ORIGINAL ARTICLE

Sarcopenia and Health-related Quality of Life in Community-dwelling Older Adults

Nasrin Nasimi[1], MSc;
Mohammad Hossein Dabbaghmanesh[2], MD;
Mohammad Fararooei[3], PhD;
Amirhossein Asadi[4], MSc;
Marzieh Akbarzadeh[5], PhD;
Zahra Sohrabi[5], PhD

[1]Department of Community Nutrition, School of Nutrition and Food Sciences, Shiraz University of Medical Sciences, Shiraz, Iran
[2]Shiraz Endocrinology and Metabolism Research Center, Nemazee Hospital, Shiraz University of Medical Sciences, Shiraz, Iran
[3]Department of Epidemiology, School of Health, Shiraz University of Medical Sciences, Shiraz, Iran
[4]Student Research Committee, Shiraz University of Medical Sciences, Shiraz, Iran
[5]Nutrition Research Center, School of Nutrition and Food Sciences, Shiraz University of Medical Sciences, Shiraz, Iran

Correspondence:
Zahra Sohrabi, PhD;
Nutrition Research Center, School of Nutrition and Food Sciences, Shiraz University of Medical Science, Shiraz, Iran
Email: Zahra_2043@yahoo.com
Received: 01 January 2024
Revised: 02 February 2024
Accepted: 07 March 2024

Abstract

Background: Sarcopenia, an age-related decline in muscle mass, strength, and function, contributes to various adverse health outcomes and physical impairments. This study aimed to investigate the association between sarcopenia components and health-related quality of life (HRQoL) among community-dwelling older adults.

Methods: In this cross-sectional study, 501 adults aged 65 years or older participated. Sarcopenia was diagnosed according to the Asian Working Group for Sarcopenia (AWGS) guideline. Muscle mass was measured by bioelectrical impedance analysis (BIA), muscle strength by hand dynamometer, and physical function by 4-m gait speed. The HRQoL was assessed using 12-item short-form healthy survey (SF-12) questionnaire.

Results: There was a significant relationship between the sarcopenia and demographic characteristics (educational levels and smoking habits). After adjustment for age, sex, Body Mass Index, education level, smoking habits, and number of comorbidities, a significant relationship was observed between sarcopenia and physical components of HRQoL. According to multivariate linear regression, low muscle mass was negatively related to physical aspects of HRQoL. Low handgrip strength (HGS) and gait speed (GS) were inversely correlated to both physical and mental components of HRQoL.

Conclusion: Our study highlighted the adverse impact of sarcopenia on HRQoL in elderly population. Reduction in muscle strength and physical performance not only affected physical aspects but also were linked with mental components of HRQoL. Therefore, it seems HGS and GS might be good indicators affecting all aspects of HRQoL in the elderly groups.

Please cite this article as: Nasimi N, Dabbaghmanesh MH, Fararooei M, Asadi AH, Akbarzadeh M, Sohrabi Z. Sarcopenia and Health-related Quality of Life in Community-dwelling Older Adults. J Health Sci Surveillance Sys. 2024;12(2):141-148.

Keywords: Sarcopenia, Handgrip, Gait speed, Quality of life, Physical, Mental

Introduction

Sarcopenia is a state of age-related progressive loss of muscle mass and function (low muscle strength and physical performance). Due to population aging in the recent decades, the prevalence of sarcopenia has been growing considerably worldwide. In this context, sarcopenia has globally affected more than 29 percent of community-dwelling and 14-33 percent of institutionalized older adult populations.[1] Thus, this geriatric syndrome has been an important health concern. Indeed, it has been estimated that 500 million older adults will have suffered from sarcopenia by 2050.[2]

Sarcopenia is linked with several health outcomes, including higher risk of falls and fractures, disability, limitation of mobility, functional dependence, higher rate of hospitalization, increased mortality rate, and risk of comorbidities such as type 2 diabetes,

osteoporosis and obesity.[3] These adverse effects might have a detrimental effect on Health-Related Quality of Life (HRQoL). These days, healthy aging is of great importance and is considered as one of the objectives for achieving healthy longevity is improving HRQoL.[4]

The World Health Organization (WHO) has comprehensively defined HRQoL as "individuals' perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards, and concerns".[5] HRQoL consists of two broad dimensions of physical and mental health status. Previous research has revealed a close relationship between sarcopenia and worse HRQoL.[6] Similar results were also reported in a recent meta-analysis, which showed that sarcopenia was significantly associated with cognitive impairment.[7] Therefore, the assessment of HRQoL could be a good indicator providing valuable information for the development of public health strategies to improve the elderly population's health status.[8]

All the aforementioned information clearly confirm the association between the sarcopenia presence and lower quality of life in the elderly; however, there are limited data concerning the associations between sarcopenia components (including low muscle mass, decreased muscle strength, and physical impairment) and HRQoL dimensions. In addition, there is little evidence on the association between sarcopenia and HRQoL among Iranian community-dwelling older adults, and this seems to be a gap of knowledge. Thus, the present study aimed to identify the impact of sarcopenia on the physical and mental components of HRQoL and to investigate the association between sarcopenia components and HRQoL variables among community-dwelling older adults.

