

# Evaluation of the Mini Nutritional Assessment in the elderly, Tehran, Iran

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## Abstract

**Objective:** To determine whether the Mini Nutritional Assessment (MNA) can screen and diagnose for malnutrition in the Iranian elderly.

**Design:** The MNA was administered to all volunteers. Each patient underwent anthropometric and serum albumin measurements. Reliability, validity, sensitivity, specificity, positive- and negative-predictive values were estimated. To identify optimal threshold values for predicting malnutrition, receiver-operating characteristic curve analysis was performed for MNA scores.

**Setting:** Kahrizak Charity Foundation (Tehran, Iran).

**Subjects:** Two hundred and twenty-one consecutive elderly patients entered into the cross-sectional study. Amputees and patients with liver or renal disorders, oedema or any end-stage diseases were excluded.

**Results:** According to MNA score, 3.2% were malnourished, 43.4% were at risk of malnutrition and 53.4% were well nourished. The proportions in these categories according to ideal body weight and serum albumin were 2.3%, 17.1% and 80.6%, respectively. Cronbach's  $\alpha$  coefficient (reliability) was 0.61. The correlations between total MNA score, anthropometric values and serum albumin (criterion-related validity) were all significant. There were significant differences in total MNA score between two BMI groups but not between two categories according to serum albumin and skin ulcers (construct validity). The sensitivity and specificity of the MNA according to its established cut-off points were 82% and 63%, respectively. Positive-predictive value was 35% and negative-predictive value was 93%. By using the best cut-off point (MNA score of 22 according to Youden index), the sensitivity, specificity, positive-predictive value and negative-predictive value were 88%, 62%, 57% and 89%, respectively.

**Conclusions:** The MNA with its established cut-off points may not be a good fit for Asian populations, including Iranian elderly.

**Keywords**  
Mini Nutritional Assessment  
Elderly  
Tehran

Malnutrition is a frequent and serious problem in geriatric patients. In ill elderly subjects it is one of the most common and least-heeded problems in hospitals and nursing homes<sup>(1–4)</sup>. The prevalence of undernutrition among older patients in nursing homes and hospitals reaches high levels, 30–60%<sup>(5)</sup>. According to a recent review, a high prevalence of malnutrition is reported in hospitalized and institutionalized elderly patients: 23 (SE 0.5) % (range 1–74%) in hospitals (thirty-five studies, 8596 elderly subjects) and 21 (SE 0.5) % (range 5–71%) in institutions (thirty-two studies, 6821 elderly subjects). An even higher prevalence of risk of malnutrition is observed in the same populations: 46 (SE 0.5) % (range 8–63%) and 51 (SE 0.6) % (range 27–70%), respectively. In cognitively impaired elderly patients (ten studies, 2051 elderly subjects), the prevalence of malnutrition was 15 (SE 0.8) %

(range 0–62%) and 44 (SE 1.1) % (range 19–87%) were at risk of malnutrition<sup>(6)</sup>. Different studies have also suggested that malnutrition is an important predictor of morbidity and mortality in the elderly<sup>(7,8)</sup>.

There is no gold standard for evaluating nutritional status<sup>(9)</sup>; it is difficult to determine undernutrition or at risk for undernutrition, because there is a lack of consensus on how to define undernutrition<sup>(10,11)</sup>. This has led to a variety of different diagnostic criteria as well as the use of different reference values<sup>(12)</sup>.

Since its publication in 1994<sup>(13)</sup>, the Mini Nutritional Assessment (MNA) has been increasingly employed worldwide for the brief evaluation of older persons' nutritional status, which has been recommended by the European Society for Clinical Nutrition and Metabolism<sup>(6,14,15)</sup>. The MNA is composed of an anthropometric

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assessment, a brief questionnaire about diet characteristics, global health and environment, and a self-evaluation of health and nutritional state. The final score classifies nutritional state as 'well nourished' (scores higher than 23.5), 'at risk for undernutrition' (scores from 17 to 23.5) and 'undernourished' (scores lower than 17). Most published studies show the MNA to have high sensitivity and specificity and good predictive value for higher mortality, hospital admissions and other adverse outcomes<sup>(6,16–18)</sup>. Populations of different countries are heterogeneous in anthropometric and nutritional characteristics, which make the evaluation of this test in one country not readily applicable to other ones. In a Chilean population, for instance, the MNA failed to identify persons at risk for undernutrition<sup>(18)</sup>. The MNA has not been validated in the Iranian elderly, and thus whether the MNA and its established cut-off points for the diagnosis of malnutrition and at-risk status are applicable to the Iranian elderly remains unknown. In the present study we examined whether the MNA can screen and diagnose for malnutrition and risk for malnutrition in the elderly population in the Kahrizak Charity Foundation (Tehran, Iran).

