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Short title: Mini Nutritional Assessment and sarcopenia

Usefulness of the Mini Nutritional Assessment in the screening of sarcopenia in a sample of institutionalized older persons: A cross-sectional study.

Abstract

Background: Sarcopenia is a disease associated with muscle changes during aging, and its detection remains a challenge outside specialized clinical units.

Objective: To evaluate the utility of the Mini Nutritional Assessment (MNA) in detecting sarcopenia in institutionalized older persons.

Materials and Methods: Cross-sectional study in adults aged 55 years and older from the city of Puebla. The MNA in its short form (SF) and full form (LF) were administered. The diagnosis of sarcopenia was made according to EWGSOP2. Points obtained from MNA-SF and MNA were plotted on a ROC curve. The odds ratio (OR) for presenting sarcopenia was evaluated according to recommended cutoff points with logistic regression models, adjusted for age and sex.

Results: 162 participants were included, 64.1% were women, the mean age was 69.8 years (SD:5). The mean scores of MNA-SF and MNA-LF were 12.17 (SD:1.78), and 25.1 (SD:2.83), respectively. The prevalence of sarcopenia was 20.4%. The AUC of MNA-SF was 0.68 (95%CI:0.58-0.78) and for MNA-LF, 0.60 (95%CI:0.49-0.71). The OR for presenting sarcopenia with MNA-SF<12 was OR=2.87 (95%CI:1.31-6.29) and, after adjustment for age and sex, OR=2.47 (95%CI:1.10-5.54).

Conclusions: According to AUC, MNA-SF may be useful in detecting sarcopenia in institutionalized older persons, while MNA-LF may have reduced utility in practice.

Key words: Sarcopenia, Malnutrition, Mini Nutritional Assessment, Nutrition, Older Persons

Resumen

Antecedentes: la sarcopenia es una enfermedad asociada con cambios musculares durante el envejecimiento, y su detección sigue siendo un desafío fuera de las unidades clínicas especializadas.

Objetivo: Evaluar la utilidad del Mini Nutritional Assessment (MNA) en la detección de sarcopenia en personas mayores institucionalizadas.

Materiales y Métodos: Estudio transversal en adultos de 55 años y más de la ciudad de Puebla. Se administró el MNA en su forma corta (SF) y forma completa (LF). El diagnóstico de sarcopenia se realizó según EWGSOP2. Los puntos obtenidos de MNA-SF y MNA se representaron en una curva ROC. Se evaluó el odds ratio (OR) de presentar sarcopenia según puntos de corte recomendados con modelos de regresión logística, ajustados por edad y sexo.

Resultados: Se incluyeron 162 participantes, el 64.1% fueron mujeres, la edad media fue 69.8 años (DE:5). Las puntuaciones medias de MNA-SF y MNA-LF fueron 12.17 (DE: 1.78) y 25.1 (DE: .,83), respectivamente. La prevalencia de sarcopenia fue del 20.4%. El AUC de MNA-SF fue 0,68 (IC 95%: 0.58-0.78) y para MNA-LF, 0.60 (IC 95%: 0.49-0.71). El OR de presentar sarcopenia con MNA-SF<12 fue OR=2.87 (IC95%:1.31-6.29) y, tras ajustar por edad y sexo, OR=2.47 (IC95%:1.10-5.54).

Conclusiones: Según la AUC, MNA-SF puede ser útil para detectar sarcopenia en personas mayores institucionalizadas, mientras que MNA-LF puede tener una utilidad reducida en la práctica.

Key words: Sarcopenia, Desnutrición, Mini Nutritional Assessment, Nutrición, Personas Mayores.

Introduction

The relative fraction of older adults in the population has increased in recent years worldwide. Faced with a longer life expectancy, the age distribution has been shifting more and more towards increasingly advanced ages. By the year 2050, the World Health Organization estimates that 22% of the world's population will be represented by individuals over 60 years old (1). In Mexico, 17,958,707 people aged 60 or older were estimated to reside in the country, representing 14% of the country's population (2).

