JOURNAL OF NUTRITION FASTING AND HEALTH

Evaluation of Pre-Sarcopenia and Sarcopenia in a Well-Nourished Late-Middle-Aged Population: A Feasibility Study of a Registry

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ARTICLEINFO

Article type:
Research Paper

Article History:
Received: 05 Oct 2022
Accepted: 12 Nov 2022
Published: 01 Dec 2022

Keywords:
Sarcopenia
Geriatric
Aging
Prevalence
Iran
Pre-sarcopenia

ABSTRACT

Introduction : Sarcopenia is characterized by weakness of the skeletal muscles. This study aimed to evaluate the prevalence of sarcopenia and its relationship with dietary intake, socioeconomic status, depression, lifestyle, and physical activity for the first time in a well-nourished over 55 year's old population.

Methods: This study was conducted on a well-nourished above 55 years old population. The European Working Group on Sarcopenia in Older People-2 (EWGSOP-2) guideline was used to determine the prevalence of sarcopenia. Muscle mass was assessed using bioelectrical impedance analysis. Muscle strength and performance were evaluated using handgrip and gait speed, respectively. The dietary intake, socioeconomic status, psychological health, lifestyle, clinical factors, and physical activity were examined using valid tools.

Results: A total of 766 well-nourished individuals (mean age=65.14±6.84 years old; male:female ratio= 1:1.99) were evaluated for sarcopenia. The prevalence of pre-, confirmed-, and severe sarcopenia were 23.9%, 1.8%, and 1.3%, respectively. Age was significantly related to sarcopenia (OR=1.096 (95% CI: 1.069-1.124), p<0.001). Females had an increased risk of pre-sarcopenia (OR=2.189 [95% CI: 1.48-3.239], p=0.002), while males were at higher risk of confirmed and severe sarcopenia (OR=15.102 [95% CI: 4.461-51.131], p<0.001). The decision tree model of sarcopenia indicated age as the main predictor for sarcopenia.

Conclusion: According to EWGSOP-2, the overall prevalence of sarcopenia was 27% among well-nourished almost healthy elderly population. There was a relationship between age and sarcopenia. Females and males were at higher risk of pre-sarcopenia and confirmed and severe sarcopenia; respectively. Further research is strongly suggested to asses pre-sarcopenia.

▶ Please cite this paper as:
Shadmand Foumani Moghadam MR, Etemdi Sh, Bozzetti F, Amushahi M, Bakhshipour M, Pezeshki P, Ghayour Mobarhan M, Khadem-Rezaiyan M, khanizadeh Kh, Sutanto LB, Ferns GA, Hosseini Z. Evaluation of Pre-Sarcopenia and Sarcopenia in a Well-Nourished Late-Middle-Aged Population: A Feasibility Study of a Registry. J Nutr Fast Health. 2022; 10(4): 258-270. DOI: 10.22038/JNFH.2022.68278.1405.

Introduction

The term *sarcopenia* combined from *Sarco* (flesh) and *Penia* (low) presents losing muscle mass (1, 2). Sarcopenia was defined in the 1980s as a progressive and generalized skeletal muscle disorder and classified as a disease since 2016 by World Health Organization (WHO) (1, 2). According to the descriptions, sarcopenia is a complex disorder, which decreases muscle strength, power, mass, and performance (1-4). The primary outcomes of sarcopenia are a higher risk of falling, physical disability, higher healthcare expenses, dependency, and mortality

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in the elderly (1-4). The prevalence of this disease varies worldwide, ranging from 4 to 36%, with a mean of 10% (5-7). The prevalence of sarcopenia is likely to be higher than reported because it is often undiagnosed (1).

The global elderly population is rising, especially in Iran, and sarcopenia is a common age-related complex disorder influenced by many factors still being explored. The leading cause of sarcopenia is aging (usually more than 65 years old), and lifestyle, nutritional patterns, financial and social statements, psychological health, and physical performance are sarcopenia's possible acquired factors (2, 3, 8). While studies are still ongoing, the evidence suggests that more sarcopenia studies are needed worldwide (9). Furthermore, the risk factors and characteristics of sarcopenia should be evaluated, as well as instruments and cut-offs compared using the principles of action research (9).