## Experimental methods

### Participants

The study was performed in Tehran, Iran, in 2008. Two hundred and twenty-one elderly patients entered into the present cross-sectional study consecutively by using their records in the Kahrizak Charity Foundation. The inclusion criteria were  $\geq 65$  years of age, having the ability to communicate and the strength to carry through an interview, and informed consent. Amputees were excluded. Patients were excluded if they had liver or renal disorders, oedema or any end-stage diseases because these conditions affect serum albumin level. In forty-one cases serum albumin could not be measured because of insufficient blood sample and in five cases height measurement could not be performed.

### Nutritional assessment

As there is no one biochemical or one anthropometric parameter to be used as a gold standard to define malnutrition, undernutrition is usually defined if two, i.e. one anthropometric measure and one biochemical analysis, or more of the variables are subnormal<sup>(19,20)</sup>. In the present study serum albumin and percentile of ideal body

weight (IBW) were used to identify malnourished, at risk of malnutrition and well-nourished elderly people (Table 1)<sup>(21)</sup>.

Severe and moderate protein–energy malnutrition (PEM), protein malnutrition (PM) and energy malnutrition (EM) were classified as malnutrition; and mild PEM, EM and PM were classified as at risk of malnutrition.

IBW was calculated using the Hamwi equation<sup>(22)</sup> as follows.

For men: IBW = 48 kg + 1 kg for every centimetre  
more than 150 cm of height

For women: IBW = 45 kg + 0.9 kg for every centimetre  
more than 150 cm of height

+10% for large skeleton; –10% for small skeleton

The following equation was used to determine skeleton size<sup>(22)</sup>:

$$r = \text{height (cm)} / \text{hand wrist circumference (cm)}$$

Men have small, medium and large skeletons if  $r > 10.4$ ,  $r = 9.6–10.4$  and  $r < 9.6$ , respectively. For women small, medium and large skeletons are defined as  $r > 11.0$ ,  $r = 10.1–11.0$  and  $r < 10.1$ , respectively.

The full-form MNA was administered to all the volunteers. For research purposes the full test was applied to every volunteer, despite the score in the first part of the test. Each patient underwent a clinical examination including measurement of mid-arm circumference (MAC), calf circumference (CC), weight and height. Weight was recorded to the nearest 0.1 kg, with the subject in light clothes and barefoot, using a three-lever scale calibrated with 1 kg and 5 kg standard weights after each measurement. Height was recorded to the nearest 0.1 cm using a flexible inextensible tape, with the subject's bare feet close together, back and heels against the wall, standing erect and looking straight ahead. To measure MAC the mid-point between the tip of the acromion and the olecranon process was marked while the subject held the forearm in horizontal position. The measurement was performed on the subject's arm hanging freely along the trunk with a flexible inextensible tape. CC was measured at the maximal circumference between the ankle and the knee with a flexible tape measure, manipulated to maintain close contact with the skin without compression of underlying tissues. These measures were performed on the non-dominant arm and leg. BMI was calculated

**Table 1** Nutritional classification based on percentile of ideal body weight and serum albumin in elderly people<sup>(21)</sup>

Serum albumin (g/dl)	<60% IBW	60–70% IBW	71–90% IBW	>90% IBW
<2.5	Severe PEM	Severe PEM	Moderate PEM	Severe PM
2.5–3.0	Severe PEM	Moderate PEM	Moderate PEM	Moderate PM
3.1–3.5	Moderate PEM	Moderate PEM	Mild PEM	Mild PM
>3.5	Severe EM	Severe EM	Mild to moderate EM	Well nourished

IBW, ideal body weight; PM, protein malnutrition; PEM, protein–energy malnutrition; EM, energy malnutrition.

as body weight in kilograms divided by the square of height in metres. Serum albumin was measured using the bromocresol green method with a Pars Azmoon kit (Tehran, Iran). All interviews and anthropometric measurements were performed by trained nutritionists.