Sarcopenia is a progressive and widespread muscular disease (muscular atrophy) that originates from adverse muscular changes that accumulate throughout life (3). According to its etiology, it can be divided into primary (age-related) when there is no specific evident cause and secondary (disease, inactivity, or malnutrition) (4). Sarcopenia is associated with high personal, social, and economic burdens (5), increases the risk of falls and fractures (6,7), leads to a lower quality of life (8), loss of independence and/or the need for long-term care (9-11), and higher mortality (12). It affects between 5% and 13% of adults aged 60 to 70 years, and 50% of adults over 80 years old. By the year 2025, it is estimated that 1.2 billion people will have sarcopenia, and by the year 2050, this figure will reach 2 billion patients (13).

Malnutrition is considered one of the main causes of sarcopenia, with the coexistence of nutritional alterations such as low nutritional intake and weight loss with the decrease in muscle mass and strength (14, 15). Therefore, nutritional screening tools have been proposed to be useful in screening for sarcopenia in older adults. The Mini Nutritional Assessment (MNA) has been considered a highly sensitive and specific nutritional screening tool to assess the risk of malnutrition (16), and it has recently been proposed as a potential tool in the assessment of sarcopenia in hospitalized older adults (17, 18). However, to our knowledge, its usefulness outside of hospital settings has not been evaluated. Therefore, the objective of the study is to evaluate the utility of the Mini Nutritional Assessment (MNA) in detecting sarcopenia in institutionalized older persons.

Material and methods

Study design and setting

A cross-sectional study was conducted from May to August of 2021 in institutionalized older adults at the day center " La Casa del Jubilado," for retired individuals formerly employed by the Benemérita Universidad Autónoma de Puebla, located in the city of Puebla, Mexico. The present study was approved by the ethics and research committee of the Benemérita Universidad Autónoma de Puebla (C.Q./CT 052P/2021).

Participants

The study included individuals over 55 years old with normal cognitive function determined by a score greater than 14 on the abbreviated Mini-Mental State Examination, the ability to walk, and who provided informed consent to participate. Exclusion criteria were the presence of eating disorders and the use of specialized diets or nutritional treatments. Elimination criteria included withdrawal of consent for participation and incomplete data during anthropometric and functionality assessments.

Data Collection and Measurements

Antropometric and body composition measurements

Anthropometric measurements such as weight, height, waist circumference, calf circumference, mid-upper arm circumference, and calf skinfold were collected. All measurements were performed by a certified anthropometrist following the standards of measurement established by the International Society for the Advancement of Kinanthropometry.

For obtaining body weight, a SECA Mod 813 floor scale with a precision of 100g was used, height was measured using a SECA Mod 225 stadiometer with a precision of 0.1 cm, and waist, arm, and calf circumferences were measured using a SECA Mod 201 measuring tape. Waist circumference was measured above the upper border of the iliac crests (approximately at the level of the navel). Calf circumference was measured at the most prominent part of the calf while keeping the leg at a 90° angle. Mid-upper arm circumference was measured at the midpoint between the acromion process of the scapula and the olecranon process (elbow) on the non-dominant arm when relaxed. The calf skinfold was measured on the medial side of the lower leg, at the greatest circumference of the calf.

The percentage of body fat was measured through bioimpedance analysis (Biodynamics Body Cell Mass Analyzer Mod 550, Washington, USA) following the standardized protocol provided by the manufacturer.

Minimal Nutritional Assessment

We used both the Mini Nutritional Assessment in its short version (MNA-SF) and its long version (MNA-LF) (19, 20). The MNA-SF consists of 6 items (BMI, recent weight loss, appetite or eating problems, mobility impairment, acute illness/psychological stress, and dementia or depression), whereas the MNA-LF comprises 18 items, including the first 6 items of the MNA-SF plus 12 items covering aspects such as muscle mass (arm circumference and calf circumference), lifestyle, mobility, medication, number of meals, protein sources consumption, fruits and vegetables intake, fluids, and self-perception of health. The Spanish adaptations of both questionnaires can be found at the following link: https://www.gob.mx/inger/documentos/guia-de-instrumentos-de-evaluacion-de-la-capacidad-funcional.

Subjects were classified according to the scores obtained in each test as follows: normal nutritional status (MNA-SF: 12-14, MNA-LF: 24-30), risk of malnutrition (MNA-SF: 8-11, MNA-LF: 17-23.5), and malnutrition (MNA-SF: <7, MNA-LF: <17).

