22.6±1.7	21.2±2.	426.7±2.6	26.1±3.0	<0.0001	0.195	0.508
Triceps skinfold thickness(cm)	5.8±1.7	6.5±2.5	7.7±2.2	11.9±3.9	<0.0001	0.001	0.029
Calf circumference(cm)	26.9±1.5	26.2±2.2	32.0±2.1	32.2±3.2	<0.0001	0.764	0.550
Arm muscle area(cm)2	33.9±4.2	28.9±6.0	46.4±9.3	39.7±8.3	<0.0001	0.003	0.663
Arm muscle circumference(cm)	20.7±1.3	19.1±2.0	24.2±2.3	22.4±2.4	<0.0001	0.002	0.864

C

Variables	BMI<22		BMI≧22		p value		
	Male(n=12)	Female(n=40)	Male(n=9)	Female(n=19)	BMIgroup	sex	BMIgroup*sex
Age(years)	75.4±6.4	86.2±7.4	72.4±6.4	79.4±9.6	0.001	<0.0001	0.356
Body weight(kg)	47.4±5.3	38.7±6.1	59.3±5.1	51.9±3.5	<0.0001	<0.0001	0.666
Body mass index(kg/m2)	18.5±1.8	18.5±2.4	23.3±1.3	24.5±2.2	<0.0001	0.365	0.321
MNA score(points)	16.4±1.7	18.7±3.0	21.1±1.7	22.5±2.4	<0.0001	0.005	0.497
Basic ADL(points)	37.1±25.9	63.9±23.5	47.2±24.6	62.1±19.7	0.946	0.0004	0.327
Mid-arm circumference(cm)	23.3±1.7	22.0±2.6	27.5±2.7	28.1±1.7	<0.0001	0.343	0.115
Triceps skinfold thickness(cm)	6.0±1.8	7.5±2.7	8.3±2.1	13.7±3.8	<0.0001	<0.0001	0.010
Calf circumference(cm)	28.1±2.2	27.8±2.9	32.7±2.2	33.3±3.7	<0.0001	0.964	0.546
Arm muscle area(cm)2	36.1±5.2	30.4±6.5	49.1±9.8	44.6±5.6	<0.0001	0.003	0.740
Arm muscle circumference(cm)	21.4±1.5	19.6±2.1	24.9±2.5	23.8±1.5	<0.0001	0.003	0.501

Data were expressed as n(%) or mean±SD. Two Way ANOVA for continuous variables were performed.

patients who are at risk of malnutrition (6). In contrast, CC can be measured easily in bedridden elderly people and involves fewer inter-rater errors than TSF. Therefore, we consider CC to be a very useful factor for easily nutritional assessment regardless of functional autonomy in the elderly. However, it must be considered that CC measurement is more easily influenced by edema than upper limb measurement.

AMA was not such a strong predictor, but ≤36 cm^2 AMA was associated with hospitalization. AMA can be easily calculated using MAC and TSF, and it can be a useful variable in cases where CC measurement is difficult. Enoki et al have shown that AMA <23.5 $cm^2$was an independent risk factor for 2-year mortality compared to AMA ≥33.4 cm^2 (14). In our study, AMA was categorized into 2 groups by dichotomy because only a small number of subjects were recruited, and hospitalization due to deteriorating symptoms was considered as the outcome. Moreover, there was some inter-rater error in the TSF scores used for calculation of AMA. Therefore, we consider that AMA has a higher value than suggested by previous studies.

Charlson comorbidity index scores showed that higher scores indicate more severe comorbidity. However, higher comorbidity index scores showed lower odds ratio in the present study. These results indicate that institutionalized elderly have many chronic diseases, but can be kept in a stable state with suitable treatment. Therefore, the charlson comorbidity index was not associated with hospitalization in the multivariate analysis.

This study indicates that CC, BMI are more useful predictors for hospitalization than MNA. CC is a very useful factor for simple nutritional assessment regardless of functional autonomy. However, the CC cut-off point used in Japan is a standard derived from western countries; hence, it is difficult to determine its suitability for use in Japan. Further studies must collect CC data from multiple facilities in order to define a Japanese cut-off point.

