

Relationship between Sarcopenia and Mortality in Elderly Inpatients

Elif Bayraktar¹ , Pinar Tosun Tasar² , Dogan Nasir Binici¹ , Omer Karasahin³ , Ozge Timur¹ , Sevnaz Sahin⁴ 



ABSTRACT

Objective: Sarcopenia, a geriatric syndrome, is an indicator of poor prognosis in elderly inpatients. In this study, we aimed to determine the effect of sarcopenia on mortality in elderly patients.

Materials and Methods: Mobile/immobile geriatric inpatients, treated in the internal medicine ward between February and November 2018, were included in the study between Days 2 and 7 of hospitalization. The patients' fat-free mass (FFM) was measured by bioimpedance. The FFM index (FFMI) (kg/m²) was determined by dividing fat-free mass by body surface area (FFM/BSA). Sarcopenia was defined as a FFMI value at least two standard deviations below the gender-specific mean of normal young adults.

Results: The study included 200 geriatric inpatients; 96 (48.0%) were men, and the mean age was 74.49±6.32 years. Sarcopenia was detected in 28 (14%) of the patients. Diabetes mellitus was associated with a significantly lower sarcopenia prevalence (p=0.006). The risk of sarcopenia was 9.046 times higher in malnourished patients. The sarcopenia group had more deaths (p=0.012).

Conclusion: Sarcopenia in geriatric inpatients increased the length of hospital stay and mortality. Our findings may guide future studies examining the relationship between sarcopenia and mortality among elderly inpatients in other hospitals.

Keywords: Sarcopenia, aged, mortality

Introduction

Sarcopenia is a geriatric syndrome that reduces the quality of life, leads to fragility, and increases functional dependence and mortality [1, 2]. Sarcopenia was first described by Irwing Rosenberg as age-related loss of muscle mass. The Sarcopenia European Working Group (EWG-SOP), established in 2010, defined sarcopenia as low muscle function (in terms of strength or performance) and muscle mass [1]. The incidence of sarcopenia increases with age [3]. However, studies have reported varying prevalence rates due to a lack of standard diagnostic criteria and differences in sample populations and methods used to assess the muscle mass, strength, and physical performance. In the literature, the reported prevalence of sarcopenia in elderly adults is 5%-45% [4-6]. Sarcopenia is one of the indicators of poor prognosis among elderly inpatients [7]. Studies on the prevalence of sarcopenia in inpatients demonstrated that the impact of requiring hospitalization, the stress of inpatient treatment, and low calorie intake while in hospital contributed to reduced protein synthesis in the muscles and lower muscle mass and strength [8].

There has been limited research on sarcopenia among elderly inpatients in Turkey. Therefore, we aimed to investigate the effect of sarcopenia on mortality in elderly Turkish inpatients.

Materials and Methods

Mobile/immobile geriatric patients hospitalized and treated in the internal medicine ward of our hospital in the February-October 2018 period were included in our study. Patients aged <65 years, those admitted for less than 24 hours, and those who did not sign the consent form were excluded from the study. Demographic data (gender, age, occupation, marital status, education level, number of children, place of residence, income, and habits such as smoking), medications

Cite this article as: Bayraktar E, Tosun Tasar P, Binici DN, Karasahin O, Timur O, Sahin S. Relationship between Sarcopenia and Mortality in Elderly Inpatients. *Eurasian J Med* 2020; 52(1): 29-33.

¹Department of Internal Medicine, Erzurum Regional Training and Research Hospital, Erzurum, Turkey

²Department of Geriatrics, Ataturk University School of Medicine, Erzurum, Turkey

³Department of Infectious Diseases Erzurum Regional Training and Research Hospital, Erzurum, Turkey

⁴Department of Geriatrics, Ege University School of Medicine, Izmir, Turkey

Received: September 23, 2019

Accepted: November 04, 2019

Correspondence to: Pinar Tosun Tasar
E-mail: pinar.tosun@gmail.com

DOI 10.5152/eurasianjmed.2020.19214



Content of this journal is licensed under a Creative Commons Attribution 4.0 International License.