Sarcopenia evaluation

To determine the diagnosis of sarcopenia, the classification of the European Working Group on Sarcopenia in Older People 2 (EWGSOP2) was used, in which sarcopenia is classified as probable sarcopenia due to the presence of low muscle strength, confirmed sarcopenia due to the presence of low muscle strength and low muscle quantity or quality, and severe sarcopenia due to the presence of both of the above plus low physical performance (4).

For the assessment of muscle strength, a Jamar hand dynamometer (5030J1) was used, following the Southampton protocol (21). The highest score of 6 measurements was obtained (3 per arm), and the score was recorded to the nearest 1 kg. Muscle strength was classified as low according to the cutoff points of EWGSOP2, which are <27 kg for men and <16 kg for women.

The assessment of muscle mass quantity was performed through the calculation of appendicular skeletal muscle mass adjusted for height (ASMM/height^2). The calculation of

ASMM was done using the anthropometric equation by Kawakami et al 2021 (22). Muscle mass was classified as low according to the cutoff points of EWGSOP2, which are <7.0 kg/m^2 for men and <5.5 kg/m^2 for women.

Physical performance was assessed using the 4-m gait speed test, in which the time in seconds it takes the subject to walk 4 meters without stopping is recorded. Speed was calculated in m/s. Physical performance was classified as low according to the cutoff points of EWGSOP2, which are <0.8 m/s for both men and women.

Statistical methods

Descriptive data of the sample are presented with mean, standard deviation, and range. Scores of MNA-SF and MNA-LF are presented as median and interquartile range. The presence of sarcopenia at each stage, as well as the presence of low muscle strength, mass, and performance, is presented as frequency and percentage. The 95% confidence interval (95% CI) was calculated through bootstrapping with 1000 iterations.

The scores of MNA-SF and MNA-LF were plotted on a ROC curve. The areas under the ROC curve (AUC) with their 95% CI were obtained, as well as the cutoff points for sensitivity and specificity values. Sensitivity and specificity of the cutoff point recommended by each MNA to define an alteration in nutritional status (MNA-SF <12 and MNA-LF <24) were also calculated.

To estimate the odds of presenting sarcopenia and each of its criteria according to the cutoff points suggested by the ROC curve and those used to estimate an alteration in the nutritional status of each version of MNA, various logistic regression models were performed. Data are presented as Odds Ratio (OR) with their 95% CI for each univariable model and for models adjusted by sex and age (quantitative). Assumptions of the models were evaluated by residual analysis.

A significance level of $p<0.05$ was considered statistically significant. All analyses were performed using SPSS software v.21 and graphs were created using GraphPad Prism software v.10.2.2.

Results

A total of 164 subjects met the inclusion criteria for the study. Two subjects were excluded for not completing the muscle strength evaluation protocol. Therefore, 162 participants were included in the analysis, of which 64.1% (n=103) were women. The mean age was 69.8 years (SD: 5.5). Among the subjects, 18.5% (n=30) were aged 55-65 years, 66% (n=107) were aged 65-75 years, 14.3% (n=23) were aged 75-85 years, and 1.2% (n=2) were older than 85 years. Regarding BMI, 6.8% (n=11) of the subjects had a BMI <22, 35.8% (n=58) had a BMI between 22-26.9, 27.2% (n=44) had a BMI between 27-29.9, and 30.2% (n=49) had a BMI ≥30. Descriptive results of the study sample are presented in Table 1.

Regarding sarcopenia criteria results, it was observed that the maximum dynamometry of the subjects was 17.90 (SD: 6.34) in women and 23.72 (SD: 5.15) in men. The ASMM/Height^2 was 6.53 (SD: 1.03) in women and 7.91 (SD: 1.10) in men. The gait speed was 1.03 (SD: 0.33). Among the participants, 72.2% (95% CI: 65.4-79.0) were classified with low muscle strength, 20.4% (95% CI: 14.2-27.2%) with low muscle mass, and 34% (95% CI: 27.2-41.4) with low muscle performance. Of the total sample, 33 subjects (20.4%, 95% CI: 14.2-27.2) were diagnosed with sarcopenia, of which 12 (36.4%, 95%CI: 19.0-53.7) had severe sarcopenia. Tables 2 and 3 present the data on body composition, strength, mass, and muscle performance among the classifications of MNA-SF and MNA-LF, respectively.

