Original Article

Population-specific anthropometric cut-points improve the functionality of the Mini Nutritional Assessment (MNA) in elderly Taiwanese

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The objective of this study was to determine the population-specific cut-points of body mass index (BMI), mid-arm circumference (MAC) and calf circumference (CC) for identifying subnormal nutritional status in elderly Taiwanese, and to evaluate the possibility of improving the functionality of the Mini Nutritional Assessment (MNA) by adopting these cut-points. This study analyzed data from 1583 men and 1307 women, 65 years or older, of a national survey. The survey involved in-home, face-to-face, interviews and anthropometric measurements. Results showed that based on the cumulative percentile curves, the fifth percentile values were: BMI, 17 kg/m^2 for both men and women; MAC, 22.5 cm for men and 21 cm for women; and CC, 28 cm for men and 25 cm for women. Substitution of these population-specific cut-points for respective values in the MNA screen resulted in lowered proportions of elderly classified malnourished or at risk of malnutrition. The prevalence of malnutrition was reduced from 1.7% to 1.4% in men and from 2.4% to 1.5% in women. The proportions classified at risk of malnutrition were reduced from 10.1% to 8.9% for men and 16.8% to 12.8% for women. In conclusion, results suggest that the MNA is a valuable tool for geriatric nutritional risk assessment. However, in populations where significant differences exist in anthropometric measurements from the Caucasian populations, population-specific cut-points should be used.

Key Words: Mini Nutritional Assessment, elderly, BMI, calf circumference, Taiwan

INTRODUCTION

The Mini Nutritional Assessment (MNA) is a simple and non-invasive tool for assessing the nutritional risk of the elderly.[1] The tool is composed of simple anthropometric measurements, global and dietary assessments, and subjective self-evaluations. It has been successfully used to assess the nutritional risk of older adults of varying health conditions including healthy free-living individuals, frail persons and clinical patients.[2-7] The MNA was developed and validated with clinical studies conducted in Caucasian populations in Europe and the US.[1] There have been some concerns whether the tool can be applied to assess nutritional status of Asian populations without modifications.[8] In a recent study we used the tool to assess the prevalence of malnutrition in elderly Taiwanese and found that the BMI (body mass index) scale of the tool classified a large proportion (53%) of a nationally representative sample of elderly Taiwanese in the mild to severe underweight categories and the CC (calf circumference) scale classified 16% of men and 34% of women in subnormal categories.[9] These findings indicate that the cut-points for both BMI and CC in the MNA are too high for the Taiwanese population. On the other hand, the MAC (mid-arm circumference) scale of the MNA classified only 0.7% of Taiwanese elderly men in the subnormal category, suggesting that the MAC cut-point might be too low for Taiwanese men. These results raised the question whether the BMI, MAC and CC cut-points in the MNA are fully applicable to the Oriental populations. It is well known that significant differences in anthropometric characteristics, lifestyle and biochemical indicators exist among various ethnic populations. For example, the Asians have been shown to have different BMI to body fat relationships from that of the Caucasian.[10-12] At a given BMI, the Asians have a higher percentage of body fat than that of the Caucasians.[13,14] In fact, the Department of Health of Taiwan has proposed a scale of BMI 24-27 as overweight and BMI ≥27 as obese for the Taiwanese.[15] Uniform cut-points for the classification of obesity using BMI, WHR (waist to hip ratio) or WC (waist circumference) have also been shown to result in

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Table 1. Assigned scores, and BMI, MAC and CC distributions (%) of elderly men and women according to scales in the MNA or population-specific scales derived from a national representative sample.