Methods

Study Design and Participants

This cross-sectional population-based study was performed at health centers of Shiraz, southern Iran, between August 2017 and February 2018 to assess the prevalence of sarcopenia which was described previously.[9-12] Briefly, the participants of this geriatric health survey included 501 old adults who were chosen by clustered, stratified, multistage sampling according to the geographical region. Healthy community-dwelling adults aged ≥65 years with independent walking ability were eligible to participate in this study. The exclusion criteria of the survey were having an artificial limb or metal prosthesis, suffering from active malignancies, suffering uncontrolled metabolic or endocrine diseases, or cardiac conduction abnormalities, and being unable to cooperate or comprehend the questions. The study was conducted with the collaboration of the Nutrition and Endocrine-Metabolic Research Center of Shiraz Medical University of Sciences (SUMS). The study protocol was reviewed and approved by the Ethics Committee of SUMS (IR.SUMS.REC.1396.89). Written informed consents for taking part in the research were also obtained from all participants.

Socioeconomic and Clinical Characteristics

The demographic questionnaire including information on age, gender, marital status (single or married), education level, retirement time, living status (alone at home or with family), smoking history, and economic status was completed for each participant by the main investigator. Education level was categorized into three groups of illiterate, studying for less than 12 years, and studying for more than 12 years. Additionally, smoking status as a modifiable lifestyle risk factor was classified into three categories of current smoker, former smoker, and non-smoker. The participants who had smoked at least 100 cigarettes in their lifetime were considered as former smokers, and those who had smoked during the past week were considered as current smokers. All of the questionnaires were completed by the main investigator.

Body weight and height were measured using standard methods[13] and Body Mass Index (BMI) was computed by dividing body weight (kg) by height squared (m^2). Waist circumference was also determined as the midway between the lowest ribs and the iliac crest by a tape measure.

The participants' electronic medical reports were reviewed to get information regarding their medical history, drug use history, and number of comorbidities (such as coronary heart disease, hypertension, kidney failure, diabetes, osteoporosis, etc.).

Diagnosis of Sarcopenia

Sarcopenia was defined based on the recommended algorithm by the Asian Working Group on Sarcopenia (AWGS).[14] Considering AWGS guideline, low muscle mass and low muscle function (including low muscle strength and/or low physical performance) was considered as sarcopenia. Skeletal muscle mass was measured using the segmental multi-frequency Bioelectrical Impedance Analysis (BIA) (InBody S10 analyzer, BioSpace Co., Ltd., South Korea). Skeletal Muscle Index (SMI) was defined as the Appendicular Lean Mass (ALM) (sum of the segmental muscle mass values of the legs and arms) divided by height squared (kg/m^2). According to the guideline, SMI<7.0 kg/m^2 for males and <5.7 kg/m^2 for females were considered as reference values for muscle loss.[14]

Handgrip Strength (HGS), as a muscle strength criterion, was measured using a hydraulic hand dynamometer (model MSD, Sihan, South Korea).

The measurements were carried out three times for both hands in sitting position, and the highest result was selected for analysis. Cutoff values <26 kg for males and <18 kg for females were used for muscle strength loss.[14]

Muscle performance criteria were measured by usual Gait Speed (GS) in meters per second. All participants were required to walk a 4-meter distance independently. GS<0.8 m/s was the low muscle performance cutoff.[14] For better precision, all measurements were done by the main investigator who was trained and experienced.

Quality of Life Assessment

HRQoL status was assessed using the validated 12-item Short-Form Health Survey questionnaire (SF-12) (Persian validated version), which is a generic instrument for measurement of health status from participants' viewpoints.[15] This questionnaire contains 12 items assessing eight health-related domains, including general health, physical functioning, role limitations due to physical problems, bodily pain, mental health, role limitations due to emotional problems, vitality, and social functioning. Physical Component Summery (PCS) and Mental Component Summery (MCS) were calculated using physical and mental domains of SF-12, respectively. According to the standard SF-12 scoring guideline, the responses for each domain are rated and converted into scores ranging from 0 to 100, which represent the worst and best health statuses, respectively. The two main categories of HRQoL are also scored from 0 (worst) to 100 (perfect), but it has no cutoff for classifying people as groups with low or high quality of life.

