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AGREEMENT BETWEEN DIFFERENT VERSIONS OF MNA

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Abstract: Malnutrition occurs frequently in the elderly with important clinical and functional consequences. Moreover, the treatment of malnutrition in the elderly may be effective if clinical and nutritional interventions are performed in the early stages. Therefore the early identification of the risk of malnutrition using validated and handy tools plays a pivotal role in terms of clinical outcome. Mini Nutritional Assessment (MNA) was validated for this purpose since many years but it is still ongoing the debate over whether the use of different items in certain clinical conditions can be effective without affecting the validity of the nutritional status evaluation. The aim of this study was to assess the agreement between different versions of MNA in the evaluation of nutritional risk in elderly subjects. *Methods:* 522 subjects, 345 women and 177 men, were recruited from nursing homes or were free living in three different regions in Italy. All subjects underwent a multidimensional geriatric evaluation, addressed especially to nutritional status. We compared three different versions of MNA: the "original" version; a "proportional" MNA (MNA- P) in which the total MNA score was replaced by the ratio between the maximum score that each subject could obtain without including the body mass index (BMI) and the total original MNA score; and a third version in which calf circumference (CC) and mid- upper arm circumference (MAC) were used instead of BMI. *Results:* According to the original MNA, a high prevalence of malnutrition was found out in both genders (26% of women and 16.3% of men); both the versions of MNA, in which BMI was not considered, showed a good predictive value compared to original MNA. In particular, the MNA- P. showed an overall efficiency equal to 89,1% with specificity and positive predictive value respectively equal to 97.5% and 95.2%. MNA- CC- MAC showed even better results in terms of overall efficiency (91.4%), sensitivity (81.1%), specificity (97.1%), positive and negative predictive values (94.2% and 94.4%, respectively). *Conclusion:* The different versions of MNA gave similar results in the classifications of subjects and in comparison with nutritional and biochemical parameters. Moreover MNA versions that did not considered BMI seem to be more effective in singling out subjects with risk factors related to malnutrition (disability, reduced strength and calf circumference, anaemia).

Key words: MNA, malnutrition, elderly.

Introduction

Malnutrition occurs frequently in the elderly with important clinical and functional consequences. Available data in the literature demonstrate that up to 15% of community- dwelling and home- bound elderly, 20 to 60% of hospitalized subjects and up to 85% of nursing home residents are malnourished (1-4).

Because of energy and protein deficiencies, malnutrition causes adverse effects on body composition and on body function such as impaired muscle function, decreased bone mass, immune dysfunction, anaemia, reduced cognitive function, poor wound healing, delayed recovering from surgery, higher hospitalization and readmission rate, and mortality (5). These phenomena are amplified in case of hospitalization, and the presence of malnutrition may deeply affect the prognosis, the length of hospitalization, the incidence of acute events and complications (6).

Moreover, the treatment of malnutrition in the elderly may be effective if clinical and nutritional interventions are performed in the early stages. In particular in the elderly, there is probably a "point of no return": when malnutrition is too severe, any nutritional intervention will be no more effective (7-10).

Therefore the early identification of the risk of malnutrition using validated and handy tools plays a pivotal role in terms of clinical outcome. The Mini Nutritional Assessment (MNA) is a validated nutrition screening and assessment tool, but it is still ongoing the debate over whether the use of different items in certain clinical conditions can be effective without affecting the validity of the nutritional status evaluation (11, 12).

The aim of this study was to assess the variation of agreement between MNA and nutritional status parameters when data about body weight and stature are not available.

Materials and methods

The study was carried out involving a sample of subjects who were selected in order to evaluate the role of social and economic determinants on malnutrition in elderly (13). This study was promoted by the Italian National Institute for Health, Migration and Poverty (NIHMP) in collaboration with

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"Sapienza" University of Rome. The study was performed after the approval of the local ethics committees. Oral and written informed consent was obtained from participants or their legally authorized representatives.

Three Italian research centres (in Lazio, Emilia- Romagna and Sicily regions) participated in the study. From June 2009 to June 2011, participants were recruited among subjects admitted in the nursing homes (NH) or elderly community-dwelling ambulatory subjects attending the involved geriatric facilities.