Parameter Score	Original MNA screen				Population-specific cut-points			
	Men		Women		Men		Women	
	Scale	Distrib.	Scale	Distrib.	Scale	Distrib.	Scale	Distrib.
BMI								
0 point	<19	10.6	<19	11.7	<17	2.8	<17	3.2
1	19-21	17.6	19-21	16.6	17-19	7.8	17-19	8.5
2	21-23	24.9	19-21	24.0	19-21	17.6	19-21	16.6
3	≥23	47.0	≥23	47.6	≥21	71.8	≥21	71.7
MAC								
0 point	<21	0.7	<21	3.8	<22.5	3.7	<21	5.2
0.5	21-22	1.0	21-22	1.4	22.5-23.5	4.5	21-22	2.5
1	≥22		≥22		≥23.5		≥22	
CC								
0 point	<31	16.2	<31	34.0	<28	4.6	<25	3.8
1	≥31	83.8	≥31	66.0	≥28	95.4	≥25	96.2

in marked variation in the levels of glucose-metabolic abnormalities between ethnic groups.[16] The standards that were developed based on Caucasian populations may not be fully applicable to the non-Caucasian populations. Thus, the present study was undertaken to determine (a) if population-specific BMI, MAC and CC cut-points would be different from those of the Caucasian and (b) whether application of these population-specific cut-points would improve the functionality of the MNA for the Taiwanese population.

METHODS

Data of this study were from the "Survey of Health and Living Status of the Elderly in Taiwan" (SHLSET),[17] a longitudinal population-based cohort project. The project was designed to gain an understanding of the age-associated changes in socioeconomic and health status, quality of life and healthcare use of older adults in Taiwan. Initiated in 1989 the project conducted periodic interview surveys on, initially, a cohort of 4049 men and women, 60 years or older, representing a national random sample. In 1996, 2462 subjects, 50-66 years old, selected based on the same method, were added to the cohort. The remaining 4915 subjects constituted the sampling size of the 1999 survey. The detail of the methods and procedures of the survey have been described elsewhere.[18,19] In each survey, participants underwent individual, face-to-face, in-home interviews. In the 1999 survey the questionnaire included, among other components, the MNA[1] and the Nutrition Screening Initiative[20] to assess the prevalence of nutritional risk of older adults. MAC and CC of each participant were measured according to reference procedures using a flexible but non-stretchable measuring tape at the time of home interviews.[21] Self-reported height and weight were also obtained during the interview. The Human-Subject Study Ethic Committee of the research institute (Taiwan Provincial Institute of Family Planning) approved the protocol of the study.

To comply with the commonly accepted elderly age range, only data from subjects who were 65 years or older (1583 men and 1307 women) were analyzed in this study. "Measured height" of each participant was derived from self-reported standing height using regression equations reported by Kuczmarski et al.[22] BMI values of participants were calculated based on the equation of kg/m^2 using corrected heights. Cumulative percentile curves of BMI, MAC and CC were plotted and the 5th percentile values were pinpointed and used as the population-specific cut-points. Nutritional status of each elder was evaluated with the MNA in two ways: (a) as specified in the original MNA screen, and (b) the same screen but with population-specific BMI, MAC and CC cut-points. All other procedures remained the same.

Results were statistically analyzed with the SPSS (SPSS Base 10.0Application Guide, 1999 by SPSS Inc. Chicago, IL). Pearson's correlations of each of the health indicators with the MNA scores of the original or the revised MNA screen were analyzed. A 5% probability level was designated as the level of statistical significance.

RESULTS

Fig. 1-3 present the gender-specific cumulative percentile curves and the 5th percentile values of BMI, MAC, and CC of a nationally representative sample of Taiwanese men and women, 65 years or older. According to these curves, the 5th percentile BMI values were approximately 17 kg/m^2 for both men and women; the 5th percentile MAC values were approximately 22.5 cm for men and 21 cm for women, and the 5th percentile CC values were approximately 28 cm for men and 25 cm for women.

Table 1 shows the weighted scores, cut-points and proportions of subnormal BMI, MAC and CC status in elderly men and women assessed according to the scales specified in the MNA or the revised population-specific scale (from results shown in Fig. 1-3). The population-specific BMI scale classified 2.8% of men and 3.2% of women in severe underweight category compared to 10.6% of men and 11.7% of women according to the scale in the MNA. The population-specific BMI scale classified an additional 25% of men and women in mild or moderate underweight category compared to 42.5% of men and 41% of women according to the original MNA scale. The population-specific CC scale classified 4.6% of men and 3.8% of women in the subnormal status compared to 16.2% of men and 34% of women according to the original scale in the MNA. The population-specific