Statistical Analysis

The data were analyzed using IBM SPSS Statistics, version 21.0. Descriptive statistics were expressed as mean±SD and number (percentage) for continuous and categorical variables, respectively. Comparison of the participants with and without sarcopenia regarding socio-demographic characteristics and HRQoL was carried out using an independent *t*-test for continuous variables and a chi-square test for categorical ones. The relationship between sarcopenia status and the two main domains of HRQoL (PCS and MCS) was evaluated via multivariate linear regression models adjusted for potential confounders. Linear regression was applied using PCS and MCS components of HRQoL as the dependent variable. Independent variables with P<0.2 in univariate analysis were entered into the regression model as covariates. Multivariate linear regression models were also used to determine the correlations between sarcopenia components (low SMI, HGS, and GS) and HRQoL items. The minimally important difference was calculated using distribution-based method (half a standard deviation). Endogeneity was tested through COPULA correction method using R6.2. Statistical significance was set at P≤0.05.

Results

This study was performed on 501 old adults with the mean age of 70.3±4.6 years, including 254 males (50.7%). Among the participants, 20.4 percent were single, 10.6 percent lived alone, 26.5 percent were illiterate, 20.4 percent were current smokers, and 38.3 percent had low economic status (Table 1).

Considering AWGS guidelines, 104 participants, including 70 males (27.5%) and 34 females (13.8%), were diagnosed with sarcopenia (Figure 1). The prevalence of sarcopenia was reported to be 20.8 percent among the community-dwelling older adults.

Comparison of the two groups with respect to their basic characteristics is presented in Table 1. Accordingly, males comprised most of the participants

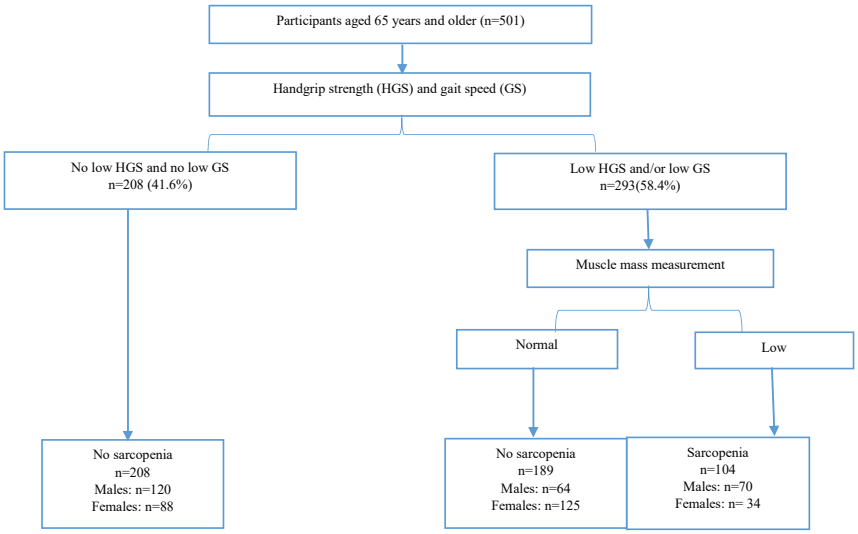

Figure 1: Diagnosis of sarcopenia according to AWGS-suggested algorithm. HGS: Handgrip strength; GS: Gait speed

Table 1: Comparison of sarcopenic and non-sarcopenic participants regarding socio-demographic characteristics and health-related quality of life

