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POPULATION-SPECIFIC ANTHROPOMETRIC CUTOFF STANDARDS IMPROVE THE FUNCTIONALITY OF THE MINI NUTRITIONAL ASSESSMENT WITHOUT BMI IN INSTITUTIONALIZED ELDERLY IN TAIWAN

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Abstract: *Objective:* To assess the nutritional status of institutionalized Taiwanese elderly with the Mini Nutritional Assessment (MNA) without BMI and to determine whether the application of population-specific MAC and CC cutoff standards would improve the functionality of the tool. *Design:* Purposive sampling. *Setting:* A long-term care facility in central Taiwan. *Participants:* Two hundred and eight >65 y residents who were free of acute infection/diseases and were able to communicate. *Measurements:* A questionnaire survey to elicit personal data and administer the MNA and measurements of anthropometric and blood biochemical indicators. *Results:* The MNA, without BMI, predicted 22.1% of participants malnourished and 61.1% at risk of malnutrition among residents of a long-term care facility in Taiwan. Replacing the population-specific cutoff standards of MAC and CC for the original cutoff standards in the MNA and increasing the weighted score of MAC and CC to replace for the weighted score of BMI preserved and improved the predicting ability of the MNA. The improvement was evidenced by the increase in the correlationships between the MNA scores and the anthropometric, biochemical or health status indicators. *Conclusion:* The MNA predicted nutritional risk status of the institutionalized elderly Taiwanese. The study suggests that whenever possible population-specific anthropometric cutoff standards should be applied to improve the functionality of the MNA. It also appears possible to preserve or even improve the functionality of the MNA without BMI. The modifications indicate an improvement in the application of the MNA in long-term care patients.

Key words: MNA, BMI, calf circumference, mid-arm circumference, Taiwan.

Introduction

In recent decades, the proportion of elderly population increases rapidly in most industrialized countries around the world. In Taiwan, the proportion of people 65 years or older is approaching 10% now and is projected to reach approximately 15% in 2020 (1). The need for long-term care will rise as the elderly population increases. Nutrition is a key component in maintaining good health, mobility and quality of life of the elderly individuals. Early detection of nutritional deficiency or abnormality is important for avoiding costly chronic conditions or diseases.

The Mini Nutritional Assessment (MNA) is a simple and non-invasive tool for assessing nutritional risk of the elderly (2). The MNA screen is composed of simple anthropometric measurements and questions for assessing global indicators, key markers of food intake patterns, and subjective self-evaluated health parameters. The tool has been successfully used to assess the nutritional risk of independently living, home-care or institutionalized elderly, and clinically ill, frail, Alzheimer's disease or cognitively impaired patients (3-10). The tool has also been used to screen for disease-related malnutrition (11). The MNA instrument was developed and validated with clinical studies conducted in Caucasian populations in Europe and the US (2). The tool has also been used in studies involving non-Caucasian populations (4, 9). However, because of the differences in body stature and lifestyle between the Caucasian and many non-Caucasian populations such as the Asians, questions have been raised whether certain components of this tool need to be modified when applied to those populations (12). In a recent study where the tool was applied to assess the prevalence of malnutrition of a nationally representative sample of elderly (>65 y) Taiwanese, the BMI (body mass index) scale of the tool placed a large proportion (53%) of the sample in the mild to severe underweight categories, and the CC (calf circumference) scale placed 16% of men and 34% of women in subnormal categories (13). On the other hand, the MAC (mid-arm circumference) scale placed only 0.7% of elderly men in the subnormal category. These extreme proportions of subnormal status suggest that the cutoff standards of BMI, MAC and CC in the MNA are not appropriate for the Taiwanese population. Thus, the present study was undertaken to evaluate the functionality of the MNA in assessing the nutritional risk status of institutionalized elderly Taiwanese and whether the application of population-specific anthropometric standards would improve the functionality of the tool.

Methods and Procedure

The study was carried out in a long-term care facility in central Taiwan. Two hundred and eight (86 men and 122