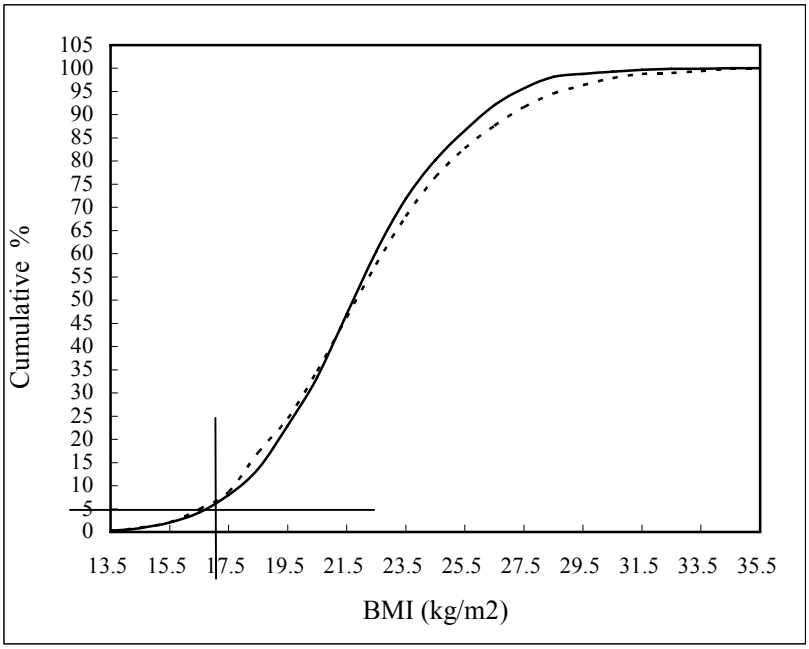

Fig. 1. BMI percentile distribution curves of Taiwanese men (____) and women (------), 65 years or older. The 5th percentile intercepts are at approximately 17 kg/m^2.

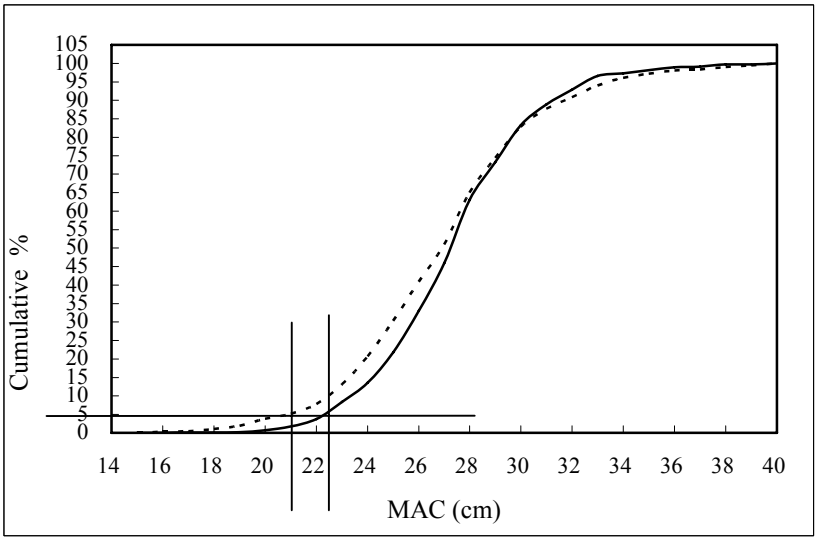

Fig. 2. MAC percentile distribution curves of Taiwanese men (____) and women (------), 65 years or older. The 5th percentile intercepts are at approximately 22.5 cm and 21 cm for men and women, respectively.