### Statistical analyses

Descriptive results are presented as means and standard deviations, frequencies and 95% confidence intervals. The Kolmogorov–Smirnov test was used to check the normal distribution of variables.

As a measure of the reliability of the MNA, homogeneity was computed using Cronbach's  $\alpha$  coefficient and Spearman's rank correlation coefficients between each MNA item and the total score. The correlation of the individual item was calculated when that particular item had been omitted from the total instrument<sup>(23,24)</sup>. The item–total correlation should be between 0.20 and 0.80<sup>(23)</sup>, and Cronbach's  $\alpha$  should be between 0.70 and 0.90. For group-level comparisons a value of 0.70 is usually adequate<sup>(23,24)</sup>.

Criterion-related validity is obtained when the instrument correlates highly with another criterion in the same area<sup>(23)</sup>. To assess criterion-related validity, Spearman's rank correlation coefficients between total MNA score obtained and the criteria of BMI, serum albumin level, MAC and CC were calculated.

Concurrent validity is a type of criterion-related validity and can be used when the instrument and another measure are compared, i.e. correlated, at the same time<sup>(23)</sup>. Spearman's rank correlation coefficients were used for assessing this validity by comparing the patient's own assessment of his/her nutritional status and total MNA score obtained.

For assessing construct validity, total MNA scores were compared between patients with BMI < 24 and  $\geq 24$  kg/m<sup>2</sup>, patients with pressure sores or other skin ulcers and those without, and patients with serum albumin < 3.5 and  $\geq 3.5$  g/dl.

A BMI of 24–29 kg/m<sup>2</sup> is a recommended reference interval for individuals over 65 years<sup>(25)</sup> and a serum albumin level of 3.5 g/dl as the cut-off point to define malnutrition has been widely accepted in previous studies<sup>(26,27)</sup>.

Differences between the groups were tested using the Mann–Whitney *U* test (two-tailed significance).

Sensitivity (the ability to identify cases correctly, i.e. the true positives), specificity (the ability to identify non-cases correctly, i.e. the true negatives), positive-predictive value

( $A/(A + B)$ ) and negative-predictive value ( $D/(C + D)$ ) were estimated<sup>(23)</sup> (see Table 2). Malnutrition and at risk of malnutrition were merged into one group and compared with the well-nourished group.

Positive-predictive value here is the probability that a patient is malnourished or at risk of malnutrition, e.g. with a positive screening result. Negative-predictive value is the probability that a patient is not malnourished or at risk of malnutrition, e.g. with a negative screening result<sup>(28)</sup>.

To identify optimal threshold values for predicting malnutrition, receiver-operating characteristic (ROC) curve analysis was performed for MNA scores. The area under the ROC curve (AUC) was also evaluated. An AUC value of 0.5 indicates that the variable performs no better than chance, whereas a value of 1.0 indicates perfect discrimination. A larger AUC represents a greater reliability and discrimination of the scoring system<sup>(29)</sup>. Cut-off values can be set depending on the purpose for which the scales are used. For screening purposes, a high sensitivity and a high negative-predictive value are required, whereas diagnosis requires a high specificity and a high-positive predictive value<sup>(30)</sup>. The best Youden index (sensitivity + specificity – 1) was used to determine the best cut-off point<sup>(30)</sup>. The Youden index is used to compare the proportion of cases correctly classified. The higher the Youden index, the more accurate the prediction (higher true positives and true negatives, and fewer false positives and false negatives) at the cut-off point.

*P* values lower than 0.05 were considered significant. All computations were performed using the SPSS statistical software package version 11 (SPSS Inc., Chicago, IL, USA). Ethical approval for the study was granted by Tehran University of Medical Sciences.