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women) of 351 residents at the facility met inclusion and exclusion criteria and participated in the study. Residents who had acute infections/diseases or were hospitalized, unconscious, cognitively impaired or unable to communicate were excluded. Each participant underwent a face-to-face interview and a series of anthropometric measurements. The questionnaire included participants' sociodemographic status, healthcare-related information, and the MNA screen (2, 3). Anthropometric measurements included WC (waist circumference), MAC and CC using a flexible but non-stretchable measuring tape and were recorded to 1/10 cm. All measurements were performed according to standard procedures (14) but with subjects in supine positions. A 10 CC blood specimen was taken from each participant under an overnight fasting condition on a separate day but within one week of the interview for biochemical measurements. In order to avoid interpersonal variations in carrying out anthropometric measurements, one technician performed all measurements. All biochemical assays were performed with standardized procedures by a government approved clinical laboratory (Sing Chung San Clinical Laboratory) in Taichung, Taiwan. All interviews, measurements and blood samplings were carried out within a period of four weeks, beginning in late September of 2005. Body weight and height were not measured because many residents were bed-ridden and the institution did not have special equipment for carrying out these measurements. Each participant was assessed for his/her nutritional risk status with the MNA in three versions: (a) the original MNA screen, (b) replacing the population-specific cutoff standards for the original MAC and CC standards and (c) replacing the population-specific cutoff standards for the original MAC and CC standards and adjusting the assigned scores of MAC and CC to cover for the scores of BMI (increasing the weighted score of MAC from 1 to 2 points and CC from 1 to 3 points) (Table 2). In all three versions, BMI data were not available. All other components of the MNA remained constant. The revised MAC and CC cutoff standards were the fifth percentile values of the distribution of a nationally representative sample of elderly Taiwanese (15). The Institutional Review Board of Asia University approved the study protocol. Written consent was obtained from each participant or his/her legal guardian. Subject's confidentiality was preserved throughout the study.

Results of the study were statistically analyzed with SPSS (Statistical Package for the Social Sciences, SPSS Base 10.0 Application Guide, 1999 by SPSS Inc. Chicago, IL) and presented in Tables 1-4. Pearson's correlation analyses were performed to determine the significance of the relationships of the MNA scores with each of the anthropometric, biochemical and health-related variables. In order to avoid the situation where the variable being analyzed was a component of the dependent variable (the MNA score), the contributing scores of MAC and CC were removed from the total MNA scores when analyzing the correlation with each of these two variables, respectively. A 5% probability was designated as the level of statistical significance but higher levels of significance were also reported.

Table 1
Percentage of elderly with subnormal status for each question according to the original MNA scale (N = 208).

MNA questions	Full score	Assigned score	%
A. Declined food intake: Severely	2	0	4.3
Moderately		1	15.4
B. Weight loss: >3kg body weight	3	0	4.3
Does not know		1	37.0
1-3 kg		2	10.6
C. Mobility: Bed- or chair-bound	2	0	39.9
Able to get out of bed but does not go out		1	44.2
D. Psychological stress/acute disease: yes	2	0	25.5
E. Neuropsychological problems:	2		
Severe dementia/depression		0	3.4
Mild dementia		1	19.2
F. Body mass index	3	(Not measured)	
G. Unable to live independently	1	0	100.0
H. Taking >3 prescribed medicine	1	0	68.8
I. Have pressure sores or skin ulcers	1	0	9.1
J. Full meals patient eat daily: 1 meal	2	0	5.8
2 meals		1	8.2
K. Consumption of protein-rich foods:	1		
0 or 1 "yes"		0	5.8
2 "yes"		0.5	39.4
L.Fruit & vegetable intake < 2 servings/d	1	0	13.9
M. Fluid consumed per day: <3 cups	1	0	21.2
3-5 cups		0.5	45.2
N. Unable to eat without assistance: yes	2	0	8.2
Self-fed with some difficulty		1	7.2
O. Self-view of nutritional status:	2		
Malnourished		0	31.3
Uncertain of status		1	33.2
P. Self-view of health status:	2		
Not as good as others		0	27.4
Not sure		0.5	6.3
As good as others		1	38.9
Q. Mid-arm circumference: <21 cm	1	0	17.3
21-22 cm		0.5	9.1
R. Calf circumference <31 cm	1	0	72.6

Results

All participants were 65 years or older and the average ages were 77.0 ± 7 y for men and 82.3 ± 7.5 y for women. The majority, 86% of men and 96% of women, had less than six years of formal education. Forty-two percent of male and 25% of female participants were on social welfare programs while the rest were self-supported. Eighty-four percent of elderly men and 77% of women were able to feed themselves; 10.5% of men and 13.9% of women needed assistance in order to eat; and 5.8% of men and 9% of women were tube-fed. Forty-three percent of participants had confirmed hypertension; 16% had heart problems; 23% had diabetes; 33.2% experienced stroke;

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6.3% had Parkinson disease; 5.8% had congestive pulmonary disease; 10% had digestive problems; 11.5% had osteoarthritis; and 5.3% had moderate levels of cognitive impairment (all diagnosed cases). Twenty-four percent of participants had sleep difficulties; 52% had frequent constipation; and 78% wore pads.