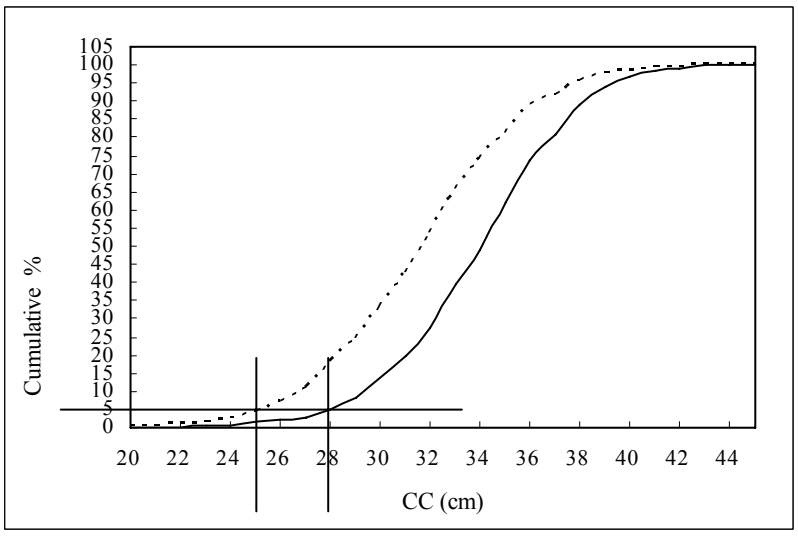

Fig. 3. CC percentile distribution curves of Taiwanese men (____) and women (------), 65 years or older. The 5th percentile intercepts are at approximately 28 cm and 25 cm for men and women, respectively.

Table 2. The prevalence of malnutrition and at risk of malnutrition of elderly Taiwanese men and women classified according to the original MNA or the same screen with population-specific BMI, CC and MAC cut-points†.

Age (y)	N	Original MNA		Revised for Taiwanese	
		Malnourished	At risk	Malnourished	At risk
Men					
65-74	812	1.6	8.9	1.5	8.3
75-84	454	1.8	12.3	1.3	9.9
>85	59	1.7	10.2	1.7	10.2
All	1325	1.7	10.1	1.4	8.9
Women					
65-74	610	1.6	13.8	1.0	11.0
75-84	454	3.0	20.0	2.0	14.5
>85	59	6.8	27.1	3.4	20.3
All	1075	62.4	16.8	1.5	12.8
Total	2400	2.0	13.1	1.5	10.7

†The cut-points are based on the fifth percentile values of a population-representative sample as shown in Fig. 1-3.

Table 3. Correlation of the original and revised MNA scores with age, BMI, MAC, CC, mobility, self-rated nutrition, self-rated health status, hospital admissions and hospital length of stay of Taiwanese men and women, 65 years or older (N = 2429).

	Original screen		Revised screen	
	r	*p*	r	*p*
Age	-0.133	<0.001	0.117	<0.001
Mobility	0.272	<0.001	0.283	<0.001
Self-rated nutritional status	0.418	<0.001	0.414	<0.001
Self-rated health status	0.367	<0.001	0.374	<0.001
Hospital length of stay	0.302	<0.001	0.306	<0.001

MAC scale placed 3.7% of men in the subnormal status compared to 0.7% according to the original scale in the MNA. The population-specific cut-point for MAC in women was the same as in the original MNA and the prevalence was 3.8%.

Table 2 presents the prevalence of malnutrition and the prevalence of at risk of malnutrition in the elderly men and women assessed according to the original MNA screen or the same screen but with population-specific BMI, MAC and CC cut-points. The revised MNA classified 1.4% of men and 1.5% of women malnourished compared to 1.7% of men and 2.4% of women according to the original MNA. The revised MNA classified 8.9% of men and 12.8% of women at risk of malnutrition compared to 10.1% of men and 16.8% of women according to the original MNA. The prevalence of malnutrition or at-risk of malnutrition remained fairly constant throughout all elderly age-ranges in men while increased with age in women.

Table 3 shows the correlations of participants' age, mobility status, self-rated nutritional status, self-rated health status, and total length of hospital stay with the MNA scores, calculated according to the original MNA screen or the revised screen. Application of population-specific BMI, MAC and CC cut-points either maintained or appeared to have slightly improved the correlation of the total MNA score with other variables.