Figure 1 shows the ROC curves of MNA-SF (Figure 1a) and MNA-LF (Figure 1b) for sarcopenia detection. The AUC of MNA-SF was 0.68 (95% CI: 0.58-0.78) and of MNA-LF was 0.60 (95% CI: 0.49-0.71). The suggested cutoff point for sarcopenia detection by MNA-SF was <13, and <25.5 for MNA-LF. In Figure 2, ROC curves for detecting each criterion for sarcopenia diagnosis are shown.

Table 4 shows the sensitivity and specificity values for the suggested cutoff points for both MNAs and for the cutoff points recommended to define an alteration in nutritional status, for sarcopenia detection, and for each diagnostic criterion. It was observed that the cutoff points MNA-SF <12 and MNA-LF <24 showed higher sensitivity for sarcopenia, low strength, and low muscle mass detection.

Table 5 shows the results of logistic regression models to determine the odds of detecting sarcopenia and each component by the cutoff points of MNA-SF and MNA-LF. Subjects with MNA-SF <13 had 2 times higher odds of presenting sarcopenia (OR=2.36, 95% CI: 1.02-5.45, p=0.04) after adjustment for sex and age, while MNA-LF cutoff points were not associated with sarcopenia. For determining each criterion of sarcopenia diagnosis, MNA-SF was associated with low muscle mass at both cutoff points, and MNA-LF was associated with low muscle strength at the <25.5 cutoff point.

Discussion

In the present study, our objective was to evaluate the utility of the Mini Nutritional Assessment (MNA) in detecting sarcopenia in institutionalized older persons. We observed that the MNA in its short version is associated with the presence of sarcopenia, and that the cutoff point associated with sarcopenia is the point that defines an alteration in nutritional status (MNA-SF <12). Thus, subjects with an alteration in nutritional status had twice the odds of presenting sarcopenia than those with normal nutritional status.

Both the MNA-SF and the MNA-LF have a high sensitivity and specificity to malnutrition (16), what differentiates them is that the MNA-LF collects more information on dietary intake and muscle mass than the MNA-SF; and despite the evidence on the relationship between dietary intakes and sarcopenia (14), in our study an association of MNA-LF with sarcopenia was not observed, although it was observed with low muscle strength, it is important to emphasize the possibility that this finding is a type 2 error due to the lack of power of our study, more research is required to show whether this beech tree is replicable, since other studies that have explored research questions similar to ours only use the MNA-SF.

Our findings replicate findings of other authors in recent years. However, the difference in our study is that it is the first to evaluate the utility of the MNA in detecting sarcopenia in institutionalized older persons. Previous studies were conducted in hospitalized older persons. In 2020, Zhang X et al. (18) examined the efficacy of MNA-SF for sarcopenia detection in hospitalized older persons, observing an AUC of 0.76 (95% CI 0.72-0.81). Additionally, they observed that patients with sarcopenia and malnutrition by MNA-SF had lower survival in a 20-month follow-up. In this study, 66.4% of patients with sarcopenia had malnutrition, whereas in our study, 54.5% of patients with sarcopenia were at risk of malnutrition. Another study conducted in hospitalized patients in 2017 (17) showed similar results to Zhang X's findings, as MNA-SF had an AUC of 0.76 for sarcopenia detection in individuals aged 65 years and older according to EWGSOP criteria.

The most recent study in outpatient patients was conducted in China in 2023 (23), showing that MNA-SF had an AUC of 0.80 (95% CI: 0.72-0.87), with a sensitivity of 66.6% and specificity of 85.8%, using a cutoff point of 12 points. The target population of this study was more similar to ours; nonetheless, they used EWGSOP criteria, which prioritize muscle mass over strength for sarcopenia detection.

Reduced muscle mass or quality is also established as a phenotypic criterion in adult malnutrition in clinical settings by the Global Leadership Initiative on Malnutrition (24), which is evaluated through tests such as dual-energy X-ray absorptiometry (DXA) or other validated body composition measures such as bioelectrical impedance analysis (BIA), ultrasound, computed tomography (CT), and magnetic resonance imaging or magnetic resonance spectroscopy. However, these methods are not always available in most clinical or nutritional care settings, let alone in primary care or geriatric care centers. It is in these latter settings where the use of more accessible and simple assessment methods such as physical examination, anthropometric measurements of calf and/or arm muscle circumferences, as well as strength testing through dynamometry, becomes relevant. However, even these tools may not be available in geriatric care centers, not to mention the lack of trained personnel for their use and evaluation, which has been associated with the presence of malnutrition (25) and a low improvement in the nutritional status of older persons (26).