Sarcopenia screening was performed based on the 2010 EWGSOP consensus report. Muscle strength and fat-free mass (FFM) of the patients were measured using Takei TKK 540I Digital Handgrip and QuadScan 4000 bioimpedance. Normal muscle strength was accepted as ≥ 20 kg and ≥ 30 kg in women and men, respectively [1]. Handgrip was measured three times using the dominant hand, and the highest value was recorded as muscle strength. The patients' FFM was measured by bioimpedance. The DuBois formula ($BSA = [kg^{0.425} \times cm^{0.725}] \times 0.007184$) was used to calculate body surface area (BSA). The FFM index (FFMI) (kg/m^2) was determined by dividing FFM by BSA. FFM was compared to community-dwelling adults (50 men, 50 women) aged 18-45 years who had no disease and did not use any drugs. Sarcopenia was defined as having an FFMI value at least two standard deviations below the gender-specific mean of normal young adults [9]. The mean FFMI was 17.70 ± 2.16 in young women (median age 32 [18-42] years) and 21.35 ± 2.40 in young men (median age 33 [18-44] years). FFMI values < 16.55 kg/m^2 for men and < 13.38 kg/m^2 for women were considered low FFM. Because both mobile and immobile patients were included in the study, a walking test could not be included in our assessments. Mini Nutrition Assessment (MNA) and Barthel index were used to evaluate malnutrition and daily living activities [10, 11]. The level of dependency was rated according to Barthel index scores as severe (21-61), moderate (62-90), mild (91-99), or none (100). The 10 areas assessed include feeding, wheelchair/bed transfer, grooming, toileting, walking, using a wheelchair, stair climbing, dressing, bladder and bowel control, and bathing [11]. The Barthel index was introduced in 1967, and it evaluates a total of 10 areas of activities of daily living and mobility [12]. Validity and reliability studies of the Turkish version were conducted in 2000 by Küçükdeveci et al. [13].

weights are added to find the index for a specific patient (e.g., a patient with depression, chronic obstructive pulmonary disease, and lymphoma would have a weight of) [15].

This study was approved by the Erzurum Regional Training and Research Hospital Ethics Committee (ethics committee number 2017/06-38).

The data were analyzed using the The Statistical Package for the Social Sciences (SPSS) version 21.0 (IBM Corp.; Armonk, NY, USA) statistical software package. The chi-squared test was used in comparisons of categorical data between the sarcopenia and nonsarcopenia groups, while the nonparametric Mann–Whitney U test and Kruskal–Wallis test were used in comparisons of continuous data due to non-normal distribution. To identify risk factors for sarcopenia, logistic regression was done using sex, age, occupation, nutritional status, diabetes mellitus, place of residence, arm and calf

Demographic Characteristics		Sarcopenia	No Sarcopenia	p
Median age (minimum–maximum)		79 (66-90)	73 (65-93)	0.001
Sex, n (%)	Female	8 (7.7%)	96 (92.3%)	0.007
	Male	20 (20.8%)	76 (79.2%)	
Place of residence, n (%)	Rural	20 (19.4%)	83 (80.6%)	0.023
	Urban	8 (8.2%)	89 (91.8%)	
Education level n (%)	Illiterate	9 (32.1%)	84 (48.8%)	0.340
	Literate	9 (32.1%)	29 (16.9%)	
	Elementary school	9 (32.1%)	51 (29.7%)	
	Middle school	-	3 (1.7%)	
	High school	1 (3.6%)	3 (1.7%)	
	University	-	2 (1.2%)	
Occupation n (%)	Retired	11 (39.3%)	47 (27.3%)	0.001
	Farmer	12 (42.9%)	30 (17.4%)	
	Homemaker	5 (17.9%)	90 (52.3%)	
	Shopkeeper	-	5 (2.9%)	
Smoking status, n (%)	Never smoker	19 (67.9%)	123 (71.5%)	0.738
	Current smoker	3 (10.7%)	22 (12.8%)	
	Former smoker	6 (21.4%)	27 (15.7%)	
Marital status n (%)	Married	14 (50%)	114 (66.3%)	0.096
	Widowed	14 (50%)	58 (33.7%)	
Children n (%)	Yes	25 (100%)	168 (97.7%)	0.415
	No	-	4 (2.3%)	
Income level, n (%)	Income < Expenses	70 (85.4%)	12 (14.6%)	0.930
	Income > Expenses	23 (88.5%)	3 (11.5%)	
	Income = Expenses	79 (85.9%)	13 (14.1%)	