Subjects were screened according to the following inclusion and exclusion criteria :

- inclusion criteria:
  - age > 65 years;
- exclusion criteria:
  - subjects on artificial nutrition;
  - grade "4" comorbidity or severely disabling conditions or at high risk of death according to the Cumulative Illness Rating Scale (CIRS) (14).

Anamnesis, physical examination and nutritional assessment were performed:

- Mini Nutritional Assessment (MNA): three different versions of this tool were used:
  - The "original" MNA, consisting of 18 questions grouped into 4 parts: anthropometry [body mass index (BMI), weight loss, mid upper arm and calf circumferences], clinical status (medications, mobility, pressure sores and skin ulcers, lifestyle, psychological stress or neuropsychological diseases), dietary assessment (autonomy on feeding, quality and number of meals, fluid intake) and self- perception of health status and nutrition. The total score ranges from 0 to 30 points. MNA score < 17 points indicates malnutrition; from 17 to 23,5 MNA score is an indicator of a risk of malnutrition, instead a good nutritional status is defined by MNA score ≥ 24 (15);
  - A "proportional" MNA, that we called MNA- P, in which the original MNA total score was replaced by the ratio between the maximum score that each subject could obtain excluding BMI (usually accounting for three points) and the original MNA total score. Similarly, the cut-off points (17 and 24) were substituted by the ratio between these values and the maximum obtainable points by a complete MNA (27). Patients were classified as "malnourished" below 0.56, "at risk of malnutrition" from 0.56 to 0.79, and "well- nourished" from 0.8 and up (16).
  - A third version (called MNA- CC- MAC), in which the MNA was modified using calf circumference (CC) and mid- upper arm circumference (MAC) instead of BMI. The score assigned to CC was tripled while the score assigned to MAC was doubled. In this version cut-off points were the same of the "classic" MNA (17).
- Nutritional status evaluation
  - anthropometric parameters: body weight, height, arm circumference (AC), triceps skinfold thickness (TSF), calf circumference (CC).

    The body mass index [BMI= body weight (Kg)/ height (m^2)], muscle arm circumference [MAC = (AC- TSF) × π]. The anthropometric measures were taken following the procedures described in the "Anthropometric standardization reference manual" (18).

    The anthropometric data collection was preceded by an inter- assessor training session. The same tools were used in all the facilities involved in the project: SECA scale 86 (200 kg, to the nearest 0,1 Kg, certified and homologated as class III), flexible metallic tape (200 cm, to the nearest 1 cm), telescopic stadiometer (200 cm; 49 cm of telescopic arm), Holtain Tanner Whitehouse Plicometer, anthropometer with a graduated scale in centimeters.
  - muscle strength of the flexor muscles of the forearm, expressed in kg was measured by the Jamar hydraulic dynamometer (19)
  - dietary anamnesis was performed by a dietician to evaluate the energy intake and was carried out using the weighted average of the major food categories of macronutrients provided by the Italian National Institute for Research on Food and Nutrition (INRAN) (20)
- Multidimensional Geriatric Assessment using:
  - the Cumulative Illness Rating Scale (CIRS) (5) for the evaluation of comorbidities; it is divided in two parts: the comorbidity index (CI) and the severity index (SI);
  - the Short Portable Mental Status Questionnaire (SPMSQ) was performed to identify cognitive impairment (21);
  - Geriatric Depression Scale (GDS) (22);
  - Psychological and social aspects, education level, income, family support, presence of a caregiver, social support, distance from food supply centres, availability of transportation services, nutrition knowledge, current social role and previously assumed social role;
  - the Instrumental Activities of Daily Living (IADL) scale and the ADL (Activities of Daily Living) test evaluating the current functional ability (23, 24)
- laboratory parameters: albumin, transferrin, hemoglobin, lymphocyte count, cholesterol, and cholinesterase levels were tested. Biochemical assays were carried out at the Clinical Rehabilitation Institute "Villa delle Querce" in Nemi (Rome) using commercial kits supplied by ABX Italy (Rome). The COBAS-MIRA biochemistry analyzer was used (Roche, Germany). Plasma samples were obtained from the antecubital vein; blood sampling was performed in the early morning after an overnight fasting.