An evidence-based study should be conducted in a population with the lowest probability of bias to address gaps, determine major lifestyle risk factors, including lifestyle, dietary patterns, socioeconomic, psychological health, and physical activity, and compare data across nations and regions to provide a more qualified guideline for this disease (2, 3, 8). Disease and malnutrition are already considered as the most decisive risk factors for sarcopenia. Therefore, selecting a healthy population without these risk factors may be critical in assessing the impact of lifestyle components on sarcopenia risk and understand the goal of adapting clinical and community-based lifestyle interventions in the future (1-4, 8-10).

Despite research being conducted worldwide on this subject, there are still some gaps in the field that need to be considered. Considering the population aging and the lack of studies on lifestyle, nutritional pattern, financial, socioeconomic, psychological health, and physical performance in a population with the least bias risk, this study aimed to evaluate a well-nourished population without any severe disease as a feasibility study.

Material and Method

Ethics Approval and Consent to Participate

The Ethics Committee approval was obtained from Mashhad University of Medical Science, Iran: IR.MUMS.REC.1398.229 (http://ethics.research.ac.ir). According to the Ethical Principles and Declaration of Helsinki, informed written consent was obtained individually from all participants. According to our population's age and vast content of assessment, the short form of each questionnaire was used, and online registration was established to prevent people from long attendance at clinics. Every participant was given 15-30 minutes free of charge nutrition consolation by a Registered Dietitian and Nutritionist (RDN) with a full-color report of their status. According to medical ethics, if a specific health-related issue was recognized during any assessment stage, the individuals had been proposed to visit a specialist.

Design

This study was conducted in collaboration with the Nutrition Department of Varastegan Institute for Medical Sciences, the Welfare Organization of Khorasan Razavi (Central Khorasan) Province, and the Khorasan Razavi (Central Khorasan) Retirement Association. The data were collected from November 2019 to May 2021.

Sample Size

The sample size was estimated by assuming the prevalence of sarcopenia and pre-sarcopenia (50%) among the retired aged population (n≈275000), the confidence level (95%), and the margin of error (3.5%) using the $n=\frac{z^2*\hat{p}(1-\hat{p})}{\varepsilon^2}$ formula. The final calculated sample size was 782 individuals.

Inclusion and Exclusion Criteria

The inclusion criteria were the age of 55 or more, currently living in one of the municipal areas of Mashhad province (city and covering villages) for the last ten years, lack of severe disease leading to catabolism (advanced diabetes, cardiovascular diseases, rheumatism, osteoporosis, cancer, and chronic kidney disease), having proper nutrition, no confirmed mental disabilities, Alzheimer, or psychological disorders. The exclusion criteria were being at the risk of malnutrition using Mini Nutrition Assessment-short-form (MNA-SF), being hospitalized in the previous full year, physical disabilities, unreported catabolic disease history, and having metal in the body. Nevertheless, obesity and overweight were not considered as the exclusion criteria.

Study Participants

The population was selected on two levels in nursing houses and the population using the

convenient method in different areas of Mashhad city (Figure 1). The sampling continued in the case of individual exclusion until the sample size was reached. All eligible individuals in nursing houses were included due to the limited population. According to the Mashhad municipality report, the population of all 13 municipal areas was equal, which provides an equal contribution to municipal regions. The living region of individuals was recorded in the nursing houses.

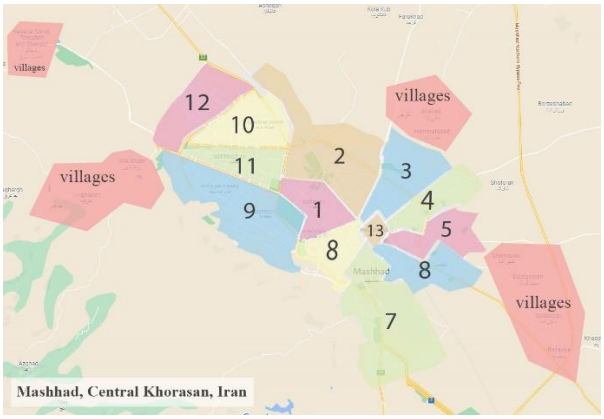

Figure 1. The 13-municipal areas of Mashhad and covering villages.

