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Research paper

Malnutrition and sarcopenia are associated with increased mortality rate in nursing home residents: A prospective study

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ABSTRACT

Background and aims: The aim of this study was to determine the prevalence of malnutrition risk and sarcopenia in our elderly (≥ 65 years) nursing home residents and find out their association with mortality.
Material and method: This prospective observational study with a follow-up of 12 months was done in 402 subjects (65 years old or older) living in a nursing home. Nutritional status was determined with Mini Nutritional Assessment (MNA). Sarcopenia was diagnosed according to European Working Group on Sarcopenia in Older People (EWGSOP) with the measurements of muscle mass, muscle strength and physical performance using mid upper arm muscle circumference (MUAC, cm), calf circumference (CC), a standardized handheld dynamometer and gait speed. Nutritional status and sarcopenia were compared with the 1-year mortality rate.
Results: According to MNA, 56.5% of the individuals were normal, 24.8% had malnutrition risk (MR) and 18.7% had malnutrition (MN). Sarcopenia was diagnosed in 73.3% of the residents. Reduced muscle strength was found in 94.5% of the population. MN/MR were found associated with sarcopenia ($P < 0.0001$). After 12 months of follow-up, total mortality rate was 16.2%. MN, sarcopenia, BMI and MUAC were found well correlated with mortality (normal nutrition status: 10.6%, MR: 20.0% and MN: 28.0%, $P < 0.001$; sarcopenic: 19.3% and non-sarcopenic: 7.5%, $P = 0.012$). Malnutrition and sarcopenia were found related with mortality independent from other factors.
Conclusion: Malnutrition and sarcopenia are prevalent in nursing home residents. It is important to diagnose and treat malnutrition and sarcopenia in elderly nursing home residents for both can increase mortality independently.

1. Introduction

Nearly one third of the old aged people fail to meet their daily dietary requirement for energy. Two out of three elderly people stated that they do skip meals. Malnutrition (MN) is related with variety of geriatric syndromes like sarcopenia, dependency, falls and fractures. It can increase the risk of pressure ulcers, cognitive decline, infections, hospital stay, costs and mortality [1]. The prevalence of malnutrition is different in various care settings. It is 5–30% in community-dwelling elderly, 30–50% in nursing homes, and 50–70% in the hospitals [2–7]. Ulger et al. found increased 18-months mortality rate in nursing home residents with malnutrition risk (MR) or MN (N: 9.9%, MN risk: 24%, MN: 40.8%) [8]. Torma et al. also indicated increased mortality rate with malnutrition in nursing home independent from chronic diseases [9].

Anthropometric measurements, screening and assessment tests are used to diagnose MR and MN. Anthropometric measurements include weight, body mass index (BMI), circumferences of the extremities and skin-fold measurements. Height decreases with aging due the reasons such as senile kyphosis, shortening of spinal vertebrae and thinning of weight-bearing cartilage tissue. BMI < 21 kg/m^2 was considered as an indicator of malnutrition (MN) [10]. International Dietetics and Nutrition Terminology defined BMI < 23 kg/m^2 in elderly as underweight [11]. In elderly, calf circumference (CC) was found well correlated

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with muscle mass [12], and mid upper arm circumference (MUAC) was related with BMI [13].

Mini Nutritional Assessment (MNA) evaluates anthropometric measurements, BMI, weight loss, mobility, medical history (especially depression and cognitive disorders), medications, dietary intake and self-assessment of the patients. It can be used in all care settings including nursing homes [14,15].

According to definition by European Working Group on Sarcopenia in Older People (EWGSOP), sarcopenia is loss in muscle strength and function with extensive and progressive reduction in skeletal muscle mass [16]. Sarcopenia accelerates with age. In many studies, the prevalence is 5–25% in people aged between 60–70 years, and 11–50% in those over 80 years old. Halil et al. showed 68% sarcopenia in a national nursing home project including 711 elderly residents. They used handgrip strength for the diagnosis of sarcopenia according to Cardiovascular Health Study criteria [17]. Various studies about sarcopenia in nursing home residents showed prevalence between 29–85.4% [18–21]. Physical dependency and falls were associated with decreased quality of life in elderly [22]. As far as we know, few data exist in the literature about association between sarcopenia and mortality in nursing homes. Landi et al. showed association between sarcopenia and 6-months mortality rate in nursing home with hazard ratio of 2.34 [23]. Kimyagarov et al. could not find any significant relationship with sarcopenia and 1-year mortality rate [24].

In this study, our aim was to examine the prevalence of MR/MN and sarcopenia in our elderly (≥ 65 years) nursing home residents and find out their association with mortality after 12 months of follow-up.

2. Material and method

2.1. Study design and patients

This was a prospective observational study, performed in a nursing home between May 2012 and May 2013. All residents over 65 years and older were included into the study. Exclusion criteria were age < 65 years, residing in the center for less than a month, acute medical problem or trauma in the last month and severe cognitive impairment (Mini mental state examination score < 10/30) that impaired MNA and muscle strength examination were excluded. At the beginning, there were 539 residents in the center and 402 participated in the study according to inclusion/exclusion criteria.