Variables	Overall (n=501)	Sarcopenic (n=104)	Non-sarcopenic (n=397)	P-value
Male sex, n (%)	254 (50.7)	70 (67.3)	184 (46.3)	<0.0001
Age, years	70.3±4.6	72.6±5.3	69.7±4.1	<0.0001
BMI, kg/m^2	27.24±4.75	23.18±3.45	28.30±4.46	<0.0001
Waist circumference, cm	93.43±10.25	85.21±8.21	95.65±9.61	<0.0001
Sociodemographic data				
Retirement time, year	8.24±9.22	11.44±11.50	7.40±8.34	<0.0001
Education level, n (%)				0.002
Illiterate (%)	133 (26.5)	41 (39.4)	92 (23.2)	
<12 years (%)	301 (60.1)	55 (52.9)	246 (62.0)	
>12 years (%)	67 (13.4)	59 (14.9)	8 (7.7)	
Marital status, n (%)				0.934
Single (%)	102 (20.4)	21 (20.2)	81 (20.4)	
Married (%)	399 (79.6)	83 (79.8)	316 (79.6)	
Living situation, n (%)				0.282
Alone (%)	53 (10.6)	8 (7.7)	45 (11.3)	
With family (%)	448 (89.4)	96 (92.3)	352 (88.7)	
Economic status, n (%)				0.406
Low (%)	192 (38.3)	39 (37.9)	153 (38.5)	
Medium (%)	218 (43.5)	50 (48.5)	168 (42.3)	
High (%)	87 (17.4)	14 (13.6)	73 (18.4)	
Smoking, n (%)				0.001
Never (%)	341 (68.1)	56 (53.8)	285 (71.8)	
Former (%)	58 (11.6)	21 (20.2)	37 (9.3)	
Current (%)	102 (20.4)	27 (26.0)	75 (18.9)	
HRQoL domains				
General health	40.22±25.31	35.52±26.12	41.46±24.98	0.033
Physical functioning	55.73±38.31	46.87±39.05	58.06±37.82	0.008
Role physical	66.42±33.12	58.83±36.93	68.41±31.80	0.017
Bodily pain	47.60±28.35	36.77±26.97	50.44±28.06	<0.0001
Vitality	62.22±30.80	57.93±30.81	63.35±30.74	0.110
Role emotional	76.49±30.05	73.43±34.99	77.29±28.61	0.301
Social functioning	81.43±27.78	76.92±31.48	82.61±26.65	0.093
Mental health	65.81±28.42	66.34±27.54	65.68±28.68	0.832
PCS	48.63±28.21	40.09±28.44	50.86±27.75	<0.0001
MCS	58.78±20.00	58.18±21.07	59.20±19.72	0.360
Total score	54.66±19.95	50.18±21.37	55.84±19.41	0.010
Sarcopenia criteria				
SMI, kg/m^2	7.13±1.03	6.20±0.69	7.38±0.96	<0.0001
HGS, kg	42.45±18.21	33.39±12.79	44.82±18.88	<0.0001
GS, m/s	0.84±0.66	0.67±0.13	0.88±0.73	0.004
Comorbidities				
0	197 (39.3)	54 (51.9)	143 (36.0)	0.029
1	204 (40.7)	33 (31.7)	171 (43.1)	
2	81 (16.2)	13 (12.5)	68 (17.1)	
>3	19 (3.8)	4 (3.8)	15 (3.8)	

PCS: Physical component summery; MCS: Mental component summery; SE: Standard error; BMI: Body mass index

with sarcopenia. These participants were significantly older and had significantly lower BMI, waist circumference, SMI, HGS, and GS compared to those without sarcopenia.

Considering socio-demographic data, sarcopenic participants had significantly lower education levels and smoked more in comparison to non-sarcopenic ones. Also, the participants with sarcopenia were retired a longer time ago compared to those without sarcopenia.

Regarding HRQoL dimensions, the participants diagnosed with sarcopenia obtained significantly lower scores on general health, physical functioning, role limitations due to physical problems, and bodily pain domains of SF-12 compared to non-sarcopenic ones. The findings also indicated a significant difference between the two groups with respect to PCS score as well as the total score of SF-12. The minimally important difference was calculated as 13.9 for total score, 9.85 for PCS, and 9.70 for MSC. However, the difference was not significant according to the calculated MID.

The correlation between HRQoL and sarcopenia status is presented in Table 2. According to the results of multivariate linear models adjusted for age, sex, BMI, education level, smoking habit, and number of comorbidities, an inverse relationship was observed between sarcopenia status and the PCS of HRQoL. However, no significant associations were found between the presence of sarcopenia and the MCS of HRQoL. Similarly, the difference was not significant according to the calculated MID. Also, no endogeneity bias was observed in the models.

Table 2: Multivariate linear regression coefficients for sarcopenia status according to SF-12 subscales

Covariates	SF-12 subscales					
	PCS (N=501)			MCS (n=501)		
	β	SE	P-value	β	SE	P-value
Sarcopenia status (reference: no sarcopenia)	-11.04	3.01	<0.0001	-1.85	2.36	0.433
Male	-14.31	2.49	<0.0001	-14.21	1.95	<0.0001
Age	-1.25	0.24	<0.0001	0.14	0.19	0.455
BMI	-0.69	0.27	0.011	0.52	0.213	0.015
Education level	12.90	1.79	<0.0001	1.95	1.40	0.166
Smoking habit	-3.50	1.40	0.013	-3.96	1.10	<0.0001
Number of comorbidities	-6.53	1.32	<0.0001	-2.68	1.03	0.010