Institutionalized older adults have a lower quality of life and a higher risk of developing a worse overall health status (25). In Mexico, it has been found that institutionalized older persons have factors such as polypharmacy, depression, and lack of trained personnel associated with their nutritional deterioration (27). Therefore, our findings may provide evidence of the utility of a rapid, easy-to-administer nutritional screening test that does not require training, which can be used to detect the presence of sarcopenia in ambulatory older persons.

Our study has several limitations, the main one being the relatively small sample size for an epidemiological study. It is necessary to continue research on the application of various nutritional screening tests and their association with sarcopenia. On the other hand, although the cross-sectional design of our study is suitable for our objective, the lack of follow-up does not allow us to know if subjects who did not present sarcopenia but did have a nutritional alteration could develop sarcopenia over time.

Conclusion

In conclusion, according to AUC, MNA-SF may be useful in detecting sarcopenia in institutionalized older persons, while MNA-LF may have reduced utility in practice. The main criterion associated with MNA-SF is low muscle mass. Efforts should be directed towards conducting research in institutionalized populations of older persons to determine both the feasibility of using simple tools for sarcopenia detection and the effects of such early detections as a call to action for improving and preventing nutritional disorders.

Declarations

Ethics Approval and Consent to Participate

This study was approved by the Research Ethics Committee of the Benemérita Universidad Autónoma de Puebla (C.Q./CT 052P/2021).

Consent for Publication

All authors consent to this manuscript's publication.

Conflict of interest

The authors declare no conflicts of interest.

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Authors' Contributions

Ashuin Kammar-García: Writing-original draft, Writing-review & editing, Formal Analysis.

Javier Mancilla-Galindo: Supervision, Software.

Esmeralda Garza-Santiago: Validation, Visualization, Writing-original draft.

Addi Rhode Navarro-Cruz: Resources, Conceptualization.

Orietta Segura-Badilla: Data curation, Funding acquisition.

Obdulia Vera-López: Investigation.

Martín Lazcano-Hernández: Investigation, Methodology.

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Tables

Table 1. Descriptive results of the study sample		
	Mean (SD)	Rank
Age, years	69.75 (5.51)	54.00-89.00
Body composition		
Weight, Kg	68.19 (11.57)	32.70-103.00
Height, cm	156.37 (7.45)	136.00-174.00
BMI	27.87 4.26)	15.76-40.53
Arm circumference, cm	29.93 (3.76)	20.47-43.83
Waist circumference, cm	96.75 (9.92)	67.83-128.33
Calf circumference, cm	34.73 (3.31)	25.87-49.50
Calf fold, mm	17.60 (6.41)	4.67-50.00
Fat, %	31.82 (7.94)	9.30-47.90
MNA-SF, score	12.17 (1.78)	4.00-14.00
MNA-LF, score	25.13 (2.83)	9.50-30.00

BMI: Body mass index, MNA-SF: Minimal Nutritional Assesement short form, MNA-LF: Minimal Nutritional Assesement long form

Table 2. Data on age, body composition, strength, mass and muscle performance between the MNA-SF categories.

	MNA-SF: 12-14 points n=106		MNA-SF: 8-11 points n=55		MNA-SF: 0-7 points n=1	
	Mean	SD	Mean	SD	Mean	SD
Age, years	69.13	4.90	70.73	6.30	81.00	-
Body composition						
Weight, Kg	68.80	10.60	67.38	13.07	47.10	-
Height, cm	156.05	7.18	157.13	7.97	149.00	-
BMI	28.25	3.81	27.26	4.94	21.22	-
Arm circumference, cm	30.16	3.46	29.59	4.25	24.37	-
Waist circumference, cm	97.15	9.73	96.39	9.97	74.30	-
Calf circumference, cm	34.95	3.18	34.38	3.52	30.07	-
Calf fold, mm	18.24	6.60	16.44	5.93	13.33	-
Fat, %	32.28	7.51	31.12	8.66	20.60	-
Muscular strength						
Dynamometry	20.43	6.35	19.31	6.83	9.43	
Muscle mass						
ASMM, Kg	17.39	3.79	17.30	4.50	11.78	-
ASMM/Height^2	7.08	1.10	6.94	1.48	5.31	-
Muscle function						
Run time, seconds	4.08	1.31	4.18	1.42	5.00	-
Walking speed, m/s	1.02	0.33	1.05	0.35	1.25	-
MNA-SF, score	13.24	0.85	10.25	0.95	4.00	-
MNA-LF, score	26.34	1.98	23.08	2.15	9.50	-

BMI: Body mass index, ASMM: appendicular skeletal muscle mass, MNA-SF: Minimal Nutritional Assesment short form, MNA-LF: Minimal Nutritional Assesment long form.