Data analysis

Predictive value of MNA-P and MNA- CC- MAC versus MNA (considered the gold standard) was measured through the evaluation of:

- efficiency: the fraction of all the tested individuals who were correctly classified as either having or not having the disease. [true positives (TP) + true negatives (TN)] / [true

positives (TP) + false positives (FP) + true negatives (TN) + false negatives (FN)];
- Sensitivity: the proportion of positives who were correctly identified [TP/ TP+FN] (probability of a positive test given that the patient is malnourished);
- Specificity: the proportion of negatives who were correctly identified [TN/ TN+FP] (probability of a negative test given that the patient was not malnourished);
- Predictive value of positive test: PPV = [TP/ TP+FP] (probability that the patient with a positive test result was malnourished);
- Predictive value of negative test: NPV- = [TN/ TN+FN] (probability that the patient with a negative result was not malnourished).

	MNA-P or MNA-CC-MAC	
MNA	**Number of subjects with positive test result**	**Number of subjects with negative test result**
Number of subjects with disease	True Positive (TP)	False Negative (FN)
Number of subjects without disease	False Positive (FP	True Positive (TN)

Statistical analysis was carried out after verification of the normal distribution of the variables with parametric tests for comparison of means (Student's t-test and ANOVA) and for the evaluation of the frequency distribution ($\chi 2$ di Pearson). Statistical significance was set at p value < 0,05.

Data were entered into a Microsoft Excel spreadsheet and analyzed using the statistical software SPSS for Windows 10.0 (SPSS Inc. 1989-1999).

Results

Subjects' Characteristics

522 subjects were enrolled over a 2- year period (from 2009 to 2011): 345 women (mean age: 77.5±8 years) and 177 men (mean age: 76,3±7 years). Subjects came from nursing homes (41,3% of females and 49,2% of males) or were free living (FL) (table 1).

A high prevalence of malnutrition, estimated by the original MNA, was found in both genders: 23,2% of women and 13,6% of men were classified as malnourished (MNA score <17); 40,3% of women and 35,6% of men were at risk of malnutrition (MNA score: 17- 23,5). The prevalence of malnutrition was significantly higher in nursing home residents in both sexes when compared to their free- living counterparts (table 1).

The average level of comorbidity defined by the Cumulative Illness Rating Scale was high and was similar in both sexes; a high level of disability and depression were very frequent (table 1). Clinical and functional parameters were more impaired in nursing home subjects (data not shown; see 13)

Table 1
Sample description

		Nursing Home		Free living		P
		F	M	F	M	
No. of subjects		195	121	277	125	
Age (years)		81.6±8	77.5±8	75.6±7	76.1±6	* **
MNA						
	Malnourished (%)	42,5	30,8	14,5	2	* **
	Patients at risk of malnutrition (%)	43,3	34,6	39	35,6	
	Normal nutritional status (%)	14,2	34,6	46,5	62,4	
CIRS						
	Comorbidity index	3±1	2.9±2	2.1±1	2.1±1	*
	Severity index	2±0.5	1.8±0.7	1.7±0.4	1.6±0.5	Ns
IADL						
	Score	4±5	6.4±5	9.2±5	10.4±5	* **
	Less autonomous subjects (%)	72.9	49.1	25.2	19.8	**
ADL						
	Score	5.9±4	7.3±4	8.8±4	9.8±3	*
	Lost functions/6	2.8±2	2.3±2	1.5±2	1±1	* **
	> 2 functions lost (%)	53.2	37.9	25.2	17.4	* **
SPMSQ						
	Score	4.3±3	3.6±3	3±3	2.6±3	*
	Cognitive status impairment (score > 7) (%)	18.9	16.4	8.9	6.7	*
GDS						
	Score	6.2±3	5.4±4	4.6±4	2.8±3	* **
	depression (score > 10/15) (%)	60.6	44.3	38.5	17.4	* **

* p < 0.05 between nursing home and free living subjects (regardless of gender); ** p < 0.05 between males (M)and females (F), regardless of setting; NS: not significant; Data represented as mean ± standard deviation, unless otherwise stated; Abbreviations. MNA: Mini Nutritional Assessment; F: females; M: males; CIRS: Cumulative Illness Rating Scale; IADL: Instrumental Activities of Daily Living; ADL: Activities of Daily Living; SPMSQ: Short Portable Mental Status Questionnaire; GDS: Geriatric Depression Scale

Agreement between MNA and MNA-P or MNA-CC-MAC

Both the versions of MNA, in which BMI was not considered, showed a good predictive value compared to the "original" MNA.