BMI: Body mass index; HRQoL: Health-related quality of life; PCS: Physical component summery; MCS: Mental component summery; SMI: Skeletal muscle mass; HGS: Hand grip strength; GS: Gait speed

Table 3: Multivariate linear regression coefficients for sarcopenia components according to SF-12 subscales

	PCS								MCS							
	General health		Physical function		Role physical		Bodily pain		Vitality		Role emotional		Social function		Mental health	
	B	SE	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE
Low SMI	-5.77*	2.73	-11.98*	3.95	-3.75	3.73	-13.56*	3.00	-5.90	3.53	-1.84	3.53	-2.40	3.27	2.29	3.29
Low HGS	-4.85	4.32	-21.61*	6.20	-23.31*	5.79	-18.31*	4.76	-9.11	5.56	-16.33*	5.51	-9.95	5.14	-12.68*	5.15
Low GS	-10.58*	2.15	-25.04*	2.98	-16.45*	2.89	-17.52*	2.32	-7.78*	2.81	-2.86	2.82	-4.54	2.61	-6.05*	2.62

Adjusted for age, sex, BMI, education level, smoking habit, and number of comorbidities. PCS: Physical component summery; MCS: Mental component summery; SMI: Skeletal muscle mass; HGS: Handgrip strength; GS: Gait speed; *P<0.05

The associations between sarcopenia components (low SMI, MS, and GS) and each dimension of SF-12 are displayed in Table 3. Accordingly, multivariate linear regression models demonstrated a negative association between low SMI and general health, physical functioning, and bodily pain (as physical components). Moreover, low HGS was significantly associated with physical functioning, role limitations due to physical problems, bodily pain, role limitations due to emotional problems, and mental health (comprising both physical and mental components). Furthermore, low GS was inversely associated with most HRQoL domains, except for role limitations due to emotional problems and social functioning. However, the observed association was not significant according to the calculated MID.

Discussion

This study mainly focused on the association between the presence of sarcopenia and poor quality of life, especially in the physical aspects, in community-dwelling older adults. The main result of this study was that among the measures of sarcopenia diagnosis, low muscle strength and impaired physical function affected not only the physical but also the mental aspects of quality of life. Notably, results also showed a significant relationship between the presence of sarcopenia and demographic characteristics such as low educational levels and smoking habits.

Sarcopenia is a major aging problem that can affect many older adults all around the world. In the current study, the prevalence of sarcopenia was 20.8 percent which was similar to the prevalence demonstrated in a study in Northern Iran (26.7% for males and 20.6% for females).[16]

The current results are in the same line those of other studies considering the related factors of sarcopenia.[17] The present study showed that older adults with sarcopenia were retired a longer time ago compared to those without sarcopenia, showing the effect of age on sarcopenia progression. Further, those sarcopenic older adults had low educational status. It was also confirmed by some studies that low education levels can predict low muscle strength and physical function.[18] It can be proposed that people with higher education status could learn to avoid unhealthy behaviors than those with lower education level.[19]

Moreover, our results indicated that sarcopenic individuals smoked more compared to non-sarcopenic ones. In previous studies, it was found that smoking was highly associated with sarcopenia.[20] The main reason for the deleterious effect of smoking on muscles is related to its effect on compromising the function of the buffering system for providing energy for the muscles.[21]

The current study results highlighted a poor quality of life among older adults with sarcopenia. The result of the negative relationship between sarcopenia and quality of life was also reported by the previous studies.[22, 23] In the current study, older adults with sarcopenia obtained significantly lower scores on

the PCS-SF12 and the total- SF12. After adjustment for other factors known to be related to HRQOL, a negative association was also revealed between sarcopenia and low PCS of HRQoL in the elderly. Similarly, recent studies proposed that participants with sarcopenia had significantly higher rates of reduced mobility and usual activity problems.[24] This association might be related to high levels of pro-inflammatory indicators, which could contribute to decreased muscle quantity and quality, exhaustion, lower dietary intake, and limited mobility.[25] On the other hand, in a study by Kull et al., low physical role functioning, vitality, and emotional role functioning were shown in older adults with sarcopenia (both physical and mental aspects of the quality of life).[26] Moreover, a positive association was also reported between sarcopenia and mental aspects (i.e. cognitive impairment) in a meta-analysis,[7] while no significant association was found between sarcopenia and MCS-SF12 score.

The current study results demonstrated that low SMI was inversely related to general health, physical functioning, and bodily pain (domains of PCS). Consistently, Bekfani et al. revealed a significant positive relationship between high ALM and better quality of life among the elderly population.[27] An increment in muscle turnover and reduction in the number of muscle cells might cause discomfort or pain during usual activities.