Tabla 3. Data on age, body composition, strength, mass and muscle performance between the MNA-LF categories

	MNA-LF: 24-30 points n=119		MNA-LF: 17-23.5 points n=42		MNA-LF: 0-16 points n=1	
	Mean	SD	Mean	SD	Mean	SD
Age, years	69.11	5.13	71.29	6.06	81.00	-
Body composition						
Weight, Kg	68.42	10.16	68.02	14.75	47.10	-
Height, cm	156.69	7.31	155.64	7.90	149.00	-
BMI	27.88	3.70	28.00	5.54	21.22	-
Arm circumference, cm	30.15	3.40	29.43	4.61	24.37	
Waist circumference, cm	96.76	9.66	97.26	10.25	74.30	-
Calf circumference, cm	34.87	3.05	34.42	3.95	30.07	-
Calf fold, mm	17.73	6.56	17.35	6.07	13.33	-
Fat, %	31.78	7.49	32.18	9.08	20.60	-
Muscular strength						
Dynamometry	20.44	6.18	19.75	6.84	9.43	-
Muscle mass						
ASMM, Kg	17.47	3.64	17.06	5.01	11.78	-
ASMM/Height^2	7.06	1.03	6.96	1.72	5.31	-
Muscle function						
Run time, seconds	4.13	1.43	4.07	1.07	5.00	-
Walking speed, m/s	1.03	0.36	1.02	0.27	1.25	-
MNA-SF, score	13.5	12-14	11	10.0-11.0	4.00	-
MNA-LF, score	26.5	25-27.5	23.5	22.0-24.5	9.50	-

BMI: Body mass index, ASMM: appendicular skeletal muscle mass, MNA-SF: Minimal Nutritional Assesment short form, MNA-LF: Minimal Nutritional Assesment long form.

Table 4. Results of the sensitivity and specificity of the MNA-SF and MNA-LF cut-off points for the detection of sarcopenia and its components.

	Cut-off value	Sensitivity (95%CI)	Specificity (95%CI)
Sarcopenia			
MNA-SF	<13	69.70 (52.66-82.62)	52.71 (44.14-61.13)
	<12	54.55 (37.99-70.16)	70.54 (62.17-77.72)
MNA-LF	<25.5	69.70 (52.66-82.62)	49.61 (41.12-58.13)
	<24	36.36 (22.19-53.38)	75.97 (67.91-82.52)
Low muscle strength			
MNA-SF	<13	56.14 (46.98-64.90)	58.33 (44.28-71.15)
	<12	39.47 (30.98-48.65)	77.08 (63.46-86.69)
MNA-LF	<25.5	63.16 (54.01-71.45)	66.67 (52.54-78.32)
	<24	28.07 (20.64-36.93)	77.08 (63.46-86.69)
Low muscle mass			
MNA-SF	<13	69.70 (52.70-82.62)	52.71 (44.14-61.13)
	<12	54.55 (37.99-70.16)	70.54 (62.17-77.72)
MNA-LF	<25.5	69.70 (52.66-82.62)	49.61 (41.12-58.13)
	<24	36.36 (22.19-53.38)	75.97 (67.91-82.52)
Low muscle performance			
MNA-SF	<13	54.55 (41.52-66.97)	55.14 (45.70-64.22)
	<12	69.09 (55.97-79.72)	36.45 (27.95-45.89)
MNA-LF	<25.5	52.73 (39.79-65.31)	57.94 (48.47-66.86)
	<24	81.82 (69.67-89.81)	30.84 (22.88-40.13)

MNA-SF: Minimal Nutritional Assesement short form, MNA-LF: Minimal Nutritional Assesement long form.