In particular, the MNA- P, in which the total MNA score was replaced by the ratio between the total MNA score and the maximum points that each subject could obtain without including BMI, showed an overall efficiency equal to 89,1% with a quite good specificity and positive predictive value (97.5% and 95.2%, respectively) (table 2).

Table 2
Agreement between MNA-P and MNA

	MNA-P		
MNA	**Malnutrition**	**At risk of Malnutrition**	**Normal nutritional status**
Malnutrition	99	5	
At risk of malnutrition	27	173	2
Normal nutritional status		23	193

Efficiency: 89.1%; Sensitivity: 81.1%; Specificity: 97.5%; Positive predictive value: 95.2%; Negative predictive value: 89.4%. Abbreviations. MNA: Mini Nutritional Assessment; MNA-P: "proportional" MNA in which the total MNA score was replaced by the ratio between this value and the maximum points that each subject could obtain without including BMI

Consisting of a modified MNA using the calf circumference (CC) and mid- upper arm circumference (MAC) instead of the BMI, the MNA- CC- MAC showed even better results in terms of overall efficiency (91.4%), sensitivity (81.1%), specificity (97.1%), positive and negative predictive values (94.2% and 94.4%, respectively) (table 3).

Table 3
Agreement between MNA-CC-MAC and MNA

	MNA-CC-MAC		
MNA	Malnutrition	At risk of Malnutrition	Normal nutritional status
Malnutrition	98	6	
At risk of malnutrition	26	175	1
Normal nutritional status		12	204

Efficiency: 91.4%; Sensitivity: 81.1%; Specificity: 97.1%; Positive predictive value: 94.2%; Negative predictive value: 94.4%. Legend: MNA: Mini Nutritional Assessment; MNA-CC-MAC: MNA was modified using calf circumference (CC) and mid-upper arm circumference (MAC) instead of BMI.

Correlation between different versions of MNA, nutritional and biochemical parameters (tables 4-6)

Nutritional parameters (energy intake, BMI, AC, CC, TSF, MAC, and hand-grip strength) and biochemical parameters (albumin, transferrin, hemoglobin, lymphocyte count, cholesterol, and cholinesterase levels) were significantly correlated with MNA scores and classes. Particularly, the mean values of all these parameters were significantly different in malnourished, at risk of malnutrition and normal nutritional status subjects independently of the version of MNA used.

Table 4
MNA and Nutritional status parameters

			MNA		
		Malnutrition	At risk of malnutrition	Normal nutritional status	p
Energy intake	kcal/day	1520±552	1757±476	2074±513	0.000
BMI	kg/m2	23.8±5	29.2±6	30.6±6	0.000
AC	cm	23±4	27±4	30.1±4	0.000
CC	cm	28.1±4	32.6±4	35.5±4	0.000
TSF	mm	11.9±6	17.4±8	19.6±8	0.000
MAC	cm	19.3±3	21.6±3	24±3	0.000
HG	Right	kg	9.2±6	13.7±6	22±9
0.000					
	Left	kg	7.9±6	13.4±6	19.8±9
0.000					
Hb	mg/dl	11.2±1	12.1±1	13.1±1	0.000
Lymphocytes	#/mm3	1881±982	2021±983	2205±1119	0.032
Transferrin	mg/dl	185.2±48	220.6±42	256.4±41	0.000
Albumin	mg/dl	3.6±0.6	3.9±0.5	4.2±0.4	0.000
CHE	UI/l	5879±2291	6804±2042	7904±1845	0.000
Cholesterol	mg/dl	172.7±47	184.7±46	196.8±47	0.000

Data represented as mean ± standard deviation, unless otherwise stated; p<0.05. Abbreviations. BMI: body mass index; AC: arm circumference; CC: calf circumference; TSF: triceps skinfold; MAC: mid upper arm circumference; HG: hand grip; Hb: hemoglobin; CHE: cholinesterase