circumference, BMI, albumin, and prealbumin (Model: Backward LR; Entry: 0.05 and Removal: 0.10). The diagnostic value of prealbumin and albumin was determined using receiver operating characteristic (ROC) curve analysis. In sarcopenic patients, cut-off values for albumin and prealbumin were determined by Youden index. The Kaplan–Meier analysis was conducted to determine whether sarcopenia is a risk factor affecting survival time. A $p < 0.05$ was accepted as statistically significant.

Results

A total of 200 geriatric inpatients were included in the study. Of these, 104 (52.0%) were women, and the mean age was 74.49 ± 6.32 years. Sarcopenia was detected in 28 patients (14%). Relationships between sarcopenia and selected demographic characteristics of the patients are presented in Table 1. The prevalence of sarcopenia was significantly higher among males ($p = 0.007$). In terms of the place of residence, sarcopenia was significantly more common among patients who lived in rural areas compared to those living in urban centers ($p = 0.023$). There was a significant association between sarcopenia and occupation. This difference was found to be attributable to the differences between housewives and farmers and between housewives and retirees. Sarcopenia was significantly less frequent among housewives when compared with farmers and retirees ($p < 0.001$ and $p = 0.007$, respectively). Sarcopenia was not statistically associated with the education level, marital status, smoking status, presence of children, or income level ($p > 0.05$).

Sarcopenia was also not associated with functional dependence as assessed by Barthel index. The mean Barthel index score was 85.05 ± 19.86 in patients without sarcopenia and 79.64 ± 19.99 in patients with sarcopenia. The mean MNA score was 16.19 ± 5.30 in patients with sarcopenia and 20.70 ± 4.26 in patients without sarcopenia ($p < 0.001$). The prevalence of malnutrition was significantly higher in patients with sarcopenia ($p = 0.012$). Sarcopenia was not associated with height ($p = 0.134$). BMI, weight, and arm and calf circumferences were significantly lower in patients with sarcopenia compared to those without sarcopenia ($p < 0.001$). The mean number of comorbidities was significantly lower in patients with sarcopenia ($p = 0.047$). Diabetes mellitus was associated with a significantly lower sarcopenia prevalence ($p = 0.006$). There was no statistically significant relationship between sarcopenia and hypertension, chronic kidney disease, malignancy, chronic heart failure, Parkinson's disease, dementia, peripheral artery disease, diabetes mellitus, cerebrovascular disease,

or coronary artery disease ($p > 0.05$). Relationships between comorbidities and sarcopenia were examined in Table 2.

Relationships between sarcopenia and the analyzed biomarkers are presented in Table 3. Albumin and prealbumin levels were significantly lower in patients with sarcopenia ($p = 0.040$ and $p < 0.001$, respectively). No statistically significant relationships were detected between sarcopenia and hemoglobin, leukocyte count, lymphocyte count, platelet count, MCV, CRP, BUN, creatinine, Na, K, Cl, TSH, fT3, fT4, or vitamin D level ($p > 0.05$).