2.2. Data collection

Demographic data, medical history, anthropometric measurements such as height, weight, mid upper arm circumference (MUAC), calf circumference (CC) and triceps skin-fold (TSF), MNA, a standardized handheld dynamometer and gait speed were used to assess nutritional status and sarcopenia. Demographic data and medical history were learned from residents, medical reports of the center and caregivers. Medical history of chronic diseases including dementia and depression was reported for each resident.

2.3. Assessment of nutrition status

Nutritional status was evaluated with MNA. It includes a short form with 6 questions (MNA-SF; screening test) and a second part including 12 more questions that is for the assessment [14]. MNA-SF score ≥ 12 was defined as normal nutritional status and no further assessment was done to those patients. Residents with MNA-SF ≤ 11 indicated further evaluation with the remaining 12 questions. The sum of the score of 18 questions was the result of MNA long form (MNA). According to MNA, score ≥ 24 indicated normal nutritional status, score between 17–23.5 showed MR and score < 17 was MN.

2.4. Sarcopenia diagnosis: assessment of muscle mass and physical activity

Sarcopenia was diagnosed according to definition of European Working Group on Sarcopenia in Older People (EWGSOP), using muscle mass, muscle strength and physical performance [16] (Fig. 1). Muscle mass was predicted with the anthropometric measurements such as MUAC, TSF and CC [12,25]. MUAC is measured from the middle point of the upper arm between acromion of the scapula at the posterior part of the shoulder and olecranon process of ulna at elbow. CC is measured from the widest point of the calf, and < 31 cm was related with decreased muscle mass [26]. TSF was measured with a Lange Skin-fold Caliper having a pressure of 10 g/mm^2 of contact surface area. The measurement

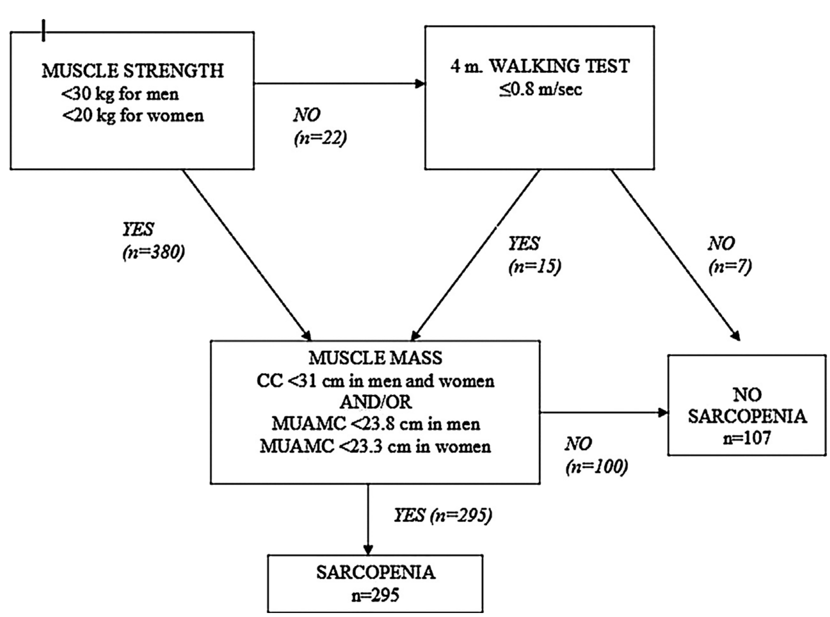

Fig. 1. Sarcopenia diagnosis algorithm.

was taken on the back of the arm and midway between the point of the acromion and olecranon process. MUAMC was calculated using the formula; MUAC–(3.14 × TSF in cm) [27,28]. Cut-off values for normal muscle mass were 23.8 cm and 23.3 cm in men and women, respectively [28]. MAMA (in cm^2) was calculated using the formula; $(MUAC-\pi TSF)^2/4\pi-10$ for males and $(MUAC-\pi TSF)^2/4\pi-6.5$ for females [29].

Muscle strength was measured with a standardized handheld dynamometer (Janmar, USA) that was determined as the best of 3 measurements made in the dominant hand. In residents who had only one upper extremity or who could use only one extremity, the measurement was made with this extremity. Cut-off values were used as mentioned by Lauretani et al., < 30 kg for men and < 20 kg for women, those were also indicated in EWGSOP consensus report [16,30]. Physical performance was measured with 4-m walking speed and ≤ 0.8 m/s was interpreted as decreased gait speed [16]. All of the measurements were done by the same two clinical nutrition nurses those have previous experiences in the field. After 12 months, mortality rate of the whole population and sub-populations were evaluated.

2.5. Statistical analysis and ethics

The data were analyzed using Statistical Package for Social Science 15.0 (SPSS) statistics program. Statistical significance was accepted as $P < 0.05$. Chi^2 test was used to evaluate categorical data. In the comparison of the data showing parametric distribution taking distribution of data into consideration during analysis of continuous variables, Student's *t*-test was used in independent samples and the Mann-Whitney U test was used to evaluate non-parametric data. Kruskal Wallis analyses were made when the distributions were not normal or homogeneity conditions of variances could not be met, and Mann-Whitney U tests were used in multi-comparisons. The degree of relationship with each continuous variable was determined using the Spearman correlation coefficient. Logistic regression analysis was used to show the relationship of continuous variables, independent of other factors.