Data Collecting Progress

Two assessments were conducted on the same day. The primary assessments included demographic and social-economic records, anthropometric tests, blood pressure, nutritional, depression, and sarcopenia assessments. The secondary tests included lifestyle, anxiety, and depression tests using validated questionnaires. Expert dietitians clinically trained for three months asked all the questions in a face-to-face interview. All the data were recorded in the registration system, and no paper was used for data collection. Each assessment was performed in separate rooms.

General Information

Demographic data, working and socioeconomic status, smoking and alcohol use, family medical history, and drug consumption history were documented using a questionnaire. The financial status of each individual was determined based on their access to welfare amenities and income. The monthly income of individuals was compared with the country's average expenditures.

Malnutrition Assessment

The Mini Nutrition Assessment–short-form (MNA-SF) (2001) was used as an efficient way to diagnose wasting and protein/energy malnutrition in the aged population (11). In this questionnaire, the overall score of under seven is malnourished, 8-11 is at risk of malnutrition, and ≥12 is normal. The confounding effect of malnutrition on muscle mass and dietary intake was removed by excluding both malnourished and at-risk malnutrition populations.

Skeletal Muscle Mass Index

The bioelectric impedance analyzer (BIA) method with InBody-270 version 2018 with serial number: F1800027, InBody, Korea was used to measure skeletal muscle mass (SMM). BIA is easy to use, inexpensive, convenient, and requires minimal time for measurements with no specific difference from the dual-energy X-ray absorptiometry (DEXA) method (12,13). However, the presence of metal in the body, dehydration, and overhydration are essential factors, which may bias BIA measurements (12,14). Each person was asked to drink water and urinate before their test two hours before their test, to decrease the risk of overhydration. Dehydrated participants were asked to drink water and rest for 15-20 minutes if they were suspected of being dehydrated. Each individual was asked to stand on the BIA with the lightest available clothes and without any external objects during the assessment, including rings, necklaces, glasses, and belts, as instructed by Maughan et al. (15). SMM was divided by the square of the height in meters ($SMMI = \frac{Smm}{height^2}$)

to calculate the skeletal muscle mass index (SMMI) (3).

Muscle Strength

Muscle strength was measured using a hydraulic hand dynamometer (Hydraulic Hand Dynamometer 08-010113, Saehan, Korea) based on the Roberts et al. recommended methodology (16). Each individual sat on a chair with a bare right hand without external objects. The dominant hand upper limb was placed alongside the body with the elbow at a 90° angle, and the contralateral limb was relaxed on the thigh. The participants were instructed to provide maximum strength without shaking their hand or feeling uncomfortable. Muscle strength was measured three times for each individual, and the mean of performances was calculated with an accuracy of 1 kg/m^2.

Muscle Performance

The 4-m gait speed test was applied to evaluate muscular performance. The subject was instructed to walk as fast as possible without running (3,4). The time to complete the process was recorded accurately at 0.1 seconds. The test was performed twice with 30 seconds intervals between tests, and the mean of performances was recorded.

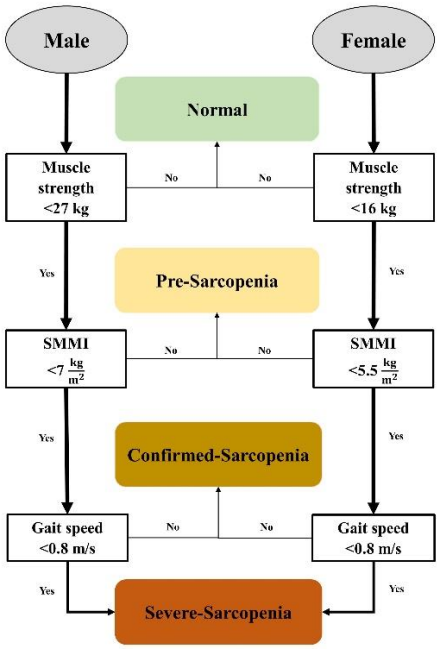

Figure 2. This figure includes cut-offs of muscle strength using handgrip, gait speed, SMMI (skeletal muscle mass index) and diagnosing definition for pre-sarcopenia, sarcopenia and severe sarcopenia according to the EWGSOP-2 (2018) guidelines.