Interestingly, analysis of the impact of sarcopenia components on HRQoL items showed an association between muscle function parameters (HGS and GS) and both physical and mental aspects of HRQol. The current study results showed that low HGS was significantly correlated with most SF-12 items, including physical functioning, role limitations due to physical problems, bodily pain, role limitations due to emotional problems, and mental health, which encompassed both physical and mental components. Some recent studies have also reported associations between muscle strength and daily physical and intellectual activity as well as social function, suggesting HGS as a predictor of mobility and cognitive activity.[28, 29] The close relationship between low muscle strength and both physical and mental components of HRQoL might result from the increase in protein degradation and levels of inflammatory markers as well as hormonal alteration, all contributing to sarcopenia.[30]

The present study results indicated that low GS was associated with all domains of SF-12 HRQoL except for role limitations due to emotional problems and social functioning. Similar research also demonstrated that slowness was related to higher rates of hospitalization and utilization of public healthcare services.[31] Recent evidence has suggested GS as the simplest available vitality scale, which has a direct impact on physical and mental health.[32]

The main strength of the study is that, due to the sampling method, most of the regions of the city (Shiraz, Iran) were assessed to find the eligible participants, so the study participants are almost good representatives of the community-dwelling older adults in Shiraz with almost no sample selection bias. Further, this population-based study examined the effect of sarcopenia on the quality of life in older adults living in a developing middle-income country with various limitations. Moreover, valid measures were used to qualify the key variables except for the measurement of the body composition that was done by BIA, due to the high expenses of DEXA as the gold standard. However, the main limitation of this study is that the causal relationships or clinical outcomes could not be assessed because of the cross-sectional study design.

Conclusion

Sarcopenia, as a prevalent age-related problem among Iranian older adults, had a negative impact on quality of life, which is considered the main cause of health challenges among the elderly population. The study findings demonstrated that muscle strength loss and physical impairment were closely related to both physical and mental components of the quality of life. Thus, HGS and GS might be good indicators affecting all aspects of HRQoL in aging groups but need further investigations. As a result, managing public health strategies for the early detection of sarcopenia and considering appropriate interventional strategies for slowing down the progression of sarcopenia is of great importance.

Authors' Contribution

All authors have contributed significantly and equally to the conception, design, and execution of the experiments, analysis of the findings, and preparation and final approval of the manuscript.

Acknowledgement

The authors would like to thank Ms. A. Keivanshekouh at the Research Improvement Center of Shiraz University of Medical Sciences for improving the use of English in the manuscript.

Ethical Approval

The study procedure was approved by the local Medical Ethics Committee of Shiraz University of Medical Sciences (IR.SUMS.REC.1396.89). All participants gave their written informed consent after receiving an explanation about the study protocol.

Funding

This work was supported by Shiraz University of Medical Sciences (grant No. 8413633).

Conflict of Interest: None declared.

References

1 Fuggle N, Shaw S, Dennison E, Cooper C. Sarcopenia. Best Pract Res Clin Rheumatol. 2017. doi: 10.1016/j.berh.2017.11.007. PMID: 29224698; PMCID: PMC5768235.

2 Hida T, Harada A, Imagama S, Ishiguro N. Managing sarcopenia and its related-fractures to improve quality of life in geriatric populations. Aging dis. 2014;5(4):226. doi: 10.14336/ad.2014.0500226. PMID: 25110607; PMCID: PMC4113513.

3 Beaudart C, Zaaria M, Pasleau F, Reginster J-Y, Bruyère O. Health outcomes of sarcopenia: a systematic review and meta-analysis. PloS one. 2017;12(1): e0169548. doi: 10.1371/journal.pone.0169548. PMID: 28095426; PMCID: PMC5240970.

4 Tokudome S, Hashimoto S, Igata A. Life expectancy and healthy life expectancy of Japan: the fastest graying society in the world. BMC Res Notes. 2016;9(1):482. doi: 10.1186/s13104-016-2281-2. PMID: 27793196; PMCID: PMC5084424.

5 Group TW. The World Health Organization quality of life assessment (WHOQOL): development and general psychometric properties. Soc Sci Med. 1998;46(12):1569-85. doi: 10.1016/s0277-9536(98)00009-4. PMID: 9672396.

6 Manrique-Espinoza B, Salinas-Rodríguez A, Rosas-Carrasco O, Gutiérrez-Robledo LM, Avila-Funes JA. Sarcopenia is associated with physical and mental components of health-related quality of life in older adults. J Am Med Dir Assoc. 2017;18(7):636. e1-. e5. doi: 10.1016/j.jamda.2017.04.005. PMID: 28549718.