No invasive intervention was carried out and no sample was obtained from the volunteers. Informed consent was obtained from each patient before enrolment and the study protocol was approved by the local ethics board. Furthermore, required legal permissions were obtained from the Turkish Social Service and Children Protection Institution.

3. Results

Two hundred and three of the residents were males and 199 of them were females (51 and 49% respectively). Mean age was 78.0 ± 7.9 years (65–101). Characteristics of the residents were given in Table 1. According to MNA, 227 of the individuals were in normal nutritional status (56.5%), 100 had MR (24.8%), and 75 had MN (18.7%). When different age groups were taken into consideration, MN rates were found increased in advanced age in both sexes (Table 2).

Mean BMI of the men and women were 25.9 ± 4.7 kg/m^2 and 26.0 ± 7.2 kg/m^2respectively. When ROC curve analysis was done with BMI according to nutritional status, BMI cut-off value of 23.7 kg/m^2 indicated 73% sensitivity and 90% specificity for the prediction of MN/MR (Fig. 2, area under curve: 0.867, $P < 0.001$).

Sarcopenia was diagnosed in 73.3% of the residents (males: 65.9%, females: 80.1%). One hundred and three residents had low CC (25.6%, 46 men and 57 women), 253 residents showed low MUAMC (62.9%, 106 men and 147 women), 380 (94.5%) had low muscle strength and 284 (70.6%) had decreased gait speed (could not be measured in 64 residents). Malnutrition and malnutrition risk together were found associated with sarcopenia (Table 3).

Table 1
Characteristics of the residents.

	Male (n = 203)	Female (n = 199)
Age (years)	74.9 ± 6.8	81.1 ± 7.8
BMI (kg/m²)	25.9 ± 4.7	26.0 ± 7.2
Functional status		
Ambulatory	162	176
Wheelchair	41	15
Bedridden	0	8
MNA		
Normal	135 (66.5%)	92 (46.2%)
MR	51 (25.1%)	49 (24.6%)
MN	17 (8.4%)	58 (29.1%)
MUAC (cm)	27.3 ± 3.4	26.6 ± 5.2
CC (cm)	34.18 ± 4.46	33.57 ± 5.92
MUAMC (cm)	22.8 ± 2.9	21.2 ± 3.3
Muscle strength (kg)	19.7 ± 7.2	7.2 ± 5.5
Gait speed (m/s)	0.64 ± 0.24	0.54 ± 0.21
No. of chronic diseases		
0	89 (43.8%)	65 (32.7%)
1–3	85 (41.9%)	114 (57.3%)
> 3	29 (14.3%)	20 (10.0%)
Dementia	47 (23.2%)	99 (49.7%)
Diabetes	27 (13.3%)	30 (15.0%)
Hypertension	66 (32.5%)	66 (33.2%)
Chronic heart failure	48 (23.6%)	11 (5.5%)
Coronary artery disease	51 (25.1%)	67 (33.7%)
Chronic kidney disease	25 (12.3%)	4 (2.0%)
COPD	46 (22.7%)	13 (6.5%)
Depression	47 (23.2%)	83 (41.7%)
Cancer	2 (1.0%)	5 (2.5%)
Stroke	30 (14.8%)	29 (14.6%)
Obesity	39 (19.2%)	51 (25.6%)
No. of drugs	8.6 ± 4.1	9.1 ± 3.6
Smoker (last 5 years)	25 (12.3%)	4 (2%)

BMI: body mass index; CC: calf circumference; COPD: chronic obstructive pulmonary disease; MAMA: mid upper arm muscle area; MN: malnutrition; MR: malnutrition risk; MUAC: mid upper arm circumference; MUAMC: mid upper arm muscle circumference; NS: 'non-significant' or 'not-related with mortality'.

Sarcopenic residents showed lower BMI, CC, MUAMC, muscle strength and gait speed. Gait speed was found related with sarcopenia diagnosis independent from other factors in multivariate logistic regression analysis ($P = 0.04$). Fig. 3 showed ROC analysis of MAMA and sarcopenia diagnosis relationship in both sexes. According to our results, area under curve for men was 0.974 ($P < 0.001$) and a cut-off value of 35.0 cm^2 showed 96% sensitivity and 100% specificity. Area under curve for women was 0.982 ($P < 0.001$) and a cut-off value of 36.7 cm^2 showed 98% sensitivity and 97% specificity.

After 12 months of follow-up, total mortality rate was 16.2% (n = 65). Table 4 showed association of different factors and clinical conditions with mortality. BMI was found related with mortality. Mortality rate was increased in lowest BMI percentiles (< 24 kg/m^2: 21.1%, 24–30 kg/m^2: 14.7%, 30–36 kg/m^2: 10%, 36–40 kg/m^2: 12.5% and > 40 kg/m2: 9%) (Fig. 4). MNA was found well correlated with mortality (Normal: 10.6%, MR: 20.0% and MN: 28.0%,

Table 2
Undernutrition (MR + MN) rates according to sex and age.