Figure 1

Kaplan-Meier cumulative hospitalization curves for elderly subjects categorized into 3 groups by MNA(A), into 2 groups by CC(B) and BMI(C). MNA (points) were classified with Malnutrition (<17), At Risk (17-23.5), Well nourished (≧24). CC(cm) was classified with <29, ≧29. BMI(kg/m^2) was classified with <22, ≧22

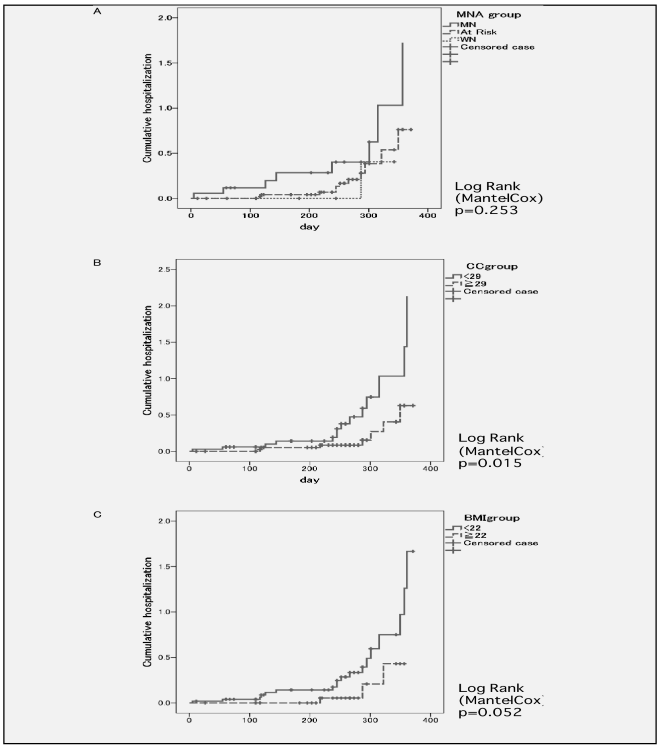

Table 4

The results of dietery intake of the study subjects by nutritional status according to MNA score(4-A), CCvalue(4-B), BMI value(4-C)

A Variables	Malnutrition (n=17) MNAscore<17	At Risk (n=54) 17≦MNAscore≦23.5	Well nourished (n=8) MNAscore≧24	p value
Energy(%)	104.9±24.4	106.9±17.4	118.1±18.3	0.254
Protein(%)	97.3±25.0	101.5±22.1	109.3±18.8	0.468
Water(ml)	1712±214.8	1637±195.0	1743±299.2	0.260

Data were expressed as mean±SD. ANOVA test for continuous variables were performed.

B Variables	CC<29 (n=33)	CC≧29 (n=45)	p value
Energy(%)	107.5±21.8	107.2±17.4	0.947
Protein(%)	105.0±26.6	98.4±18.8	0.232
Water(ml)	1602±286.7	1699±111.7	0.078

C Variables	BMI<22 n=51)	BMI≧22 (n=28)	p value(
Energy(%)	110.4±20.0	102.6±17.1	0.087
Protein(%)	106.7±24.1	91.6±15.0	0.001
Water(ml	)1639±240.4	1708±132.9	0.109

Data were expressed as mean±SD. T-test for continuous variables were performed.

The present study had some limitations. It was a small scale observational study, and it is unclear whether our results are valid for elderly people in other institutions. Furthermore, 19 subjects were transferred to another institution during the follow-up period, and some subjects dropped out.

In conclusion, our results show that nutritional assessment by MNA is useful among institutionalized elderly Japanese people and that CC and BMI are more useful predictors for hospitalization than MNA. There are few published reports regarding nutritional status among this group and further research is needed to prevent hospitalization associated with nutritional status.