7 Chang K-V, Hsu T-H, Wu W-T, Huang K-C, Han D-S. Association between sarcopenia and cognitive impairment: a systematic review and meta-analysis. J Am Med Dir Assoc. 2016;17(12):1164. e7-. e15. doi: 10.1016/j.jamda.2016.09.013. PMID: 27816484.

8 Rizzoli R, Reginster J-Y, Arnal J-F, Bautmans I, Beaudart C, Bischoff-Ferrari H, et al. Quality of life in sarcopenia and frailty. Calcif Tissue Int. 2013;93(2):101-20. doi: 10.1007/s00223-013-9758-y. PMID: 23828275; PMCID: PMC3747610.

9 Nasimi N, Dabbaghmanesh MH, Sohrabi Z. Nutritional status and body fat mass: Determinants of sarcopenia in community-dwelling older adults. Exp Gerontol. 2019;122:67-73. doi: 10.1016/j.exger.2019.04.009. PMID: 31022445.

10 Nasimi N, Sohrabi Z, Dabbaghmanesh MH, Eskandari MH, Bedeltavana A, Famouri M, et al. A novel fortified dairy product and sarcopenia measures in sarcopenic older adults: a double-blind randomized controlled trial. J Am Med Dir Assoc. 2021;22(4):809-15. doi: 10.1016/j.jamda.2020.08.035. PMID: 33067129.

11 Montazeri-Najababady N, Dabbaghmanesh MH, Nasimi N, Sohrabi Z, Chatrabnous N. The association between TP53 rs1625895 polymorphism and the risk of sarcopenic obesity in Iranian older adults: a case-control study. BMC Musculoskelet Disord. 2021;22(1):1-9. doi: 10.21203/rs.3.rs-42273/v1. PMID: 33985476; PMCID: PMC8120782.

12 Montazeri-Najafabady N, Dabbaghmanesh MH, Nasimi N, Sohrabi Z, Estedlal A, Asmarian N. Importance of TP53 codon 72 and intron 3 duplication 16 bp polymorphisms and their haplotypes in susceptibility to sarcopenia in Iranian older adults. BMC Geriatr. 2022;22(1):1-10. doi: 10.1186/s12877-022-02765-6. PMID: 35123410; PMCID: PMC8818191.

13 Jamshidi S, Ahmadi A, Nasimi N, Razmjoui N, Bagheri S, Esmaeilinezhad Z. The Relationship between Serum Vitamin B12 and Glycemic Indices, BMI, and Dietary Components in Elderly. Int J Nutr Sci. 2020;5(4):167-73. doi: 10.30476/IJNS.2019.83209.1032.

14 Chen L-K, Liu L-K, Woo J, Assantachai P, Auyeung T-W, Bahyah KS, et al. Sarcopenia in Asia: consensus report of the Asian Working Group for Sarcopenia. J Am Med Dir Assoc. 2014;15(2):95-101. doi: 10.1016/j.jamda.2013.11.025. PMID: 24461239.

15 Montazeri A, Vahdaninia M, Mousavi SJ, Asadi-Lari M, Omidvari S, Tavousi M. The 12-item medical outcomes study short form health survey version 2.0 (SF-12v2): a population-based validation study from Tehran, Iran. Health Qual Life Outcomes. 2011;9(1):12. doi: 10.1186/1477-7525-9-12. PMID: 21385359; PMCID: PMC3063185.

16 Hashemi R, Shafiee G, Motlagh AD, Pasalar P, Esmailzadeh A, Siassi F, et al. Sarcopenia and its associated factors in Iranian older individuals: Results of SARIR study. Arch Gerontol Geriatr. 2016;66:18-22. doi: 10.1016/j.archger.2016.04.016. PMID: 27176487.

17 Kim H, Hirano H, Edahiro A, Ohara Y, Watanabe Y, Kojima N, et al. Sarcopenia: Prevalence and associated factors based on different suggested definitions in community-dwelling older adults. Geriatr Gerontol Int. 2016;16:110-22. doi: 10.1111/ggi.12723. PMID: 27018289.

18 Li C-I, Li T-C, Lin W-Y, Liu C-S, Hsu C-C, Hsiung CA, et al. Combined association of chronic disease and low skeletal muscle mass with physical performance in older adults in the Sarcopenia and Translational Aging Research in Taiwan (START) study. BMC Geriatr. 2015;15(1):11. doi: 10.1186/s12877-015-0011-6. PMID: 25879214; PMCID: PMC4341862.