Table 1 shows the proportions (%) of elderly classified subnormal in each of the MNA parameters. Forty percent of participants were bed- or wheelchair-bound and another 44% could not go out of door. Twenty-six percent had psychological stress or acute disease; all were unable to live independently; and 69% were taking three or more prescribed medicine routinely. Roughly one-third of the participants thought they were malnourished and another one-third were uncertain of their nutritional status while 27% thought their health status was not as good as the peers. Seventeen percent of participants had MAC below 21 cm, 9% were between 21 and 22 cm while 73% of participants had CC below 31 cm. BMI values were not available since body weight and height were not measured.

Table 2 shows the proportions of subjects classified subnormal in MAC or CC status according to the original or the modified MNA cutoff standards. According to the original MNA scale, 4.7% of male and 26.2% of female participants had subnormal MAC (<21cm) and another 4.7% of male and 12.3% of female participants had marginal MAC (21-22 cm). When classified according to the population-specific cutoff standards, 18.6% of male participants were subnormal (<22.5 cm) and 11.6% were marginal (22.5-23.5 cm). No revision was necessary for female. For CC, 62% of male and 80% of female participants were subnormal (<31 cm) according to the original MNA scale. These proportions were reduced to 33% for men (<28 cm) and 34% for women (<25 cm) when population-specific CC cutoff standards were applied.

Table 3 presents the distribution of nutritional risk status classified according to the original or the revised MNA scales. The original scale classified 15.1% male and 27% female participants malnourished, and 64% male and 59% female participants at risk of malnutrition. Application of the population-specific MAC and CC cutoff standards reduced the proportions malnourished to 12.8% and 25.4% and the proportions at risk of malnutrition to 62.8% and 54.1% for men and women, respectively. In all, 15 of 208 (7.2%) subjects had their nutritional risk status altered. When weighted scores were also modified in addition to adopting the population-specific cutoff standards, 16.8% (35/208) of the participants had their nutritional risk status altered from the status classified by the original MNA.

Table 2

Assigned scores, cutoff standards and distribution (N and %) of participants' MAC and CC measurements according to the original or revised MNA scales[1]

	Men (N=86)				Women (N=122)			
MAC								
Original scale								
Assigned score	0	0.5	1		0	0.5	1	
Cutoff standards (cm)	<21	21-22	≥22		<21	21-22	≥22	
Distribution, N (%)	4 (4.7)	4 (4.7)	78 (90.7)		32 (26.2)	15 (12.3)	75 (61.5)	
Revised cutoff standards								
Assigned score	0	0.5	1		0	0.5	1	
Cutoff standards (cm)	<22.5	22.5-23.5	≥23.5		<21	21-22	≥22	
Distribution, N (%)	16 (18.6)	10 (11.6)	60 (69.8)		32 (26.2)	15 (12.3)	75 (61.5)	
Rated status altered	22/86 (25.6%)2				0			
Revised cutoff standards & scores								
Assigned score	0	1	2		0	1	2	
Cutoff standards (cm)	<22.5	22.5-23.5	≥23.5		<21	21-22	≥22	
Distribution, N (%)	16 (18.6)	10 (11.6)	60 (69.8)		32(26.2)	14 (12.3)	76 (61.5)	
CC								
Original scale								
Assigned score	0	1			0	1		
Cutoff standard (cm)	<31	≥31			<31	≥31		
Distribution, N (%)	53 (61.6)	33 (38.4)			98 (80.3)	24 (19.7)		
Revised cutoff standards								
Assigned score	0	1			0	1		
Cutoff standard (cm)	<28	≥28			<25	≥25		
Distribution, N (%)	28 (32.6)	58 (67.4)			41 (33.6)	81 (66.4)		
Rated status altered	25/86 (29.1%)[2]				56/122 (45.9%)			
Revised cutoff standards & scores								
Assigned score	0	1	2	3	0	1	2	3
Cutoff standards (cm)	<28	28-28.9	29-29.9	≥30	<25	25-25.9	26-26.9	≥27
Distribution, N (%)	28 (32.6)	8 (9.3)	9 (10.5)	41 (47.7)	41 (33.6)	9 (7.4)	13 (10.7)	59 (48.4)

1. The original cutoff standards are as specified in the MNA; the revised cutoff standards are population-specific values for older Taiwanese (15); 2. Total cases within gender.