Furthermore, we analyzed the data concerning the false positive subjects at the MNA- P or MNA- CC- MAC: in these subjects the classification of nutritional status by MNA- P or MNA- CC- MAC ("malnourished" or "at risk of malnutrition") was worst than using the "original" MNA, that classified them as "at risk" or with "normal nutritional status" respectively. Clinical, functional and nutritional parameters of these subjects were compared to data of true positive subjects (in whom the MNA and MNA- CC- MAC or MNA- P classification was the same). The data showed that in false positive subjects most of the parameters were less favorable. In particular functional scores (IADL and ADL), calf circumference, hand grip strength, and hemoglobin levels were significantly lower in false positive individuals than in true positive subjects (see tables 7 and 8).

Characteristics of false negative subjects were not analyzed because of the extremely reduced number of them.

Table 5
MNA-CC-MAC and Nutritional status parameters

			MNA-CC-MAC		
		Malnutrition	At risk of malnutrition	Normal nutritional status	p
Energy intake	kcal/day	1573±536	1764±491	2074±517	0.000
BMI	kg/m^2	24.4±5	29.5±6	30.5±6	0.000
AC	cm	23.4±4	27.2±4	30.3±4	0.000
CC	cm	28.1±4	32.9±4	35.8±4	0.000
TSF	mm	12.8±7	17.4±8	19.7±8	0.000
MAC	cm	19.4±3	21.8±3	24.1±4	0.000
HG Right	kg	9.3±6	14±6	22.5±9	0.000
Left	kg	8.3±6	13.7±6	20.4±9	0.000
Hb	mg/dl	11.2±1	12.1±1	13.2±1	0.000
Lymphocytes	#/mm^3	1864±956	2056±972	2206±1146	0.022
Transferrin	mg/dl	190.5±52	221±40	258.4±41	0.000
Albumin	mg/dl	3.6±0.6	3.9±0.5	4.2±0.4	0.000
CHE	UI/l	6145±2340	6818±2023	7902±1855	0.000
Cholesterol	mg/dl	178.7±48	182.6±47	197.3±47	0.001

Data represented as mean ± standard deviation, unless otherwise stated; p< 0.05. Abbreviations. BMI: body mass index; AC: arm circumference; CC: calf circumference; TSF: triceps skinfold; MAC: mid upper arm circumference; HG: hand grip; Hb: hemoglobin; CHE: cholinesterase

Table 6
MNA-P and Nutritional status parameters

			MNA-P		
		Malnutrition	At risk of malnutrition	Normal nutritional status	p
Energy intake	kcal/day	1558±525	1785±487	2080±527	0.000
BMI	kg/m^2	24.8±6	29.6±6	30.2±6	0.000
AC	cm	23.8±4	27.2±4	30.2±4	0.000
CC	cm	28.7±4	32.8±4	35.6±4	0.000
TSF	mm	13.2±7	17.6±8	19.4±8	0.000
MAC	cm	19.7±3	21.7±3	24.1±4	0.000
HG Right	kg	9.4±6	13.7±6	20.6±9	0.000
Left	kg	8.5±6	13.7±6	20.4±9	0.000
Hb	mg/dl	11±1	12.2±1	13.2±1	0.000
Lymphocytes	#/mm^3	1823±860	2086±999	2208±1170	0.009
Transferrin	mg/dl	188.2±51	221.6±39	261.3±39	0.000
Albumin	mg/dl	3.6±0.6	3.9±0.5	4.2±0.4	0.000
CHE	UI/l	5981±2169	6899±2102	8005±1779	0.000
Cholesterol	mg/dl	174±46	184.9±48	198.4±47	0.001

p<0.05; Data represented as mean ± standard deviation, unless otherwise stated. Abbreviations. BMI: body mass index; AC: arm circumference; CC: calf circumference; TSF: triceps skinfold; MAC: mid upper arm circumference; HG: hand grip; Hb: hemoglobin; CHE: cholinesterase

Table 7
Clinical, functional and nutritional parameters in false positive subjects at MNA-CC-MAC versus "original" MNA