	Age ranges (years)		
	65–74	75–84	≥ 85
Men			
Number	29 (n = 103)	29 (n = 80)	10 (n = 20)
Percentage	28.2	36.3	50
Women			
Number	11 (n = 44)	48 (n = 90)	48 (n = 65)
Percentage	25.0	53.3	73.8

MNA: mini nutritional assessment; MN: malnutrition; MR: malnutrition risk.

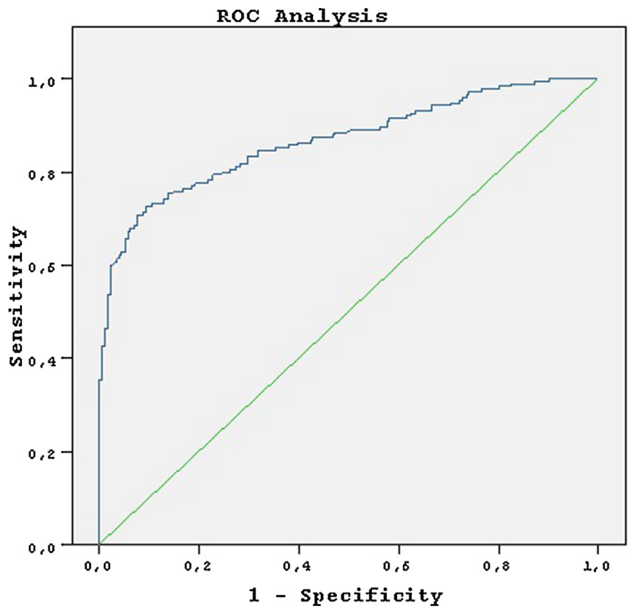

Fig. 2. ROC analysis indicating relationship between BMI and nutritional status.

Table 3
Comparison of sarcopenia diagnosis with other related factors.

	Sarcopenia (n = 295)	No Sarcopenia (n = 107)	P-value
Age (years)	79.4 ± 8.0	75.2 ± 6.5	< 0.001
Body weight (kg)	58.0 ± 14.4	76.7 ± 14.8	< 0.001
BMI (kg/m^2)	24.5 ± 5.3	29.9 ± 6.4	< 0.001
MR/MN+	158	17	< 0.001
MUAMC (cm)	20.5 ± 2.2	25.9 ± 2.0	< 0.001
CC (cm)	32.6 ± 4.8	37.2 ± 5.0	< 0.001
MAMA (cm^2)	26.0 ± 7.1	44.7 ± 9.1	< 0.001
Muscle strength (kg)	9.4 ± 7.5	15.3 ± 8.9	< 0.001
Gait speed (m/s)	0.57 ± 0.24	0.73 ± 0.20	0.002

MNA: mini nutritional assessment; MN: malnutrition; MR: malnutrition risk.

$P < 0.001$) (Table 4). Control data showed MN risk in 30.9% and MN in 12.7% of the residents. Sarcopenia and MUAC were found associated with 12 months mortality rate (sarcopenia: 19.3 vs 7.5%, $P = 0.012$, MUAC: $P = 0.011$) (Table 4).

After our population was divided into 4 groups: normal nutritional status and no sarcopenia, MN/MR without sarcopenia, sarcopenia without MN/MR and MN/MR with sarcopenia, 12-month mortality was most significant in MN/MR + sarcopenia group (24.7%, Table 5). In logistic regression analysis, MN and sarcopenia were associated with 12-month mortality independent from other factors (MN; $P = 0.04$, hazard ratio (HR): 2.01, 95% confidence interval (CI): 1.03–3.90, Sarcopenia; $P = 0.05$, HR: 2.30, 95% CI: 0.97–5.45).

Table 4
Different clinical conditions related with mortality.

Clinical conditions	Alive (n = 337)	Death (n = 65)	P-value
Age (years)	78 ± 8	79 ± 8	0.19
BMI (kg/m^2)	26.3 ± 6.0	24.1 ± 6.0	**0.009**
Nutrition status			
Normal	203	24	< **0.001**
MN/MR	134	41	
Sarcopenia			
Normal	99	8	**0.012**
Sarcopenic	238	57	
CC (cm)	34.0 ± 5.2	33.3 ± 5.3	NS
MUAC (cm)	27.2 ± 4.5	25.6 ± 4.2	**0.011**
MUAMC (cm)	22.1 ± 3.3	21.2 ± 3.0	0.09
MAMA (cm^2)	31.2 ± 11.5	28.6 ± 9.6	0.08
Gait speed (m/s)	0.62 ± 0.23	0.61 ± 0.32	NS
Muscle strength (kg)	11.1 ± 8.5	10.9 ± 7.7	NS
No. of chronic diseases > 3	41	8	NS
Dementia	144	2	NS
Depression	127	3	NS
Hypertension	130	2	NS
Diabetes	56	1	NS
Chronic heart failure	58	1	NS
Coronary artery disease	107	11	NS
Stroke	48	11	NS
Chronic kidney disease	29	0	NS
Obesity	81	9	0.08
Cancer	6	1	NS
COPD	59	0	NS
No. of drugs ≥ 7 (median)	262	49	NS
Smoking	22	7	NS

BMI: body mass index; CC: calf circumference; COPD: chronic obstructive pulmonary disease; MAMA: mid upper arm muscle area; MN: malnutrition; MR: malnutrition risk; MUAMC: mid upper arm muscle circumference; NS: 'non-significant' or 'not-related with mortality'; P-value given in bold characters indicated statistical significant result.