## Results

Eighty-nine (40.3%) men and 132 (59.7%) women participated in the present study. Their ages ranged between 65 and 102 years; mean age was 78.1 (SD 7.5) years. The most frequent medical diagnoses among the participants were CVD (42.1%) and hypertension (57.9%). Total MNA scores averaged 23.6 (SD 3.1) and ranged from a minimum of 11.5 to a maximum of 29.5. According to the original cut-off point of the full MNA, 3.2% had an MNA score lower than 17 (malnourished), 43.4% had an MNA score between 17 and 23.5 (at risk of malnutrition) and 53.4% had a score of at least 24 (well nourished). These results according to

**Table 2** Cross table for calculating sensitivity, specificity and predictive values

	Malnourished or at risk (based on %IBW and serum albumin)	Well nourished (based on %IBW and serum albumin)
Malnourished or at risk (based on MNA)	A	B
Well nourished (based on MNA)	C	D

%IBW, percentile of ideal body weight; MNA, Mini Nutritional Assessment.

percentile of IBW and serum albumin were 2.3%, 17.1% and 80.6%, respectively. Thus classification of the nutritional status of patients according to the MNA was significantly different from classification according to serum albumin and IBW percentile ( $P < 0.001$ ). Using the MNA classified more people as malnourished or at risk of malnutrition.

### Reliability

The reliability of the MNA is reflected in the item–total score correlations displayed in Table 3. Cronbach's  $\alpha$  was 0.61. Eight out of eighteen items (numbers 4, 7, 8, 9, 10, 11, 12 and 14) were not in relation to the total scale. Excluding these items from the MNA increased Cronbach's  $\alpha$  by 0.02 only.

### Validity

Criterion-related validity of the MNA, assessed as the correlations between total MNA score and BMI, MAC, CC and serum albumin, is shown in Table 4. All correlations were significant.

Concurrent validity of the instrument is shown in the correlation between total MNA scores and the patients' views of their own nutritional status, which reached a statistically significant value of  $r_s = 0.30$  ( $P < 0.001$ ; Table 3).

Construct validity of the MNA was calculated, comparing total MNA scores between patients with BMI  $< 24$  and  $\geq 24$  kg/m<sup>2</sup>, between patients with pressure sores or other skin ulcers and those without, and patients with serum albumin  $< 3.5$  and  $\geq 3.5$  g/dl (Table 5). There were significant differences between the two BMI groups ( $P < 0.001$ ), but not between groups categorized according to serum albumin and skin ulcers.

The ROC curves shown in Figs 1 and 2 plot the sensitivity *v.* 1 – specificity for total MNA score in predicting low serum albumin ( $< 3.5$  g/dl) and low BMI ( $< 24$  kg/m<sup>2</sup>)

as markers of malnutrition. The AUC was found to be 0.69 (95% CI 0.39, 1.00) for albumin ( $P = 0.12$ ) and 0.74 (95% CI 0.67, 0.81) for BMI ( $P < 0.0001$ ), indicating that the MNA test is relatively accurate in detecting malnourished people according to BMI but not according to serum albumin.

The AUC, which represents the overall accuracy of the total MNA score as a test for detecting malnutrition and the risk of malnutrition, was 0.8 (95% CI 0.7, 0.8;  $P < 0.001$ ).

The sensitivity and specificity of the MNA according to its established cut-off points were 82% and 63%, respectively. Positive-predictive value was 35% and negative-predictive value was 93%. By using the Youden index the best cut-off point to detect malnourished and at risk of malnutrition in the present study was 22, with sensitivity of 88%, specificity of 62%, positive-predictive value of 57% and negative-predictive value of 89%, respectively.

### Discussion

A simple and clinically useful instrument for the nutritional screening of older patients is very important to prevent, detect and treat undernutrition, to prevent

**Table 4** Correlations between total MNA score and nutritional status criteria (Spearman rank correlation coefficients,  $r_s$ ) among 221 elderly patients, Tehran, 2008

Criterion	<i>n</i>	$r_s$	<i>P</i> value
BMI	216	0.46	$< 0.001^*$
Mid-arm circumference	221	0.47	$< 0.001^*$
Calf circumference	221	0.55	$< 0.001^*$
Serum albumin	180	0.19	0.008*

MNA, Mini Nutritional Assessment.

\* $P < 0.05$  is significant.