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Table 3

Distribution (N and % within gender) of nutritional risk status classified according the original or revised MNA scales

	Malnourished	At risk	Normal	Risk status changed[1]
Original MNA scale (27)[2]				
MNA score	≤15	15.5-21.0	≥21.5	
scale[3]				
Men	13 (15.1%)	55 (64.0%)	18 (20.9%)	
Women	33 (27.0%)	72 (59.0%)	17 (13.9%)	
All	46 (22.1%)	127 (61.1%)	35 (16.8%)	
Revised MAC & CC cutoff standards (27)[2]				
MNA score	≤15	15.5-21.0	≥21.5	
scale[3]				
Men	11 (12.8%)	54 (62.8%)	21 (24.4%)	
Women	31 (25.4%)	66 (54.1%)	25 (20.5%)	
All	42 (20.2%)	120 (57.7%)	46 (22.1%)	15/208 (7.2%)
Revised MAC & CC cutoff standards & weighted scores (30)[2]				
MNA score	≤16.5	17-23.5	≥24	
scale				
Men	14 (16.3%)	53 (61.6%)	19 (22.1%)	
Women	33 (27.0%)	65 (53.3%)	24 (19.7%)	
All	47 (22.6%)	118 (56.7%)	43 (20.7%)	35/208 (16.8%)

1. Values are N of cases/N total (%). Risk status changed from that predicted by the original MNA scale; 2. Maximum score; 3. Malnutrition indicator scores are proportionately adjusted according to standards set in the MNA scale.

Table 4

Probability of correlations between the total MNA scores1 generated by either the original or the revised MNA scales with anthropometric, biochemical and health status variables

	N	Original scale		Revised scale A[2]		Revised scale B[2]	
		r	P	r	P	r	P
Age	208	-0.145	0.037	-0.135	0.052	-0.171	0.013
Waist circumference	207	0.341	<0.0001	0.339	<0.0001	0.454	<0.0001
MAC[1]	208	0.367	<0.0001	0.355	<0.0001	0.445	<0.0001
CC[1]	208	0.291	<0.0001	0.289	<0.0001	0.334	<0.0001
Albumin	192	0.232	<0.001	0.222	0.002	0.273	<0.0001
Total cholesterol	192	0.055	0.445	0.066	0.362	0.094	0.196
Hospital length of stay	196	-0.228	<0.001	-0.228	<0.001	-0.242	<0.001
Mode of feeding[3]	208	0.225	<0.001	0.232	<0.001	0.280	<0.0001

1. When testing the correlation of total MNA scores with MAC or CC, the total scores of MNA did not include the each of these scores, respectively; 2. Revised scale A used the population-specific MAC & CC cutoff standards instead of the values specified in the MNA. Revised scale B replaced the cutoff standards and adjusted MAC and CC scores; 3. Categorical, classified according to Question N of the MNA screen.

Table 4 shows the correlations of the total MNA scores (based on either the original scale or the revised scales) with age, WC, MAC and CC, serum albumin, serum total cholesterol, hospital length of stay, and mode of feeding of the participants. Revising the cutoff standards together with weighted score resulted in improvement in the correlation of the MNA scores with each of these parameters, except serum cholesterol. Results also showed that 87.2% of participants had normal serum albumin status (>35 g/L), 12.8% were marginal (30-35 g/L) and none was subnormal (<30 g/L). All residents had normal plasma sodium concentrations (135-145 meq/L).

Discussion

Results of this study indicate that the MNA can be used to assess the nutritional risk status of institutionalized elderly in Taiwan. The tool, without revision and without BMI, classified 22.1% of the institutionalized elderly malnourished, 61.1% at risk of malnutrition and 16.8% normal. These results are comparable to those observed by Tsai et al. (16) who assessed nutritional status of institutionalized elderly Taiwanese with the MNA and showed that 14.3% were malnourished, 61.7% were at risk of malnutrition and 24.3% were normal. On the other hand, results of the present study also suggest a need to refine the cutoff standards of MAC and CC scales for the Taiwanese population. The original MNA scale classified 4.7% of male and 26% of female participants subnormal in MAC status but 62% and 80% of the same respective groups subnormal in CC status. Similar observations have also been noted in a separate study involving the general elderly Taiwanese population (13). These drastic differences in subnormal MAC and CC proportions suggest that the cutoff standards of these anthropometric parameters in the MNA may not correctly reflect the cutoff standards of the Taiwanese and adjustment may be necessary. In a recent study we have calculated the population-specific MAC and CC cutoff standards from data of a population representative sample of 2900 elderly Taiwanese (15). Replacing these population-specific MAC and CC cutoff standards for the original cutoff standards resulted in much more consistent and reasonable subnormal MAC and CC proportions (Table 2). The new scale classified 19% of male participants subnormal in MAC status (For women, no revision was necessary since population-specific MAC cutoff point was the same as the original MNA) and 33% of male and 34% of female participants subnormal in CC status. Overall, the adjustment of MAC cutoff standards altered the status of MAC in 25.6% of men while the adjustment of CC cutoff standards altered the status of CC in 29.1% of men and 45.9% of women.