4. Discussion

MNA has been used in many studies in nursing homes for the assessment of nutritional status. In a meta-analysis, Pauly et al. evaluated 12 studies that used MNA for the assessment of

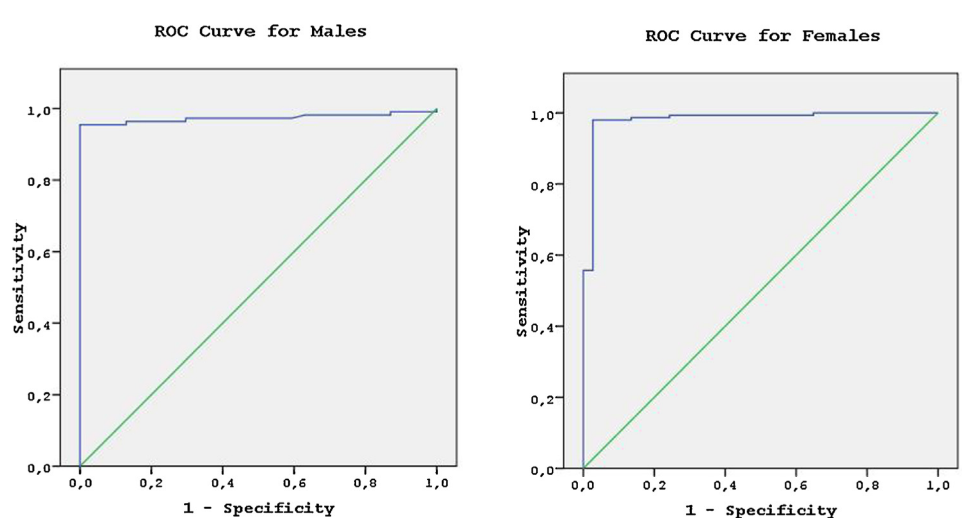

Fig. 3. ROC analysis indicating relationship between MAMA and sarcopenia.

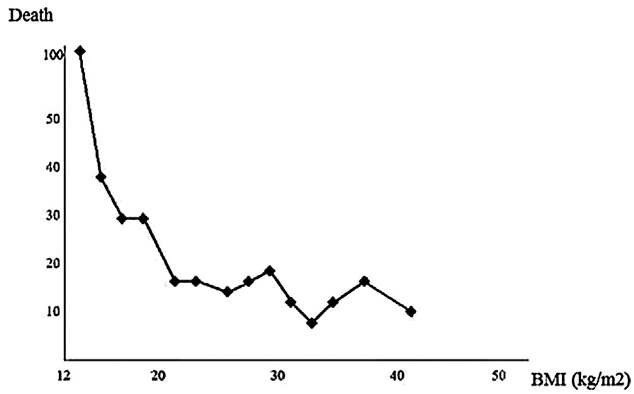

Fig. 4. Association of body mass index (BMI) with mortality.

Table 5
Survival was evaluated in different groups those arranged according to nutrition status and sarcopenia.

Groups	Alive	Death	%
MN/MR– Sarcopenia–	84	6	6.6
MN/MR+ Sarcopenia–	15	2	11.7
MN/MR– Sarcopenia+	119	18	13.1
MN/MR+ Sarcopenia+	119	39	24.7

MN: malnutrition; MR: malnutrition risk.

nutritional status in nursing homes between 1999 and 2006. Malnutrition was found between 2–38%, and MR was between 37–62% [31]. Kulnik et al. showed 48.3% MR and 38.8% MN [32], Suominen et al. mentioned 60% MR and 29% MN [33]. Kaiser et al. (2010) reported malnutrition rates of older people as 5.8% for those living in society, 13.8% for those residing in nursing homes and 38.7% for those staying in hospitals [2]. In Turkish Nursing Home Project, 1797 residents were evaluated, and MR and MN rates were 38.3% and 11.9% respectively [6]. Ulger et al. found increased mortality rates in residents with MN and MR (9.9% in normal nutrition status, 24% in MR group and 40.8% in those with MN) [34]. Our population showed similar MN rates, and mortality was found significantly increased with undernutrition (Table 4).

BMI was associated with increased mortality rates in the elderly. Landi et al. showed that one-year mortality for older people living in society increased in those with BMI < 22 kg/m^2 and did not increase with BMI > 27 kg/m^2 [35]. Dey et al. reported that, 15-year mortality rate among non-smoking people aged > 70 years was least when BMI is between 27–29 kg/m^2 for men, and 25–27 kg/m^2 for women [36]. Kvamme et al. reported increased mortality in elderly with BMI < 25 kg/m^2. They found lowest mortality with BMI between 25–29.9 kg/m^2 [37]. Kaiser et al. reported highest mortality rate in those with BMI < 20 kg/m^2 and lowest in obese residents [38]. In our study, BMI cut-off 23.7 kg/m^2 was related with MN/MR with 73% sensitivity and 90% specificity. BMI < 24 kg/m^2 was associated with highest mortality rate (Fig. 4). A lower BMI may be related with vulnerability to acute diseases. This can be related with the decreased reserve for metabolic demands and inability of the organism to cope with stress. However, elderly with higher BMI can preserve their lean muscle mass much more when compared to those with lower BMI. Although higher BMI in elderly seems to be related with lower mortality, body composition data can reflect better results.