DISCUSSION

Based on a population representative sample of elderly Taiwanese and using the fifth percentile anthropometric values to designate the cut-points for subnormal nutritional status, the present study has determined that the cut-point for BMI is 17 kg/m^2 for both men and women, for MAC the cut-points are 22.5 cm for men and 21 cm for women, and for CC the cut-points are 28 cm for men and 25 cm for women. The population-specific BMI and CC cut-points are lower than the values specified in the original MNA (BMI was 19 kg/m^2 and CC was 31 cm for men and women). The 22.5 cm of population-specific MAC value for Taiwanese elderly men is higher than the 21 cm specified in the original MNA. MAC for Taiwanese elderly women is 21 cm, the same as the value specified in the MNA. Additional cut-points for marginal nutritional conditions were set according to the intervals specified in the original MNA screen (Table 1). Application of these population-specific cut-points to the MNA scales resulted in more reasonable proportions of subnormal nutritional status. The population-specific BMI scale classified 28% of the Taiwanese elderly in the mild to severe underweight categories compared to 53% according to the original scale. These results suggest that the BMI cut-points in the original MNA scale are too high for the Taiwanese population. This observation is in line with the suggestion that the Asians are different from Caucasians in their BMI to percent body fat relationship.[10-12] At a given BMI, the Taiwanese are fatter than the Caucasian.[13,14] In studies comparing the relationship of BMI to metabolic co-morbidity, researchers have found a need to lower BMI cut-points. In fact, the Department of Health, the highest health authority of Taiwan, has recommended using a definition of BMI 24-27 for overweight and ≥27 for obese as compared to the WHO scale of BMI 25-30 and ≥30, respectively, for the general Taiwanese adult population.[15] Similarly, the revised CC scale classified 4.6% of men and 3.8% of women malnourished compared to 16% of men and 34% of women according to the original CC scale. It again suggests that

the CC cut-points in the original MNA are too high for the Taiwanese elderly. While the cut-points of both BMI and CC in the original scale appear to be too high for the Taiwanese elderly the cut-point of MAC appears to be too low for Taiwanese men. However, for women, it appears to be just right. The cut-points of 21 cm (for subnormal) and 22 cm (for marginal) in the original MNA classified only 0.7% and 1% of men in the severe and moderate subnormal categories, respectively. The population-specific cut-points, 22.5cm (for subnormal) and 23.5 cm (for marginal), classified 3.7% and 4.5% of these elderly men in severe and moderately subnormal MAC status, respectively.

Although the MNA has been found to be a useful tool for assessing the nutritional risk of older adults under various health conditions[1-7] and work effectively even in non-Caucasian populations,[8] there is room for improvement in this instrument especially for use in non-Caucasian populations. There are apparent differences in anthropometric indicators, lifestyle and food pattern among ethnic groups. Using a single set of standard for all populations undoubtedly will compromise the functionality of the tool. Application of population specific anthropometric cut-points, can significantly improve the functionality of the tool. Overall, the revised scale classified 1.5% elderly malnourished compared to 2.0% according to the original scale. The changes were more apparent for women (1.5% by revised scale compared to 2.4% by the original scale) than for men (1.4% by revised scale compared to 1.7% by the original scale). The changes appear to be the most drastic in the >85 year-old females, reduced from 6.8% to 3.4%.

The 1.5% overall prevalence of malnutrition in the elderly Taiwanese is probably a fairly reasonable estimate. However, a direct comparison is not possible since we are not aware of any other population-based study that used the MNA as a tool. The most comparable study is the one conducted by the tool developers, Guigoz et al.[23] who observed a 1% prevalence of malnutrition in healthy community elderly in Western populations. Considering that the present study is a population-representative sample that includes the healthy and frail or ill elderly, the 1.5% prevalence appears to be reasonable. The prevalence of malnutrition in frail or clinically ill patients is generally much higher, ranging from 3% in elderly home-care patients[4] to 37% in institutionalized persons.[23]

The MNA scores based on the original screen showed very high degree of statistical correlations with mobility, self-rated nutritional status, self-rated health status, and length of hospital stay. Application of population- and gender-specific BMI, MAC and CC cut-points to the screen resulted in only slightly better correlations between the MNA score and mobility, self-rated health status and length of hospital stay. The modest impact on the correlationship is understandable since the great majority of the participants were healthy subjects and the revision involved only 3 of the 18 questions contributing to only 5 of the 30 total MNA points. The revisions would have only limited impact on the total MNA scores of relatively few individuals. Despite of this, it still can be argued that population-specific cut-points or culturally sensitive criteria should be applied to a questionnaire or a measuring instrument whenever it is possible, simply because it is a right thing to do.