References

1. Persson MD, Brismar KE, Katzarski KS, Nordenstrom J, Cederholm TE. (2002) Nutritional status using mini nutritional assessment and subjective global assessment predict mortality in geriatric patients. J Am Geriatr Soc 50:1996-2002.
2. Ahluwalia N. (2004) Aging, nutrition and immune function. J Nutr Health Aging 8:2-6.
3. Odlund Olin A, Koochek A, Ljungqvist O, Cederholm T. (2005) Nutritional status, well-being and functional ability in frail elderly service flat residents. Eur J Clin Nutr 59:263-70.
4. Guigoz Y, Vellas B, Garry PJ.(1996) Assessing the nutritional status of the elderly: The Mini Nutritional Assessment as part of the geriatric evaluation. Nutr Rev Jan 54:S59-65.
5. Rubenstein LZ, Harker JO, Salva A, Guigoz Y, Vellas B.(2001) Screening for undernutrition in geriatric practice: developing the short-form mini-nutritional assessment (MNA-SF). J Gerontol A Biol Sci Med Sci 2001 Jun 56:M366-72.
6. Guigoz Y.(2006) The Mini Nutritional Assessment (MNA) review of the literature--What does it tell us? J Nutr Health Aging 10:466-85; discussion 85-7.
7. Kuzuya M, Kanda S, Koike T, Suzuki Y, Satake S, Iguchi A. (2005) Evaluation of Mini-Nutritional Assessment for Japanese frail elderly. Nutrition 21:498-503.
8. Inoue K, Kato M. (2007) Usefulness of the Mini-Nutritional Assessment (MNA) to evaluate the nutritional status of Japanese frail elderly under home care. Geriatrics & Gerontology International 7:238-44.
9. Iizaka S, Tadaka E, Sanada H. (2008) Comprehensive assessment of nutritional status and associated factors in the healthy, community-dwelling elderly. Geriatrics & Gerontology International 8:24-31.
10. Kaburagi T, Hirasawa R, Yoshino H,et al. (2011) Nutritional status is strongly correlated with grip strength and depression in community-living elderly Japanese. Public Health Nutr 14: 1893-9.
11. Mahoney FI, Barthel DW. (1965) FUNCTIONAL EVALUATION: THE BARTHEL INDEX. Md State Med J 14:61-5.
12. Charlson ME, Pompei P, Ales KL, MacKenzie CR. (1987) A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis 40:373-83.
13. Izawa S, Enoki H, Hirakawa Y, et al. (2010) The longitudinal change in anthropometric measurements and the association with physical function decline in Japanese community-dwelling frail elderly. Br J Nutr 103: 289-94.
14. Allard JP, Aghdassi E, McArthur M, et al. (2004) Nutrition risk factors for survival in the elderly living in Canadian long-term care facilities. J Am Geriatr Soc 52:59-65.
15. Enoki H, Kuzuya M, Masuda Y, et al. (2007) Anthropometric measurements of mid-upper arm as a mortality predictor for community-dwelling Japanese elderly: the Nagoya Longitudinal Study of Frail Elderly (NLS-FE). Clin Nutr 26:597-604.
16. Lin SJ, Hwang SJ, Liu CY, Lin HR. (2012) The relationship between nutritional status and physical function, admission frequency, length of hospital stay, and mortality in old people living in long-term care facilities. J Nurs Res 20: 110-21.
17. Bonnefoy M, Jauffret M, Kostka T, Jusot JF. (2002) Usefulness of calf circumference measurement in assessing the nutritional state of hospitalized elderly people. Gerontology 48:162-9.
18. Heymsfield SB, Martin-Nguyen A, Fong TM, et al. (2008) Body circumferences: clinical implications emerging from a new geometric model. Nutr Metab 5: 24.
19. Rolland Y, Lauwers-Cances V, Cournot M, et al. (2003) Sarcopenia, calf circumference, and physical function of elderly women: a cross-sectional study. J Am Geriatr Soc 51:1120-4.
20. Flodin L, Svensson S, Cederholm T. (2000) Body mass index as a predictor of 1 year mortality in geriatric patients. Clin Nutr 19:121-5.