Operational Definition and Diagnosis of Sarcopenia

The European Working Group on Sarcopenia in Older People 2 (EWGSOP-2) method was used to diagnose sarcopenia (3,4). The full description for cut-offs and classification can be found in Figure 2. In this study, people without sarcopenia are named the normal group, and three clinical stages including pre-, confirmed- and severe-sarcopenia, are categorized as the sarcopenia group.

Other Anthropometric and Clinical Assessments

Body composition data, including fat mass, muscle mass, fat-free mass, body mass index (BMI), and waist-to-hip ratio (WHR), were collected using BIA. Bodyweight and height were measured once more using a digital scale with a height measure (Body Scale Height and Weight Scale BS 703, serial number: 7030109, Body scale, Iran). The Mid-upper arm circumference (MUAC) was measured by an accuracy of 1cm as one of the critical, common, and efficient

methods for in-hospital malnutrition screenings, hospital wasting, cachexia, and mortality risks (17). A digital sphygmomanometer measured the blood pressure (OMRON 5 Series® Upper Arm Blood Pressure Monitor, Model: BP7200, Omron, Japan, and ALPK2 Sphygmomanometer A103833-8, ALPK, Japan) to evaluate the relation between blood pressure and sarcopenia as a related factor (18).

Physical Activity Assessment

The physical activity of each individual was assessed at the current age and when they were between 30-45 years as a long-term memory-based recall. According to the instruction, a valid form of the International Physical Activity Questionnaire (IPAQ) was used to classify the population into four groups (19). Then, the changes between the two physical activities were reported as increasing, decreasing, or staying the same. In addition, any specific sports or routine physical activity, including walking, swimming, and aerobics, were recorded based on the duration and frequency.

Lifestyle Assessment

The Medical Outcomes Study Health Survey Questionnaire 36-Item Short Form (SF-36) was used (20). This tool measures the quality of life based on eight domains; 1. Physical functioning, 2. Physical limitations, 3. Body pain, 4. General health, 5. Vitality, 6. Social functioning, 7. Social limitations, and 8. Mental health. This questionnaire was used for construct validity of SarQoL as a specific health-related quality-of-life questionnaire for sarcopenia in 2016 (21).

Psychological Assessment

Two tools were used for psychological assessments, and the short form of the Beck Depression Inventory (BDI-13) was utilized to validate the Iranian population (22). Additionally, Depression Anxiety Stress Scales 21-item (DASS-21) was used to assess anxiety, stress, and depression in the population (23). These questionnaires are the most common psychological assessment tools in different populations.

Nutrition Assessment

A 16-item semi-Food Frequency Questionnaire (FFQ) was developed to determine the kind and frequency of food group intake (24, 25). Then, the nutritional intake of each individual was recorded using a one-day dietary recall. Based on the evidence, one-day recall is a standard method to evaluate the nutritional intake of significant sample-sized healthy populations (26, 27). The difference between the recall and questionnaire was considered in a calculator file designed for this method to cover this method's biases and the food intake variety during a year. The data were reviewed by a registered nutritionist experienced in recall and dietary intake calculating before any changes were made. Changes included reflecting food intake from previous years and adjusting the reported intake as closely as possible to the diet pattern. The data were analyzed using the last update (December 2021) of the *United States Department of Agriculture (USDA)* food composite database (https://fdc.nal.usda.gov) with the potential to report the intake of 138 micro- and macro-nutrients with high precision. To analyze the mixed traditional foods that were not included in USDA's database, the foods were uniform to their main ingredients based on the "*Iranian Traditional Foods Recipes*," which were edited but not yet published by *the "Iran Ministry of Health" and "Medical Education Nutrition Improvement Office."* Cooking coefficient, weight, and containing water changes were considered in recalculating new foods during food processing.

Statistical Analysis

All statistical analyses were performed using the IBM SPSS Statistics software for Windows version 20.0. Results were presented as percentages (%) and means (M±SD) according to EWGSOP-2 sarcopenia outcome. Shapiro-Wilk, Levene, KMO, and Bartlett's tests were used to evaluate the data normality, quality, reliability, and homogeneity. One-Way analysis of variance (ANOVA) test and Tukey's test was used for continuous variables. Mann-Whitney U Test was considered for data with non-normal distribution. The qualitative variables were evaluated using the Chi-square test or Fisher's exact test, and the odds ratios (OR) for having one of three stages of sarcopenia (pre-, confirmed- and severe-sarcopenia) were obtained using binary logistic regression and scoring method. The Chi-Square Automatic Interaction Detector decision tree was applied using SPSS (P-value<0.05). However, the current study focuses only on primary findings and settings, and does not include all the analysis.