It should also be mentioned that there are other questions in the MNA that should be addressed for ethnicity concerns. Question B, involuntary weight loss is one. Three kg is a larger proportion of body weight for an average Taiwanese than for a Caucasian. Many elderly Taiwanese may have lost similar proportion but not quite 3 kg of body weight. It might be necessary to consider a more comparable number for this particular indicator. Number of meals per day may also deserve some consideration. Eating less than three meals a day (Question J), to many elderly Taiwanese, is a matter of personal choice or religious belief and is not necessarily a reflection of food shortage. Counting the number of servings of food consumed is difficult, at least for some food items, for many Taiwanese because foods are usually not prepared or served in serving sizes in the Taiwanese culture. Counting frequency of consumption as it did in the present study is probably a viable alternative although it might tend to overestimate consumption. There is also difficulty involved in assessing fluid intake, as many foods are prepared in soupy forms and not served in serving sizes.

Some limitations of the study should be mentioned. The present study uses the fifth percentile values of BMI, MAC and CC of the population-representative cumulative percentile curves as the cut-points to designate subnormal nutritional status of the respective parameters. This is an arbitrary and customary choice and it could have been at a higher or lower level depending on the objective of the study. Whether, those are the most appropriate cut-points require further investigation. The use of regression equations developed by Kuczmarski et al.[22] to correct self-reported weight to measured weight of each subject has its shortcomings since the equations were developed based on studies conducted in Western populations. A population-specific regression equation is not yet available.

It should also be reminded that in nutritional assessment of the elderly there is yet no gold standard. Malnutrition has multifactorial causes and it could also be complicated by disease conditions. Thus, malnutrition identified by MNA or other simple tools need to be confirmed with further laboratory tests. At the population level, the MNA can be applied to identify those elderly who are most in need of nutritional intervention or treatment. Improvement in the predicting ability of a risk-screening tool certainly will have significant public health implications.

In conclusion, this study has provided population-specific BMI, MAC and CC cumulative percentile curves and proposed cut-points for subnormal BMI, MAC and CC status for the Taiwanese elderly men and women. Application of these population-specific cut-values to the MNA, hopefully, will help to improve discriminating power of the tool in identifying those elderly who are in need of nutritional intervention.

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AUTHOR DISCLOSURES

Alan Chung-Hong Tsai, Ching-Sung Ho and Ming-Cheng Chang, no conflicts of interest.

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以族群代表性的體位指標切點修訂的「迷你營養評估」可改進其對臺灣老人的評估功能

本研究之目的在研訂臺灣老人族群代表性的身體質量指數 (BMI)、上臂圍（MAC）、及小腿圍（CC）之分切點，以期能更有效的判別營養不良的老人；及評量這些新切點改進「迷你營養評估」(MNA)功能的程度。本研究分析了一個具族群代表性的全國性的調查研究，65 歲以上的個案, 男 1582 人及女 1307 人的資料。該調查包括問卷訪談及體位測量。結果顯示各指標累進百分位分佈曲線第五百分位之值分別為：BMI 男女均為 17 kg/m^2，MAC 男 22.5 cm 女 21cm，CC 男 28 cm 女 25cm。以這些新分切點分別取代 MNA 中原切點後，減低了該研究個案老人的營養不良率。被判定為營養不良者從男 2.4%及女 1.5%分別降為 1.7%及 1.4%。而被判定為具營養風險者，則從男 16.8%及女 12.8%分別降為 10.1%及 8.9%。本研究的結論是以老人營養評估而言, MNA 是一套有價值的工具。但，當此工具被用來評估非白人族群老人時，則應採用具族群代表性的體位指標分切點。

關鍵字：迷你營養評估、老人、身體質量指數、小腿圍、臺灣。