Table 5. Logistic regression models for determining the probability of presenting sarcopenia, low strength, mass and muscle performance according to the MNA-SF and MNA-LF cut-off points.

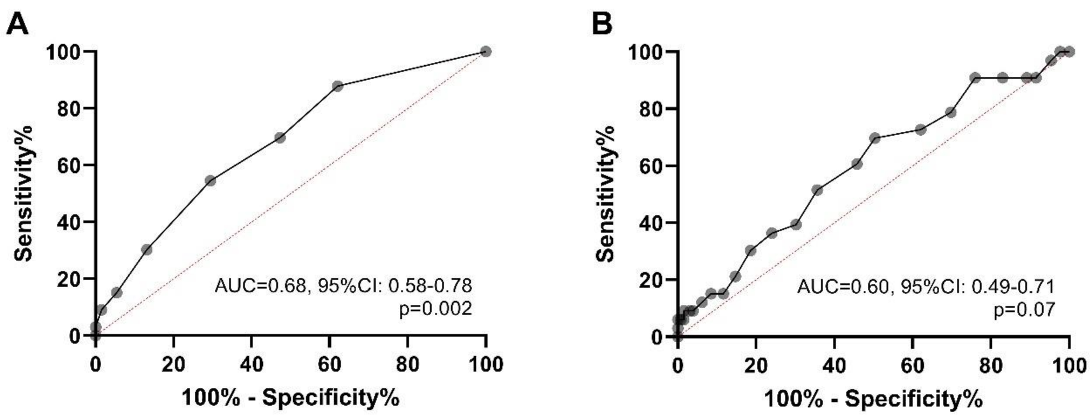
	Crude model			Adjusted model		
	OR	95%CI	p value	OR	95%CI	p value
Model for sarcopenia						
MNA-SF <13	2.56	1.13-5.82	0.02	2.36	1.02-5.45	0.04
MNA-SF <12	2.87	1.31-6.29	0.008	2.47	1.10-5.54	0.03
MNA-LF <25.5	1.83	0.84-3.98	0.13	1.51	0.67-3.40	0.32
MNA-LF <24	1.81	0.80-4.09	0.16	1.51	0.65-3.54	0.34
Model for low muscle strength						
MNA-SF <13	1.79	0.91-3.55	0.09	1.74	0.86-3.49	0.12
MNA-SF <12	2.19	1.02-4.74	0.04	1.95	0.89-4.28	0.10
MNA-LF <25.5	2.82	1.38-5.75	0.004	2.53	1.22-5.24	0.01
MNA-LF <24	1.31	0.60-2.89	0.50	1.16	0.51-2.63	0.72
Model for low muscle mass						
MNA-SF <13	2.56	1.13-5.82	0.02	2.36	1.02-5.45	0.04
MNA-SF <12	2.87	1.31-6.29	0.008	2.47	1.10-5.54	0.03
MNA-LF <25.5	1.83	0.84-3.98	0.13	1.51	0.67-3.40	0.32
MNA-LF <24	1.81	0.80-4.09	1.16	1.51	0.65-3.53	0.34
Model for Low muscle performance						
MNA-SF <13	0.68	0.35-1.30	0.24	0.67	0.33-1.34	0.26
MNA-SF <12	0.78	0.39-1.56	0.48	0.74	0.35-1.56	0.43
MNA-LF <25.5	0.73	0.38-1.41	0.35	0.72	0.35-1.46	0.36
MNA-LF <24	0.49	0.22-1.11	0.09	0.53	0.23-1.24	0.14

OR: Odds ratio, 95%CI: 95% confidence interval, MNA-SF: Minimal Nutritional Assesment short form, MNA-LF: Minimal Nutritional Assesment long form.

Adjusted model by age (Continuous) and sex.