Results

There were 1074 individuals introduced for assessment (n=39 (5.1%) nursing houses vs. n=727 (94.9%) population), of which 292 were excluded, and 782 completed assessments (Figure 3). A total of 16 out of 782 data were removed because of missing data, and finally, the data of 766 individuals (mean age=65.14±6.84 years old; male:female ratio= 1:1.99) were assessed for sarcopenia (Figure 3). There was no significant difference between the 13 municipal areas of Mashhad and covering villages for the participants (p=0.952), the prevalence (p=0.271), and other factors indicating a similar distribution of this disease in the city. The number of people in the nursing house did not significantly affect the overall prevalence (p=0.859). The power of this study was 0.998 based on the leading indicator of sarcopenia.

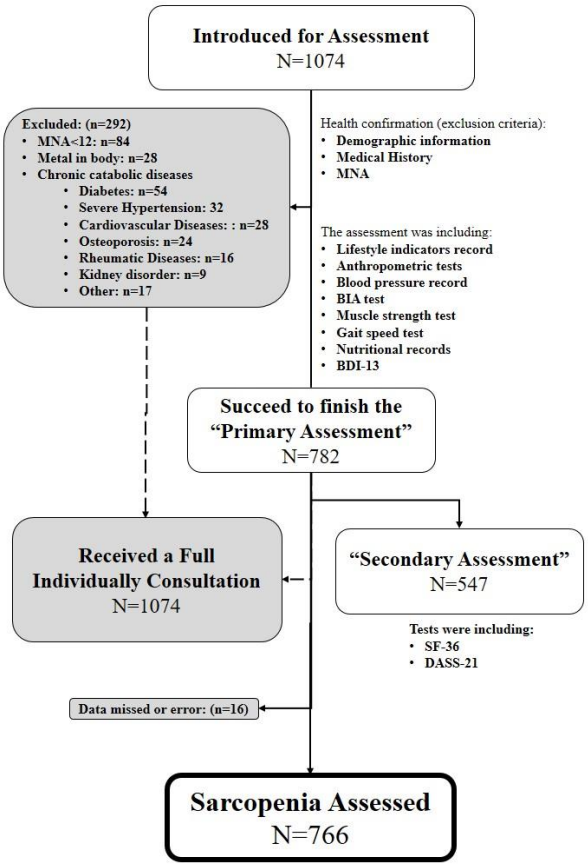

Figure 3. This flowchart includes population participant information for 1074 eligible individuals according to our registration system, the excluding path, and assessments with details. MNA: Mini Nutritional assessment, BIA: bioelectric impedance analyser, BDI-13: short form of the Beck Depression Inventory, SF-36: Medical Outcomes Study Health Survey Questionnaire 36-Item Short

The overall prevalence of normal, pre-, confirmed- and severe-sarcopenia was 73% (n=559), 23.9% (n=183), 1.8% (n=14), and 1.3% (n=10), respectively (Figure 1). There was a significant difference between all sarcopenia diagnosing criteria except the muscle performance in women, which was not significant (p=0.369), which can be related to the confirmed- and severe-sarcopenia sample size or population speed (Table 1).

Age was significantly related to sarcopenia in males (OR=1.128 (95% CI: 1.078-1.18), p<0.001), females (OR=1.081 (95% CI: 1.048-1.114), p<0.001) and the overall population (OR=1.096 (95% CI: 1.069-1.124), p<0.001). Sarcopenia groups differed significantly (p>0.001) by gender, but no statistically significant OR was found for genders and sarcopenia (pre-, confirmed-, and severe-sarcopenia). However, this finding can be explained by the significantly higher prevalence

of pre-sarcopenia in females (OR=2.189 (95% CI: 1.48-3.239), p=0.002) and higher prevalence of confirmed and severe sarcopenia in males (OR=15.102 (95% CI: 4.461-51.131), p>0.001).