MNA-CC-MAC vs MNA							
		At risk at MNA			Normal nutritional status at MNA		
		FP	TP	p	FP	TP	p
Age	Years	79.5±7	78.7±6		73.1±6	73.3±6	
Comorbidity index		1.93±0.5	1.77±0.5		1.83±0.6	1.55±0.3	
Severity index		2.88±1.4	2.64±1.6		2.17±1.5	1.87±1.6	*
IADL	Score	4.1±4	7.3±5	*	9.6±4	12.2±5	*
ADL	Score	6.3±4	8.3±3	*	9.3±3	11±2	*
SPMSQ	Score	4.7±3	3.5±2	*	2.6±2	1.42±2	*
GDS	Score	7.2±3	5.4±3	*	3.3±4	3.1±3	
Energy intake	kcal/day	1736±417	1762±485		2001±478	2078±516	
BMI	kg/m²	26.9±4	29.6±6	*	30.3±5	30.6±5	
AC	cm	24.7±3	27.4±4	*	27±3	30.3±4	*
CC	cm	28.9±2	33.1±4	*	30±1	35.8±4	*
TSF	mm	16.5±7	17.6±8		16.9±6	19.8±7	
MAC	cm	19.6±2	21.9±3	*	21.7±2	24.1±3	*
HG Right	kg	10.4±5	14.1±6	*	13±4	22.5±9	*
Left	kg	10.1±6	13.8±6	*	13.8±5	20.3±8	*
Hb	mg/dl	11.5±1	12.1±1	*	12.4±1	13.1±1	*
Lymphocytes	#/mm³	1772±765	2065±1008		2094±536	2213±1146	
Transferrin	mg/dl	209.9±56	221.9±40		224.5±25	258.4±41	*
Albumin	mg/dl	3.9±0.4	3.9±0.5		4.3±0.4	4.2±0.4	
CHE	UI/l	7151±2165	6745±2030		7912±1729	7904±1862	
Cholesterol	mg/dl	203.1±43	181.7±46	*	193.2±61	197.1±47	

* $p < 0.05$; Data represented as mean ± standard deviation, unless otherwise stated. Abbreviations. TP: true positive (MNA and MNA-CC-MAC classification was equal); FP: false positive (classification was worst at MNA-CC-MAC than at MNA); BMI: body mass index; AC: arm circumference; CC: calf circumference; TSF: triceps skinfold; MAC: mid upper arm circumference; HG: hand grip; Hb: hemoglobin; CHE: cholinesterase

Table 8
Clinical, functional and nutritional parameters in false positive subjects at MNA-P versus "original" MNA

MNA-P vs MNA							
		At risk at MNA			Normal nutritional status at MNA		
		FP	TP	p	FP	TP	p
Age	Years	80±7	78.6±6		73.9±6	73.2±6	
Comorbidity index		1.88±0.4	1.78±0.5		1.84±0.4	1.53±0.3	*
Severity index		2.93±1.2	2.63±1.6		2.61±1.6	1.8±1.5	*
IADL	Score	4±5	7.4±5	*	9.6±4	12.3±3	*
ADL	Score	5.9±4	8.3±3	*	9.1±3	11.1±3	*
SPMSQ	Score	4.1±3	3.6±2		2.1±2	1.4±2	
GDS	Score	6.8±3	5.5±3		3.8±4	3±3	
Energy intake	kcal/day	1756±359	1764±489		1939±442	2090±520	
BMI	kg/m²	28.4±4	29.4±6		32.7±5	30.3±5	
AC	cm	26.5±3	27.1±4		29±3	30.2±4	
CC	cm	30.9±2	32.8±4	*	33.7±3	35.7±4	*
TSF	mm	18±8	17.4±8		21±7	19.4±7	
MAC	cm	20.9±3	21.7±3		22.4±2	24.2±3	*
HG Dx	kg	10.6±4	14.1±6	*	13.9±8	22.9±8	*
Sn	kg	10.1±5	13.9±6	*	14.8±5	20.6±8	*
Hb	mg/dl	10.8±1	12.2±1	*	12±1	13.2±1	*
Lymphocytes	#/mm³	1757±624	2071±1021	*	2088±553	2220±1171	
Transferrin	mg/dl	201.1±58	222.9±39	*	217.4±35	261.3±39	*
Albumin	mg/dl	3.9±0.4	3.9±0.5		4.1±0.5	4.2±0.3	
CHE	UI/l	6643±1535	6825±2121		7279±2061	8023±1786	
Cholesterol	mg/dl	183±43	184.7±47		183.9±52	198.4±47	