A prealbumin cut-off value of 0.18 was identified for the diagnosis of sarcopenia. At this cut-off value, prealbumin had a 44.8% sensitivity and 89.2% specificity in the diagnosis of sarcopenia (area under the curve [AUC]: 0.700, 95% confidence interval [CI]: 0.609–0.791; $p = 0.001$). The cut-off value for albumin was determined to be 3.49. At this cut-off value, albumin had 78.4% sensitivity and 46.4% specificity in the diagnosis of sarcopenia (AUC: 0.621, 95% CI: 0.500–0.743; $p = 0.040$).

Logistic regression was done using variables that differed significantly between patients with and without sarcopenia: sex, age, occupation, nutritional status, diabetes mellitus, place of residence, arm and calf circumference, BMI, albumin, and prealbumin. The risk of sarcopenia was 9.046 times higher in the presence of malnutrition (95% CI: 1.663–49.198; $p = 0.011$), 1.245 times higher with each additional year of age (95% CI: 1.097–1.413; $p = 0.001$), and 6.002 times higher after retirement (95% CI: 1.124–32.048; $p = 0.036$).

The Kaplan–Meier analysis was used to assess life expectancy between the sarcopenic and nonsarcopenic groups (Figure 1). More deaths were observed in the sarcopenia group ($p = 0.012$). In-hospital mortality rate was 28.6% in patients with sarcopenia and 11.0% in patients without sarcopenia. Patients without sarcopenia survived significantly longer, with the mean survival time of 12.87 days (95% CI: 10.63–15.10 days) in patients with sarcopenia and 37.82 days (95% CI: 30.76–44.88 days) in those without sarcopenia (Kaplan–Meier $p = 0.001$). The relationship between mortality and sarcopenia is shown in Table 4.

Table 2. Association between sarcopenia and comorbidities

		Sarcopenia	No Sarcopenia	p
Number of comorbidities, mean \pm SD		1.46 \pm 1.036	1.99 \pm 1.296	0.047
CCI, mean \pm SD		4.46 \pm 1.68	4.40 \pm 1.67	0.806
Number of medications, mean \pm SD		2.46 \pm 2.39	3.56 \pm 2.97	0.085
Hypertension, n (%)	Yes	14 (16.3%)	100 (87.7%)	0.420
	No	14 (12.3%)	72 (83.7%)	
Chronic kidney disease, n (%)	Yes	-	11 (100.0%)	0.182
	No	28 (14.8%)	161 (85.2%)	
Malignancy, n (%)	Yes	5 (20.0%)	20 (80.0%)	0.355
	No	23 (13.1%)	152 (86.9%)	
Chronic heart failure, n (%)	Yes	4 (21.1%)	15 (78.9%)	0.265
	No	24 (13.3%)	157 (86.7%)	
Parkinson's disease, n (%)	Yes	-	1 (100.0%)	0.686
	No	28 (14.1%)	171 (85.9%)	
Dementia, n (%)	Yes	1 (33.3%)	2 (66.7%)	0.331
	No	27 (13.7%)	170 (86.3%)	
Peripheral vascular disease, n (%)	Yes	1 (100.0%)	-	0.140
	No	27 (13.6%)	172 (86.4%)	
Diabetes mellitus, n (%)	Yes	3 (4.5%)	64 (95.5%)	0.006
	No	25 (18.8%)	108 (81.2%)	
Cerebrovascular disease, n (%)	Yes	-	2 (100.0%)	0.566
	No	28 (14.1%)	170 (85.9%)	
Coronary artery disease, n (%)	Yes	3 (7.5%)	37 (92.5%)	0.185
	No	25 (15.6%)	135 (84.4%)	