Application of these population-specific cutoff standards led to moderate changes in nutritional risk status. The proportion of malnutrition was changed from 22.1% to 20.2%, at risk of malnutrition from 61.1% to 57.7%, and normal status from 16.8% to 22.1%. In all, 15 of 208 (7.2%) participants altered their nutritional risk status as a result of these modifications (Table 3). BMI, MAC and CC, all three indicators are components of the MNA and all reflect one's general nutritional status and body weight and body fatness status. MAC and CC are also indicators of body muscle and subcutaneous adipose tissue (14). BMI is one of the six best items in the MNA to predict nutritional risk status. However, BMI data are often not available because many long-term care institutions in Taiwan do not have the equipment to carry out these measurements. Thus, an attempt was made to adjust the total weighted score of MAC and CC to replace for the weighted scores of BMI, in addition to adopting the population-specific MAC and CC cutoff standards. Because CC is crucial for maintaining one's mobility, CC was assigned 3 points and

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MAC 2 points to represent the total of 5 weighted points contributed by BMI, MAC and CC. In addition, CC was modified to a four-level graded scale at 1 point/cm increment, instead of a single all-or-none cutoff point in the original scale (Table 2). By adopting these new MAC and CC scales, the revised MNA predicted 22.6% (47/208) of elderly participants malnourished, 56.7% (118/208) at risk of malnutrition and 20.7% (43/208) normal. In all, 16.8% (35/208) of the participants had their nutritional status altered from the status predicted by the original MNA.

The MNA scores of this revised scale correlated substantially better with all indicators of nutritional status, except serum cholesterol, than did the scores of the original MNA (Table 4). Thus, the modifications seem to have improved the predicting ability of the MNA for elderly Taiwanese. Several other scoring combinations were tested but none was better than the one described. These results suggest that the application of population-specific MAC and CC cutoff standards coupled with modification of the MAC and CC scores not only preserved but also improved the functionality of the MNA for elderly Taiwanese.

Serum albumin concentration is an indicator of the general nutritional status (17). Lack of a better indicator, it is often treated as the "gold standard" in validating nutritional assessment tools. Using this "gold standard", application of population-specific MAC and CC cutoff standards together with adjustment of the weighted scores improved its correlationship with the total MNA scores.

All participants in this study had normal serum sodium concentrations, within 135-145 meg/dl, suggesting that they were probably adequately hydrated. Most (89%) participants had normal serum albumin concentrations (35-50 g/L), 11% were marginal (30-35 g/L) and none was abnormal (<30 g/L). These data suggest that the biochemical markers are probably valid, reflecting normal physiological state of the elderly. The proportion of participants having pressure sore or skin ulcers was moderate (9.1%) suggesting that the quality of care was probably reasonable. However, a relatively high proportion (25.5%) of those elderly had psychological stress, suggesting that there is a need to pay greater attention to their psychological wellbeing. It should be pointed out that results of this study represent only those residents who have relatively normal cognitive status and are able to communicate. Roughly one-third of the total residents were excluded from this study because they were too frail to be evaluated with the MNA. It is possible that many of those who were excluded had worse nutritional status than subjects included in the study. Some difficulties encountered during the assessment also deserve to be mentioned. "Weight loss during the last 3 months" is not an easy question for the participants to answer, especially when weight measurement is not routinely done. Most answers to the question are guesstimates. Difficulties in assessing intake of fluid and food items in serving units also exist in these institutionalized elders as observed in independently living elders (13). The MNA is well known for its advantage of not requiring any biochemical test but the instrument appears to be geared more for independently living than for institutionalized elders (18). Unfortunately, measuring body weight and height for the frailest or disabled elders is often not a simple and easy task and the process requires special instrument and techniques. The accuracy of results is also often questionable. Thus, for those elders, a simple and non-invasive tool without involving BMI is highly desired.

In conclusion, results of this study indicate that the MNA can be used to assess nutritional risk status of institutionalized elderly Taiwanese, a non-Caucasian population, even without BMI. However, if available, population-specific anthropometric cutoff standards should be applied to improve the accuracy of the tool, especially in non-Caucasian populations. Further, under conditions that it is difficult to measure body weight and height, MAC and CC scores may be adjusted to replace the score of BMI and at the same time improve the functionality of the MNA. These modified cutoff standards and weighted scores might be applicable to other Oriental populations in the region.

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