* $p < 0.05$; Data represented as mean ± standard deviation, unless otherwise stated. Abbreviations. TP: true positive (MNA and MNA-CC-MAC classification was equal); FP: false positive (classification was worst at MNA-P than at MNA); BMI: body mass index; AC: arm circumference; CC: calf circumference; TSF: triceps skinfold; MAC: mid upper arm circumference; HG: hand grip; Hb: hemoglobin; CHE: cholinesterase

Discussion

According to the "traditional" MNA, a high prevalence of malnutrition was found out in both genders (26% of women and 16.3% of men); both the versions of MNA, in which BMI was not considered, showed a good predictive value compared to the "original" MNA.

The different versions of MNA gave similar results in the classification of subjects' nutritional status and in the comparison between the MNA classification and nutritional and biochemical parameters.

Calculating BMI requires measuring body weight and stature

that are often unavailable in bedridden subjects or not reliable in frail and disabled elderly subjects. Different studies tried to substitute BMI with calf circumference and/ or muscle arm circumference (that can be considered an index of sarcopenia) by redistributing the score attributed to BMI to these items (25-28). Previously, our group proposed a proportional score to overcome the difficulties in obtaining a reliable BMI (7). In both these cases the correlation between "traditional" MNA and the different proposed versions was good allowing an increased applicability of MNA in clinical practice (29-31). The present study confirmed these results in a large sample of elderly subjects.

To overcome the difficulties in obtaining BMI, another possible method is to calculate body weight and stature through other recumbent anthropometric data; although specific equations for geriatric populations were developed and validated in different countries (32-36) this approach is not admissible: the need to measure skinfold thickness or knee height conflicts with one of the main features of the MNA: it is easy to use and its short time- consuming.

Furthermore, these versions, that not include BMI, seem to be more effective in singling out subjects with risk factors related to malnutrition (disability, reduced strength and calf circumference, anaemia). Other studies showed that calf circumference was the best indicator, followed by muscle arm circumference and then BMI, in predicting the nutritional status and health conditions. Calf circumference and muscle arm circumference were also more effective than BMI in predicting the 12- month follow- up mortality (27). A modified version of MNA- Short Form considering calf circumference instead of BMI was prospectively confirmed to work well in a population of older people from different settings (37).

In fact, even when body weight and stature are correctly measured, BMI cannot give a reliable portrayal of body composition that can be affected by variations of its main components (fat mass, lean body mass and body water), not necessarily reflected by weight differences. Noteworthy, not only in elderly subjects, indirect estimations of body composition, like BMI, are useful for groups but unreliable in individuals (38, 39). An inter- examiner and intra- examiner variability can be attributed also to calf circumference and muscle arm circumference (40, 41). Even considering these limitations, calf circumference and muscle arm circumference are surely more related to lean body mass and therefore they can better represent the presence of sarcopenia and its clinical and functional consequences. In our study, MNA- CC- MAC, and to a lesser extent MNA- P, could better single out subjects characterized by a reduction in hand grip strength and disability. Although in these subjects nutritional parameters were not affected, these conditions can undoubtedly represent risk factors for malnutrition.

A limitation of the study can be represented by the design of the study mainly devoted to analyze the prevalence of malnutrition in different settings in three regions of Italy (13) while in this paper the collected data were used to verify the accuracy of different versions of MNA. In fact in all the subjects body weight and stature could be reliably collected and very frail subjects were not enrolled.

In conclusion, while targeting nutritional risk is extremely important in the elderly, at the same time we need to have an easy- to- use tool for care givers, at the same time acceptable to patients. Moreover, this tool needs to be highly reliable, with proven validity and sensitivity. MNA versions omitting BMI, similarly to "classic" MNA, meet these criteria and can represent important instruments to fight against malnutrition, contributing by this way to the improvement of well- being and quality of life of elderly subjects.

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