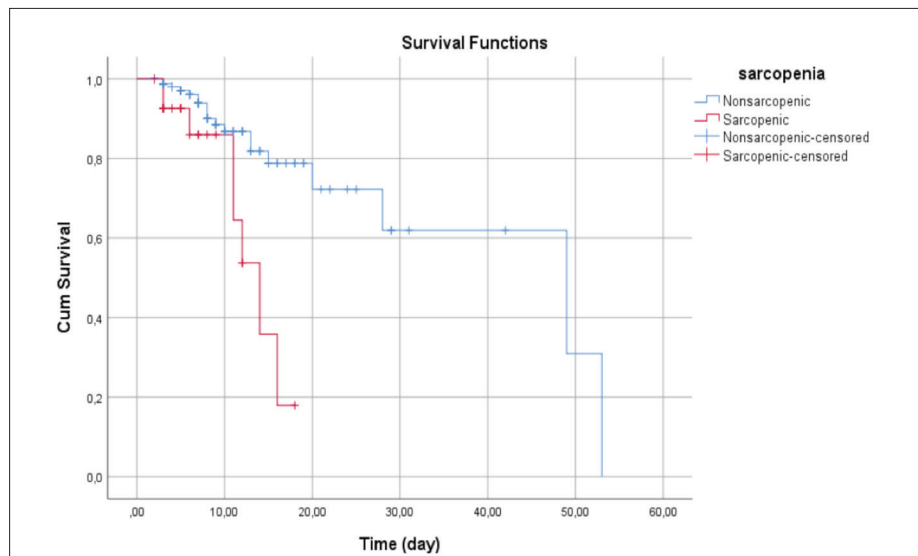
Table 3. Association between sarcopenia and biomarkers

	Sarcopenia	No Sarcopenia	P
Hemoglobin (g/dL)	12.3 (5.9-16.9)	13.4 (5.8-23.0)	0.116
Leukocyte count (10 ⁹ /L)	8000 (2120-37900)	8175 (1740-11236)	0.378
Lymphocyte count (10 ⁹ /L)	1395 (320-27700)	1580 (380-10735)	0.281
Thrombocyte count (10 ⁹ /L)	212500 (80000-585000)	240000 (18000-537000)	0.384
MVC (fL)	85.9 (70.7-94.7)	86.4 (68.2-122.1)	0.727
C-reactive protein (mg/L)	1.76 (0.32-82.70)	1.67 (4.80-44.10)	0.692
BUN (mg/dL)	21.8 (9.2-82.7)	19.7 (4.8-101.5)	0.187
Creatinine (mg/dL)	0.91 (0.49-2.11)	0.89 (0.54-13.17)	0.447
Albumin (g/dL)	3.64 (2.60-4.60)	3.88 (2.19-5.52)	0.040
Prealbumin	0.13 (0.04-0.24)	0.17 (0.03-0.38)	0.001
Sodium (mmol/L)	137 (130-144)	138 (127-163)	0.215
Potassium (mmol/L)	4.31 (2.71-6.21)	4.33 (2.35-6.66)	0.377
Chloride (mmol/L)	104 (88-113)	106 (91-140)	0.097
Thyroid stimulating hormone (μIU/MI)	0.86 (0.01-4.41)	1.06 (0-11.83)	0.491
Free T3 (pg/mL)	2.05 (1.26-3.05)	2.20 (1.00-4.40)	0.406
Free T4 (ng/dL)	1.10 (0.56-1.68)	1.00 (0.62-2.02)	0.058
Vitamin D (ng/mL)	11.65 (4.00-70.90)	11.20 (2.30-43.90)	0.889

MCV: Mean corpuscular volume; BUN: Blood urea nitrogen

Table 4. Association between sarcopenia and mortality

	Sarcopenia	No Sarcopenia	P
Deceased	8 (29.6%)	19 (70.4%)	0.012
Survived	20 (11.6%)	153 (88.4%)	

**Figure 1.** Kaplan-Meier survival curves.

Discussion

There are few studies in the literature showing the prevalence of sarcopenia in elderly patients. In a Brazilian study in which sarcopenia screening was conducted in 110 elderly inpatients, the prevalence of sarcopenia was found to be 21.8% [16]. In the United Arab Emirates, the

prevalence of sarcopenia among 432 elderly inpatients was 10%, like in our study [7]. A study in Italy that screened 394 elderly inpatients using the EWGSOP criteria determined a sarcopenia prevalence of 17.4% [17]. In another study in Brazil conducted with 68 elderly inpatients, the incidence of sarcopenia was found to be 22.1%

[16]. In our study, the incidence of sarcopenia was 14.1%. The lower rate observed in this study compared to others may be attributable to our inability to assess the walking speed due to the inclusion of immobile patients.