Sarcopenia is the muscle loss during aging, which is associated with disability, falls and frailty. Although gold standards for the measurement of muscle mass are dual X-ray absorpsiometry (DEXA) and magnetic resonance imaging (MRI), simple anthropometric measurements are practically used in many studies [28,39–41,12,42]. In our study, we used indirect measures of muscle mass; calf circumference and mid upper arm muscle circumference. 73.3% of our population had sarcopenia and it showed significant relationship with malnutrition and BMI. Landi et al. used MUAMC cut-off 21.1 cm for men and 19.2 cm for women based on their previous data [27,39,40]. When we analysed our data according to the cut-off values mentioned by Landi et al., only 40% of our population indicated sarcopenia, that was not correlated well with gait speed, muscle strength and malnutrition ratios, and did not seem suitable for our patients. Wannamethee et al. [41] used MUAMC < 24.91 cm for the lowest percentile for muscle mass in 4107 men, which was related with higher mortality. In a recent study, Akin et al. [28] found MUAMC cut-off values for muscle mass as 23.8 cm for men and 23.3 cm for women, which is conducted in Turkish population and seems more accurate according to our results. Most of our residents showed decreased muscle strength according to cut-off values for both sexes mentioned by Lauretani et al. and accepted by EWGSOP [16,30]. Recently, Laurenço et al. made an analysis on 3260 elderly people from 3 cohorts and indicated lower possible cut-off values for both gait speed and handgrip strength, according to BMI, sex and height of the individuals. They found significantly lower rates of sarcopenia in all cohorts when compared to EWGSOP criteria [43]. According to data from one of these cohorts (FIBRA-RJ from Brazil), hand grip strength cut-off values were around 23.3 kg for men with BMI > 22.4 kg/m^2, which was around 14 kg for women with BMI > 24.12 kg/m^2. They reported lower cut-off values for lower BMI values as 16.8 and 13.3 kg in men and women, respectively [44]. Then further studies are needed to determine the accuracy of these specific cut-off points.

There is progressive loss of muscle mass while ageing and sarcopenia can be caused by multiple factors in elderly. MN/MR is one of the potentially important factor in the etiology of sarcopenia. Over half of our residents with sarcopenia had MN/MR (54%) (Table 3). All of our residents with MN and 81% of those with MR had sarcopenia. Sarcopenia and decreased physical performance are related with general health of elderly [45]. It was emphasized that sarcopenia can affect prognosis negatively in those residing in nursing homes [39,46]. But there are few data about consequences of sarcopenia in nursing home residents. In our population, 12-month mortality was found increased in those with sarcopenia, independent from other factors. MUAC showed negative relationship with mortality (Table 4). Recently, Guaresi et al. reported such an association between MUAC and survival in elderly ≥ 98 years old. They suggested MUAC as an important measurement to evaluate health status of oldest old [47]. In another study, Wannamethee et al. showed a positive relationship between MUAMC and survival in elderly [41].

MAMA was especially used for children and overestimation was noted as much as 25% when applied to adults [29]. However, some studies of calculated MAMA showed positive correlation with mid-arm muscle area measured by computed tomography (measurement error of 7–8%) [48,49]. Miller et al. found association of low MAMA (≤ 21.4 cm^2 for men and ≤ 21.6 cm^2 for women) with mortality in elderly [50]. According to our data, MAMA showed higher sensitivity and specificity in the diagnosis of sarcopenia with cut-off values 35.0 cm^2 for men and 36.7 cm^2 for women.

Our study has some limitations. First, lack of DEXA or any imaging method (CT or MRI) in the measurement of muscle mass might overestimate sarcopenia prevalence. However, to use DEXA or MRI in nursing homes is very difficult and not cost-effective. Bioelectrical impedance analysis (BIA) is simple and used to assess muscle mass. However, previous data showed that it could also overestimate sarcopenia diagnosis [51]. Second, absence of national validated cut-off values for muscle strength might overestimate sarcopenia diagnosis in our study group.

5. Conclusion

According to our results, malnutrition, sarcopenia, low BMI and MUAC are important risk factors for those elderly living in nursing homes, in terms of mortality. Being overweight, even obese, showed better survival rates when compared to low BMI, which may be related with better metabolic reserve. Although previous reports of MAMA indicated risk of overestimation of sarcopenia, our data showed better results. Further studies are needed to evaluate sarcopenia-mortality relationship.

Disclosure of interest

The authors declare that they have no competing interest.