19 Ferraro KF, Shippee TP. Aging and cumulative inequality: How does inequality get under the skin? Gerontologist. 2009;49(3):333-43. doi: 10.1093/geront/gnp034. PMID: 19377044; PMCID: PMC2721665.

20 Neves T, Ferriolli E, Lopes MBM, Souza MGC, Fett CA, Fett WCR. Prevalence and factors associated with sarcopenia and dynapenia in elderly people. J Frailty Sarcopenia Falls. 2018;3(4):194. doi: 10.22540/jfsf-03-194. PMID: 32300708; PMCID: PMC7155355.

21 da Silva Alexandre T, de Oliveira Duarte Y, Santos JF, Wong R, Lebrão M. Prevalence and associated factors of sarcopenia among elderly in Brazil: findings from the SABE study. J Nutr Health Aging. 2014;18(3):284-90. doi: 10.1007/s12603-013-0413-0. PMID: 24626756.

22 Neto LSS, Karnikowski MG, Osório NB, Pereira LC, Mendes MB, Galato D, et al. Association between sarcopenia and quality of life in quilombola elderly in Brazil. Int J Gen Med. 2016;9:89. doi: 10.2147/ijgm.s92404. PMID: 27143952; PMCID: PMC4846046.

23 Verlaan S, Aspray TJ, Bauer JM, Cederholm T, Hemsworth J, Hill TR, et al. Nutritional status, body composition, and quality of life in community-dwelling sarcopenic and non-sarcopenic older adults: A case-control study. Clin Nutr. 2017;36(1):267-74. doi: 10.1016/j.clnu.2015.11.013. PMID: 26689868.

24 Sun DS, Lee H, Yim HW, Won HS, Ko YH. The impact of sarcopenia on health-related quality of life in elderly people: Korean National Health and Nutrition Examination Survey. Korean J Intern Med 2017. doi: 10.3904/kjim.2017.182. PMID: 29172406; PMCID: PMC6610192.

25 Meng Y, Wu H, Yang Y, Du H, Xia Y, Guo X, et al. Relationship of anabolic and catabolic biomarkers with muscle strength and physical performance in older adults: a population-based cross-sectional study. BMC Musculoskelet Disord. 2015;16(1):202. doi: 10.1186/s12891-015-0654-7. PMID: 26286594; PMCID: PMC4545782.

26 Kull M, Kallikorm R, Lember M. Impact of a new sarco-osteopenia definition on health-related quality of life in a population-based cohort in Northern Europe. J Clin Densitom. 2012;15(1):32-8. doi: 10.1016/j.jocd.2011.08.007. PMID: 22071030.

27 Bekfani T, Pellicori P, Morris DA, Ebner N, Valentova M, Steinbeck L, et al. Sarcopenia in patients with heart failure with preserved ejection fraction: impact on muscle strength, exercise capacity and quality of life. Int J Cardiol. 2016;222:41-6. doi: 10.1016/j.ijcard.2016.07.135. PMID: 27454614.

28 Barbat-Artigas S, Rolland Y, Cesari M, Abellan van Kan G, Vellas B, Aubertin-Leheudre M. Clinical relevance of different muscle strength indexes and functional impairment in women aged 75 years and older. J Gerontol a Biol Sci Med Sci. 2012;68(7):811-9. doi: 10.1093/gerona/gls254. PMID: 23262030.

29 Sugiura Y, Tanimoto Y, Watanabe M, Tsuda Y, Kimura M, Kusabiraki T, et al. Handgrip strength as a predictor of higher-level competence decline among community-dwelling Japanese elderly in an urban area during a 4-year follow-up. Arch Gerontol Geriatr. 2013;57(3):319-24. doi: 10.1016/j.archger.2013.06.006. PMID: 23830293.

30 Woo T, Yu S, Visvanathan R. Systematic Literature Review on the Relationship Between Biomarkers of Sarcopenia and Quality of Life in Older People. J Frailty Aging. 2016;5(2):88-99. doi: 10.14283/jfa.2016.93. PMID: 27224499.

31 Cawthon PM, Lui L-Y, McCulloch CE, Cauley JA, Paudel ML, Taylor B, et al. Sarcopenia and health care utilization in older women. J Gerontol a Biol Sci Med Sci. A: Biomedical Sciences and Medical Sciences. 2016;72(1):95-101. doi: 10.1093/gerona/glw118. PMID: 27402050; PMCID: PMC5155659.

32 Studenski S, Perera S, Patel K, Rosano C, Faulkner K, Inzitari M, et al. Gait speed and survival in older adults. JAMA. 2011;305(1):50-8. doi: 10.1001/jama.2010.1923. PMID: 21205966; PMCID: PMC3080184.