Few studies in the literature have investigated the effect of sarcopenia on mortality. Landi et al. conducted a prospective study spanning 7 years and showed that sarcopenia increased mortality 2.32-fold. screening according to EWGSOP criteria and reported that sarcopenia was associated with higher mortality in frail, community-dwelling elderly ≥ 80 years of age [18]. The INCHIANTI study showed that mortality was 1.88-fold higher in those with sarcopenia. increased mortality and prolonged hospital stay [19]. In the British Regional Heart Study, Atkins et al. reported that sarcopenia was a cause of cardiovascular mortality [20]. Studies conducted in Turkey have also associated sarcopenia with increased mortality among elderly nursing home residents [21] and intensive care patients [22]. Similarly, the patients with sarcopenia in our study had a higher mortality rate and longer mean hospital stay.

One of the strengths of our study was that it was conducted using a definition specific to inpatients. To the best of our knowledge, this is the first study using this definition. In addition, we are not aware of any previous studies documenting the incidence of sarcopenia among elderly inpatients in Turkey. Therefore, our study is important as the first research to be conducted on this subject. However, this study has some limitations. First, some of the patients included in our study were immobile. Another limitation was measuring muscle mass using bioimpedance analysis. Hydration problems are a common metabolic problem among the elderly that can alter bioimpedance measurements and yield artificially high muscle mass values [23]. Another limiting factor was that the cause of death was not recorded for the patients, and only the association between sarcopenia and mortality was investigated.

In conclusion, in our study, it was found that sarcopenia in geriatric inpatients increased the length of hospital stay and mortality. Our findings may guide future studies examining the relationship between sarcopenia and mortality among elderly inpatients in other hospitals.

Ethics Committee Approval: Ethics committee approval was received for this study from the Ethics Committee of Erzurum Regional Training and Research Hospital (ethics committee number 2017/06-38).

Informed Consent: Written informed consent was obtained from the patient who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – P.T.T., O.T., O.K.; Design – P.T.T., O.T., O.K.; Supervision – P.T.T., O.T.; Resources – P.T.T., E.B.; Materials – P.T.T., O.T., O.K.; Data Collection and/or Processing – E.B., P.T.T.; Analysis and/or Interpretation – O.K.; Literature Search – P.T.T., E.B., O.T.; Writing Manuscript – E.B., P.T.T., O.K., O.T.; Critical Review – S.S., D.N.B.

Conflict of Interest: The authors have no conflicts of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