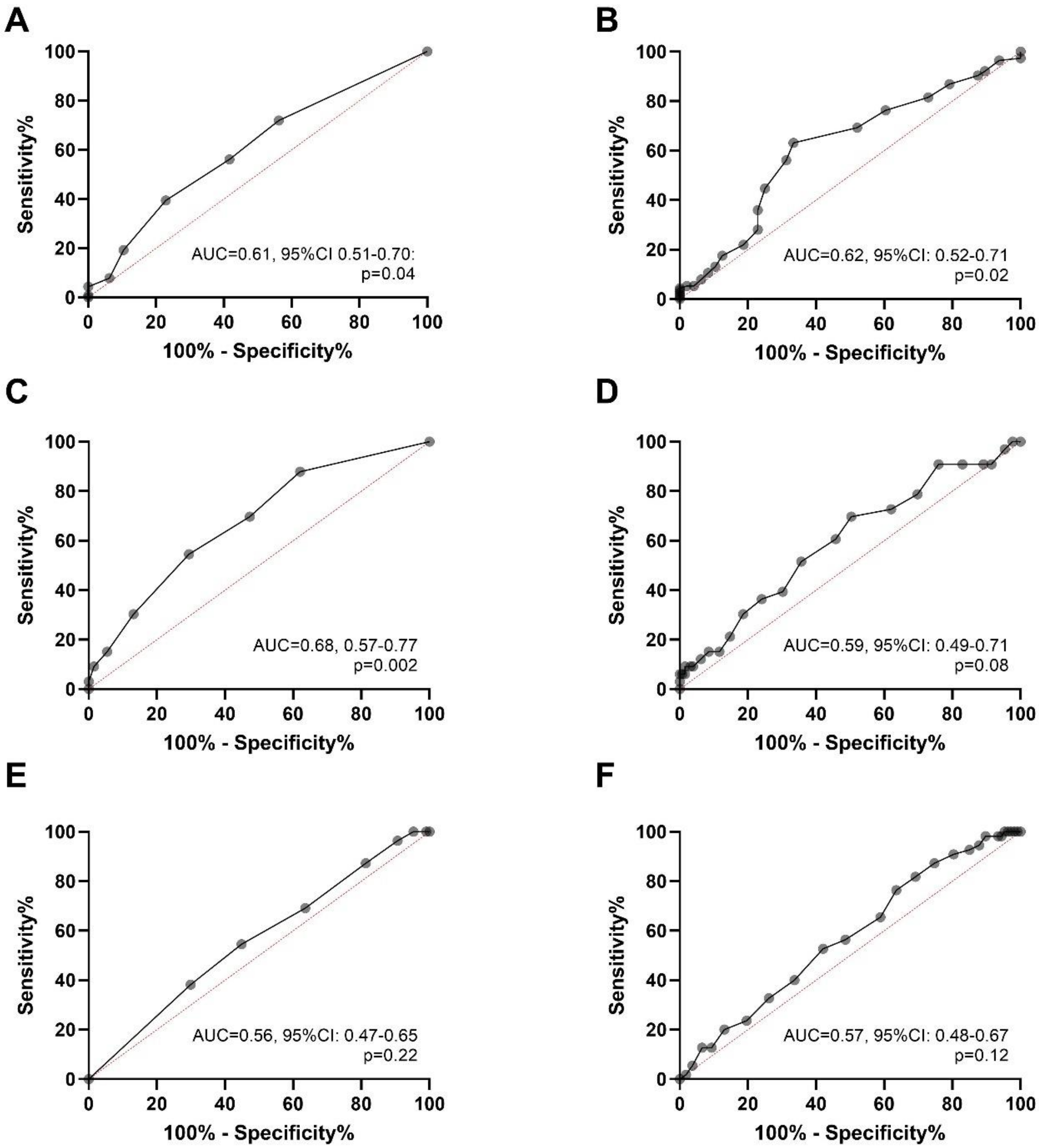
Figures:

Figure 1. ROC curves for the detection of sarcopenia by the MNA-SF and MNA-LF scores



A: MNA-SF (Minimal Nutritional Assessment short form, B: MNA-LF (Minimal Nutritional Assessment long form).

Figure 2. ROC curves for the detection of low muscle strength, mass and performance by the MNA-SF and MNA-LF scores.



A: ROC curve to detect low muscle strength by the MNA-SF (Minimal Nutritional Assessment short form, B: ROC curve to detect low muscle strength by the MNA-LF (Minimal Nutritional Assessment long form), C: ROC curve for low detector muscle mass by the MNA-SF (Minimal Nutritional Assessment short form, D: ROC curve to detect low muscle strength by the MNA-LF (Minimal Nutritional Assessment long form), E: ROC curve to detect low muscle performance by the MNA-SF (Minimal Nutritional Assessment short form, F: ROC curve to detect low muscle performance by the MNA-LF (Minimal Nutritional Assessment long form).