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References

[1] Volkert D, Berner YN, Berry E, Cederholm T, Coti Bertrand P, Milne A, et al. ESPEN guidelines on enteral nutrition: geriatrics. Clin Nutr 2006;25:330–60.
[2] Kaiser MJ, Bauer JM, Rämsch C, Uter W, Guigoz Y, Cederholm T, et al. Frequency of malnutrition in older adults: a multinational perspective using the mini nutritional assessment. J Am Geriatr Soc 2010;58:1734–8.
[3] Saka B, Kaya O, Ozturk GB, et al. Malnutrition in the elderly and its relationship with other geriatric syndromes. Clin Nutr 2010;29:745–8.
[4] Cruz-Jentoft AJ, Landi F, Schneider SM, et al. Prevalence of and interventions for sarcopenia in ageing adults: a systematic review. Report of the International Sarcopenia Initiative (EWGSOP and IWGS). Age Ageing 2014;43:748–59.
[5] Van Nie-Visser NC, Meijers JM, Schols JM, et al. Comparing quality of nutritional care in Dutch and German nursing homes. J Clin Nurs 2011;20:2501–8.
[6] Cankurtaran M, Saka B, Sahin S, et al. Turkish nursing homes and care homes nutritional status assessment project (THN-Malnutrition). Eur Geriatr Med 2013;4:329–34.
[7] Hiesmayr M, Schindler K, Pernicka E, et al. Decreased food intake is a risk factor for mortality in hospitalised patients: the Nutrition Day survey 2006. Clin Nutr 2009;28:484–91.
[8] Ulger Z, Halil M, Cankurtaran M, et al. Malnutrition in Turkish nursing homes: a correlate of short term mortality. J Nutr Health Aging 2013;17(4):305–9.
[9] Torma J, Winblad U, Cederholm T, Saletti A. Does undernutrition still prevail among nursing home residents? Clin Nutr 2013;32:562–8.
[10] de Groot CP, Perdigao AL, Deurenberg P. Longitudinal changes in anthropometric characteristics of elderly Europeans. SENECA investigators. Eur J Clin-Nutr 1996;50(Suppl. 2):S9–15.
[11] American Dietetic Association. International dietetics and nutrition terminology reference manual, 2nd Ed., The American Dietetic Association; 2009.
[12] Bonnefoy M, Jauffret M, Kostka T, Jusot JF. Usefulness of calf circumference measurement in assessing the nutritional state of hospitalized elderly people. Gerontology 2002;48:162–9.
[13] Powell-Tuck J, Hennessy EM. A comparison of mid upper arm circumference, body mass index and weight loss as indices of undernutrition in acutely hospitalized patients. Clin Nutr 2003;22:1–6.
[14] Gulgoz Y, Lauque S, Vellas BJ. Identifying the elderly at risk for malnutrition. The mini nutritional assessment. Clin Geriatr Med 2002;18:737–57.
[15] Sarikaya D, Halil M, Kuyumcu ME, et al. Mini nutritional assessment test long and short form are valid screening tools in Turkish older adults. Arch Gerontol Geriatr 2015;61:56–60.
[16] Cruz-Jentoft AJ, Baeyens JP, Bauer JM, et al. Sarcopenia: European consensus on definition and diagnosis: rport of the European Working Group on Sarcopenia in Older People (EWGSOP). Age Ageing 2010;39:412–23.
[17] Halil M, Ulger Z, Varlı M, et al. Sarcopenia assessment project in the nursing homes in Turkey. Eur J Clin Nutr 2014;68:690–4.
[18] Bahat G, Saka B, Tufan F, et al. Prevalence of sarcopenia and its association with functional and nutritional status among male residents in anursing home in Turkey. Aging Male 2010;13:211–4.
[19] Senior HE, Henwood TR, Beller EM, et al. Prevalence and risk factors of sarcopenia among adults living in nursing homes. Maturitas 2015;82:418–23.
[20] Landi F, Liperoti R, Fusco D, et al. Prevalence and risk factors of sarcopenia among nursing home older residents. J Gerontol A Biol Sci Med Sci 2012;67:48–55.
[21] Yalcin A, Aras S, Atmis V, et al. Sarcopenia prevalence and factors associated with sarcopenia in older people living in a nursing home in Ankara Turkey. Geriatr Gerontol Int 2015. http://dx.doi.org/10.1111/ggi.12570 [Epub ahead of print].
[22] Snih SA, Graham JE, Ray LA, et al. Frailty and incidence of activities of daily living disability among older Mexican Americans. J Rehabil Med 2009;41: 892–7.
[23] Landi F, Liperoti R, Fusco D, et al. Sarcopenia and mortality among older nursing home residents. J Am Med Dir Assoc 2012;13:121–6.
[24] Kimyagarov S, Klid R, Fleissig Y, et al. Skeletal muscle mass abnormalities are associated with survival rates of institutionalized elderly nursing home residents. J Nutr Health Aging 2012;16:432–6.
[25] Antonelli Incalzi R, Landi F, Cipriani L, Bruno E, Pagano F, Gemma A, et al. Nutritional assessment: a primary component of multidimensional geriatric assessment in the acute care setting. J Am Geriatr Soc 1996;44: 166–74.