**Table 3** Item–total score correlations (Spearman rank correlation coefficients,  $r_s$ ) for Mini Nutritional Assessment among 221 elderly patients, Tehran, 2008

Item no.	Item content	$r_s$	<i>P</i> value
1	Changes in dietary intake	0.29	$< 0.001^*$
2	Weight loss	0.18	0.006*
3	Mobility	0.34	$< 0.001^*$
4	Psychological stress or acute disease	0.12	0.062
5	Neuropsychological problems	0.29	$< 0.001^*$
6	BMI	0.20	0.002*
7	Lives independently	–0.029	0.66
8	More than 3 prescription drugs per day	0.076	0.26
9	Pressure sores or skin ulcers	0.00	0.99
10	Full meals per day	0.06	0.35
11	Protein intake	0.004	0.95
12	Fruits or vegetables	0.11	0.08
13	Fluid	0.19	0.004*
14	Mode of feeding	0.12	0.07
15	Self-view of nutritional status	0.30	$< 0.001^*$
16	Health status in comparison with other people of the same age	0.41	$< 0.001^*$
17	Mid-arm circumference	0.36	$< 0.001^*$
18	Calf circumference	0.41	$< 0.001^*$

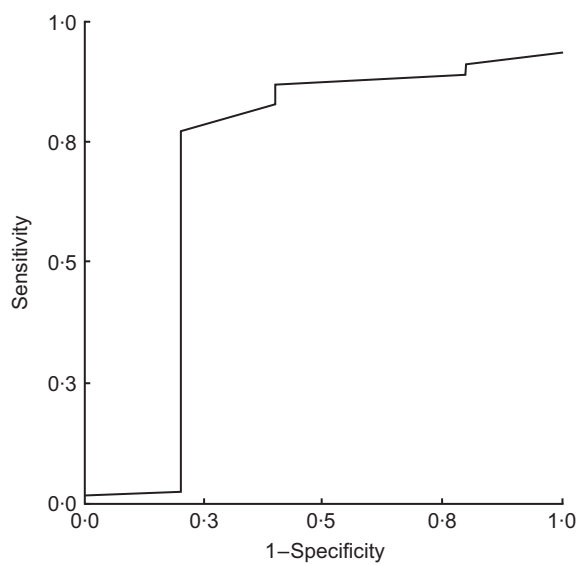
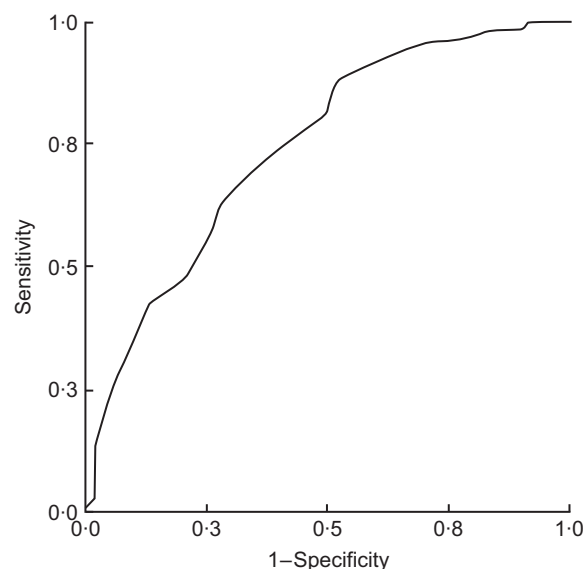
\* $P < 0.05$  is significant.

**Table 5** Comparison of MNA scores between known groups (based on BMI, serum albumin and skin ulcers) among 221 elderly patients, Tehran, 2008

Groups with expected low scores	n	MNA score		Groups with expected high scores	n	MNA score		P value
		Mean	SD			Mean	SD	
BMI < 24 kg/m <sup>2</sup>	95	22.2	3.5	BMI ≥ 24 kg/m <sup>2</sup>	121	24.8	2.2	<0.001*
Serum albumin < 3.5 g/dl	5	22.5	3.4	Serum albumin ≥ 3.5 g/dl	175	24.0	2.9	0.27
Pressure sores/skin ulcers	9	22.2	4.6	No pressure sores/skin ulcers	212	23.7	3.1	0.39

MNA, Mini Nutritional Assessment.

\*P &lt; 0.05 is significant.