References

1. Cruz-Jentoft AJ, Baeyens JP, Bauer JM, et al. Sarcopenia: European consensus on definition and diagnosis: Report of the European Working Group on Sarcopenia in Older People. *Age Ageing* 2010; 39: 412-23. [\[CrossRef\]](#)
2. Landi F, Liperoti R, Russo A, et al. Sarcopenia as a risk factor for falls in elderly individuals: results from the iSIRENTE study. *Clin Nutr* 2012; 31: 652-8. [\[CrossRef\]](#)
3. Morley JE. Sarcopenia in the elderly. *Fam Pract* 2012; 29 Suppl 1: i44-8. [\[CrossRef\]](#)
4. Janssen I, Heymsfield SB, Ross R. Low relative skeletal muscle mass (sarcopenia) in older persons is associated with functional impairment and physical disability. *J Am Geriatr Soc* 2002; 50: 889-96. [\[CrossRef\]](#)
5. Abellan van Kan G. Epidemiology and consequences of sarcopenia. *J Nutr Health Aging* 2009; 13: 708-12. [\[CrossRef\]](#)
6. Volpato S, Bianchi L, Cherubini A, et al. Prevalence and clinical correlates of sarcopenia in community-dwelling older people: application of the EWGSOP definition and diagnostic algorithm. *J Gerontol A Biol Sci Med Sci* 2014; 69: 438-46. [\[CrossRef\]](#)
7. Gariballa S, Alessa A. Sarcopenia: prevalence and prognostic significance in hospitalized patients. *Clin Nutr* 2013; 32: 772-6. [\[CrossRef\]](#)
8. Kortebein P, Ferrando A, Lombeida J, Wolfe R, Evans WJ. Effect of 10 days of bed rest on skeletal muscle in healthy older adults. *JAMA* 2007; 297: 1772-4. [\[CrossRef\]](#)
9. Iannuzzi-Sucich M, Prestwood KM, Kenny AM. Prevalence of sarcopenia and predictors of skeletal muscle mass in healthy, older men and women. *J Gerontol A Biol Sci Med Sci* 2002; 57: M772-7. [\[CrossRef\]](#)
10. Guigoz Y, Vellas B, Garry PJ. Assessing the nutritional status of the elderly: The Mini Nutritional Assessment as part of the geriatric evaluation. *Nutr Rev* 1996; 54: S59-65. [\[CrossRef\]](#)
11. Jacelon CS. The Barthel Index and other indices of functional ability. *Rehabil Nurs* 1986; 11: 9-11. [\[CrossRef\]](#)
12. Mahoney FI, Barthel DW. Functional Evaluation: The Barthel Index. *Md State Med J* 1965; 14: 61-5. [\[CrossRef\]](#)
13. Kucukdeveci AA, Yavuzer G, Tennant A, Suldur N, Sonel B, Arasil T. Adaptation of the modified Barthel Index for use in physical medicine and rehabilitation in Turkey. *Scand J Rehabil Med* 2000; 32: 87-92. [\[CrossRef\]](#)
14. Executive summary of the clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults. *Arch Intern Med* 1998; 158: 1855-67. [\[CrossRef\]](#)
15. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis* 1987; 40: 373-83. [\[CrossRef\]](#)
16. Martinez BP, Batista AK, Gomes IB, Olivieri FM, Camelier FW, Camelier AA. Frequency of sarcopenia and associated factors among hospitalized elderly patients. *BMC Musculoskelet Disord* 2015; 16: 108. [\[CrossRef\]](#)
17. Martone AM, Bianchi L, Abete P, et al. The incidence of sarcopenia among hospitalized older patients: results from the Glisten study. *J Cachexia Sarcopenia Muscle* 2017; 8: 907-14. [\[CrossRef\]](#)
18. Landi F, Cruz-Jentoft AJ, Liperoti R, et al. Sarcopenia and mortality risk in frail older persons aged 80 years and older: results from the iSIRENTE study. *Age Ageing* 2013; 42: 203-9. [\[CrossRef\]](#)
19. Bianchi L, Ferrucci L, Cherubini A, et al. The Predictive Value of the EWGSOP Definition of Sarcopenia: Results From the InCHIANTI Study. *J Gerontol A Biol Sci Med Sci* 2016; 71: 259-64. [\[CrossRef\]](#)
20. Atkins JL, Whincup PH, Morris RW, Lennon LT, Papacosta O, Wannamethee SG. Sarcopenic obesity and risk of cardiovascular disease and mortality: a population-based cohort study of older men. *J Am Geriatr Soc* 2014; 62: 253-60. [\[CrossRef\]](#)
21. Yalcin A, Aras S, Atmis V, et al. Sarcopenia and mortality in older people living in a nursing home in Turkey. *Geriatr Gerontol Int* 2017 Jul; 17: 1118-24. [\[CrossRef\]](#)
22. Toptas M, Yalcin M, Akkoc I, et al. The Relation between Sarcopenia and Mortality in Patients at Intensive Care Unit. *Biomed Res Int* 2018; 2018: 5263208. [\[CrossRef\]](#)
23. 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. [\[CrossRef\]](#)