[26] Rolland Y, Lauwers-Cances V, Cournot M, Nourhashémi F, Reynish W, Rivière D, et al. Sarcopenia, calf circumference, and physical function of elderly women: a cross-sectional study. J Am Geriatr Soc 2003;51:1120–4.
[27] Landi F, Liperoti R, Russo A, Giovannini S, Tosato M, Capuluongo E, et al. Sarcopenia as a risk factor for falls in elderly individuals: results from the ilSIRENTE study. Clin Nutr 2012;31:652–8.
[28] Akın S, Mucuk S, Öztürk A, et al. Muscle function-dependent sarcopenia and cut-off values of possible predictors in community-dwelling Turkish elderly: calf circumference, mid-arm muscle circumference and walking speed. Eur J Clin Nutr 2015. http://dx.doi.org/10.1038/ejcn.2015.42 [Epub ahead of print].
[29] Heymsfield SB, McManus C, Smith J, et al. Anthropometric measurement of muscle mass: revised equations for calculating bone-free arm muscle area. Am J Clin Nutr 1982;36:680–90.
[30] Lauretani F, Russo C, Bandinelli S, et al. Age-associated changes in skeletal muscles and their effect on mobility: an operational diagnosis of sarcopenia. J Appl Physiol 2003;95:1851–60.
[31] Pauly L, Stehle P, Volkert D. Nutritional situation of elderly nursing home residents. Z Gerontol Geriatr 2007;40:3–12.
[32] Kulnik D, Elmadfa I. Assessment of the nutritional situation of elderly nursing home residents in Vienna. Ann Nutr Metab 2008;52(Suppl. 1):51–3.
[33] Suominen M, Muurinen S, Routasalo P, et al. Malnutrition and associated factors among aged residents in all nursing homes in Helsinki. Eur J Clin Nutr 2005;59:578–83.
[34] Ulger Z, Halil M, Cankurtaran M, et al. Malnutrition in Turkish nursing homes: a correlate of short term mortality. J Nutr Health Aging 2013;17:305–9.
[35] Landi F, Zuccalà G, Gambassi G, et al. Body mass index and mortality among older people living in the community. J Am Geriatr Soc 1999;47:1072–6.
[36] Dey DK, Rothenberg E, Sundh V, et al. Body mass index, weight change and mortality in the elderly. A 15-year longitudinal population study of 70-year-olds. Eur J Clin Nutr 2001;55:482–92.
[37] Kvamme JG, Holmen J, Wilsgaard T, et al. Body mass index in elderly men and women: The Tromso and HUNT Studies. J Epidemiol Community Health 2012;66:611–7.
[38] Kaiser R, Winning K, Uter W, et al. Functionality and mortality in obese nursing home residents: an example of 'risk factor paradox'? J Am Med Dir Assoc 2010;11:428–35.
[39] Landi F, Liperoti R, Fusco D, et al. Sarcopenia and mortality among older nursing home residents. J Am Med Dir Assoc 2013;14:66–7.
[40] Landi F, Russo A, Liperoti R, et al. Mid-arm muscle circumference, physical performance and mortality: results from the aging and longevity study in the Sirente geographic area [ilSIRENTE study]. Clin Nutr 2010;29:441–7.
[41] Wannamethee SG, Shaper AG, Lennon L, Whincup PH. Decreased muscle mass and increased central adiposity are independently related to mortality in older men. Am J Clin Nutr 2007;86:1339–46.
[42] Kawakami R, Murakami H, Sanada K, et al. Calf circumference as a surrogate marker of muscle mass for diagnosing sarcopenia in Japanese men and women. Geriatr Gerontol Int 2014. http://dx.doi.org/10.1111/ggi.12377 [Epub ahead of print].
[43] Laurenço RA, Zepeda MP, Robledo RG, et al. Performance of the European Working Group on Sarcopenia in Older People algorithm in screening older adults for muscle mass assessment. Age and ageing 2015;44:334–8.
[44] Moreira VG, Lourenço RA. Prevalence and factors associated with frailty in an older population from the city of Rio de Janeiro, Brazil: the FIBRA-RJ study. Clinics 2013;68:979–85.
[45] Keevil VL, Romero-Ortuno R. Ageing well: a review of sarcopenia and frailty. Proc Nutr Soc 2015;25:1–11.
[46] Cereda E, Pedrolli C, Zagami A, et al. Body mass index and mortality in institutionalized elderly. J Am Med Dir Assoc 2011;12:174–8.
[47] Gueresi P, Miglio R, Cevenini E, Russo EG. Arm measurements as determinants of further survival in centenarians. Exp Gerontol 2014;58:230–4.

[48] Reed RL, Pearlmutter L, Yochum K, et al. The relationship between muscle mass and muscle strength in the elderly. J Am Geriatr Soc 1991;39:555–61.
[49] Sanchez FF, Faganello MM, Tanni SE, et al. Anthropometric mid-arm measurements can detect systemic fat-free mass depletion in patients with chronic obstructive pulmonary disease. Braz J Med Biol Res 2011;44:453–9.
[50] Miller MD, Crotty M, Giles LC, et al. Corrected arm muscle area: an independent predictor of longterm mortality in community-dwelling older adults? J Am Geriatr Soc 2002;50:1272–7.
[51] Beaudart C, Reginster JY, et al. Estimation of sarcopenia prevalence using various assessment tools. Exp Gerontol 2015;61:31–7.