**Fig. 1** Receiver-operating characteristic curve for the Mini Nutritional Assessment as a predictor of serum albumin level < 3.5 g/dl among 221 elderly patients, Tehran, 2008. Diagonal segments are produced by ties**Fig. 2** Receiver-operating characteristic curve for the Mini Nutritional Assessment as a predictor of BMI < 24 kg/m<sup>2</sup> among 221 elderly patients, Tehran, 2008. Diagonal segments are produced by ties

unwanted complications in the geriatric population. Thus the MNA was developed to be easy to use in identifying older patients who are nutritionally at risk. However, besides feasibility, reliability and validity are important factors for the screening outcome<sup>(11)</sup>.

The most extensively evaluated tool seems to be the MNA, which has been validated with older adult populations from the very frail to the healthy in a variety of settings, such as elective surgery<sup>(16)</sup>, outpatient clinics and nursing homes<sup>(31)</sup>. Sensitivity and specificity have also been investigated in several studies<sup>(20,32)</sup>. In a review article by Guigoz, the MNA was mentioned as a screening and assessment tool with a reliable scale that clearly defines thresholds usable by health-care professionals<sup>(6)</sup>. The MNA is considered acceptable in terms of the time required for completion and its simplicity; although concerns have been raised about the transferability of the tool to countries in which it has not been validated, it is widely recognized as a useful nutritional assessment tool<sup>(33)</sup>.

In the present study, the MNA was used to detect malnutrition or risk of malnutrition in the elderly in Iran.

Anthropometric measurements including BMI, MAC and CC, and serum albumin, were used as nutritional parameters. Although there are no generally accepted criteria for the diagnosis of malnutrition, these parameters have been widely used to evaluate nutritional status.

In the current study the MNA had a Cronbach's  $\alpha$  value of 0.6;  $\alpha$  should be between 0.70 and 0.90 to show a good reliability<sup>(20,31)</sup>.

We demonstrated that the total MNA score showed a good correlation with anthropometric markers and serum albumin; nevertheless, the AUC showed that the MNA can diagnose energy or energy-protein malnutrition but not protein malnutrition, of which low serum albumin is the marker. The significant difference between two BMI groups in mean MNA scores and the non-significant result between two groups according to serum albumin also confirm this result.

The MNA (using its established cut-off points) showed good sensitivity and specificity among the current study population, but the positive-predictive value of 35% caused a great false-positive prediction of malnutrition or

at risk of malnutrition. This means that many cases with false-positive diagnoses of malnutrition might withdraw resources from those in real need of nutritional measures.

Using the best cut-off point for MNA scores, which was 22 (by the Youden index), to detect malnourished and at risk of malnutrition in the present study, resulted in a considerable increase in sensitivity and positive-predictive value (by 6% and 22%, respectively). There were also slight decreases in specificity and negative-predictive value by 1% and 4%, respectively.

The same result was seen in the study performed by Kuzuya *et al.* in Japan, which concluded that the full MNA cut-off point for malnutrition should be modulated for this population<sup>(34)</sup>.

To date, no ethnic-specific anthropometric targets exist; rather, these targets are derived from populations of US or European origin and are inappropriately applied to men and women of Asian descent. Ethnicity has been recognized as a significant modifier in anthropometric measurements<sup>(35)</sup>. In addition, the MNA contains dietary patterns that may differ across ethnicities<sup>(36)</sup>. Therefore, the MNA or cut-off point for malnutrition may not be a good fit for Asian populations, including Iranian elderly.

In elderly populations in Europe and the USA, a cut-off point below 24 for total MNA score, as an indicator of PEM or at risk of undernutrition, was found to have a sensitivity of 96%, specificity of 98% and positive-predictive value of 97%<sup>(5)</sup>. However, the same cut-off point yielded a much lower sensitivity and specificity among Iranian elders. Moreover, the latter study group consisted of the elderly from a charity foundation. Therefore, it is hard to consider this sample representative of the elderly Iranian population.

Further studies are required to evaluate the cut-off point for malnutrition and at risk of malnutrition in the elderly Iranian population. In addition, further investigation should be conducted to determine whether the MNA can correctly identify those elderly who are likely to benefit from nutritional support.

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