Table 1. Comparison of population, age, gender and diagnosing critters according to EWGSOP-2

		Characterise	Groups					
			Normal	Sarcopenia			OR (95% CI)[sig]	P-value
				Pre-Sarcopenia	Confirmed-sarcopenia	Severe-Sarcopenia		
Both Genders		**n=766 (100%)**	**n=559 (73%)**	**n=183 (23.9%)**	**n=14 (1.8%)**	**n=10 (1.3%)**		
Muscle Strength	kg	23.82±7.9	26.51±6.99	15.84±4.83	23.36±3.15	19.85±5.76	-	**<0.001**
SMMI	Kg/m²	7.17±1.16	7.36±1.17	6.75±0.97	6.1±0.72	5.99±0.87	-	**<0.001**
Muscle Performance	m/sec	0.84±0.14	0.83±0.13	0.86±0.15	0.77±0.07	1±0.08	-	**<0.001**
Gender	Male (ref)	256 (100%)	196 (76.6%)	39 (15.2%)	13 (5.1%)	8 (3.1%)	1.323 (0.935-1.871)	**<0.001**
	Female	510 (100%)	363 (71.2%)	144 (28.2%)	1 (0.2%)	2 (0.4%)		
Age	N (Year)	65.14±6.84	64.03±6.45	67.52±7.02	71.64±4.97	74.2±3.79	**1.096 (1.069-1.124)****	**<0.001**
Males		**n= 256 (100%)**	**n= 196 (76.6%)**	**n= 39 (15.2%)**	**n= 13 (5.1%)**	**n= 8 (3.1%)**		
Muscle Strength	kg	31.53±5.78	33.78±4.61	24.59±1.31	24.08±1.71	22.44±2.09	-	**<0.001**
SMMI	Kg/m²	8.11±1.03	8.35±0.86	7.97±0.79	6.15±0.73	6.22±0.82	-	**<0.001**
Muscle Performance	m/sec	0.77±0.09	0.76±0.08	0.78±0.08	0.76±0.07	0.99±0.08	-	**<0.001**
Age	N (Year)	64.91±7.12	63.56±7.09	67.64±4.61	71.23±4.92	74.5±4.11	**1.128 (1.078-1.18)****	**<0.001**
Females		**n= 510 (100%)**	**n= 363 (71.2%)**	**n= 144 (28.2%)**	**n= 1 (0.2%)**	**n= 2 (0.4%)**		
Muscle Strength	kg	19.94±5.67	22.58±4.45	13.47±1.64	14±0	9.5±0.71	-	**<0.001**
SMMI	Kg/m²	6.7±0.91	6.83±0.94	6.42±0.72	5.41±0	5.08±0.32	-	**<0.001**
Muscle Performance	m/sec	0.88±0.14	0.87±0.14	0.88±0.15	0.8±0	1.05±0.07	-	**0.369**
Age	N (Year)	65.25±6.7	64.28±6.07	67.49±7.56	77±0	73±2.83	**1.081 (1.048-1.114)****	**<0.001**

The OR of sarcopenia predictors did not assessed because of the high and confounding impact of these factors on sarcopenia as diagnosing main criterias.
OR compared between Normal and Sarcopenia Group (Pre-Sarcopenia, Sarcopenia and Severe-Sarcopenia). For gender, male was reference.
Effect estimates with a p-value < 0.05 are indicated in bold for both OR and p.value.
For OR: P.value <0.05 reported * and <0.005 reported as **.

The decision tree model of having sarcopenia (EWGSOP-2) in Figure 4 (muscle strength (kg) excluded due to its over-impact) shows that age is the main predictor of sarcopenia. People over 74 years old are at the highest risk of sarcopenia in both genders. The SMMI can predict sarcopenia regardless of gender in people aged 65 or younger, and gender is the main predictor in people aged 65-74 years old. Sarcopenia in females aged 65-74 can be predicted using SMMI≤7.093. The other findings of this study include the impact assessment of physical activity, psychological, nutritional, lifestyle, and quality of life factors.

Discussion

To the best of knowledge, this large population-based Feasibility study was conducted for the first time to evaluate the burden of sarcopenia in a healthy population. The findings indicated a considerable prevalence of pre-sarcopenia in a well-nourished, nearly healthy population that can develop into severe sarcopenia. The results may help make evidence-based policies to

develop preventive and treatment strategies. In addition, age was the main predictor of sarcopenia, and gender could have a significant impact on the severity appearance of sarcopenia.

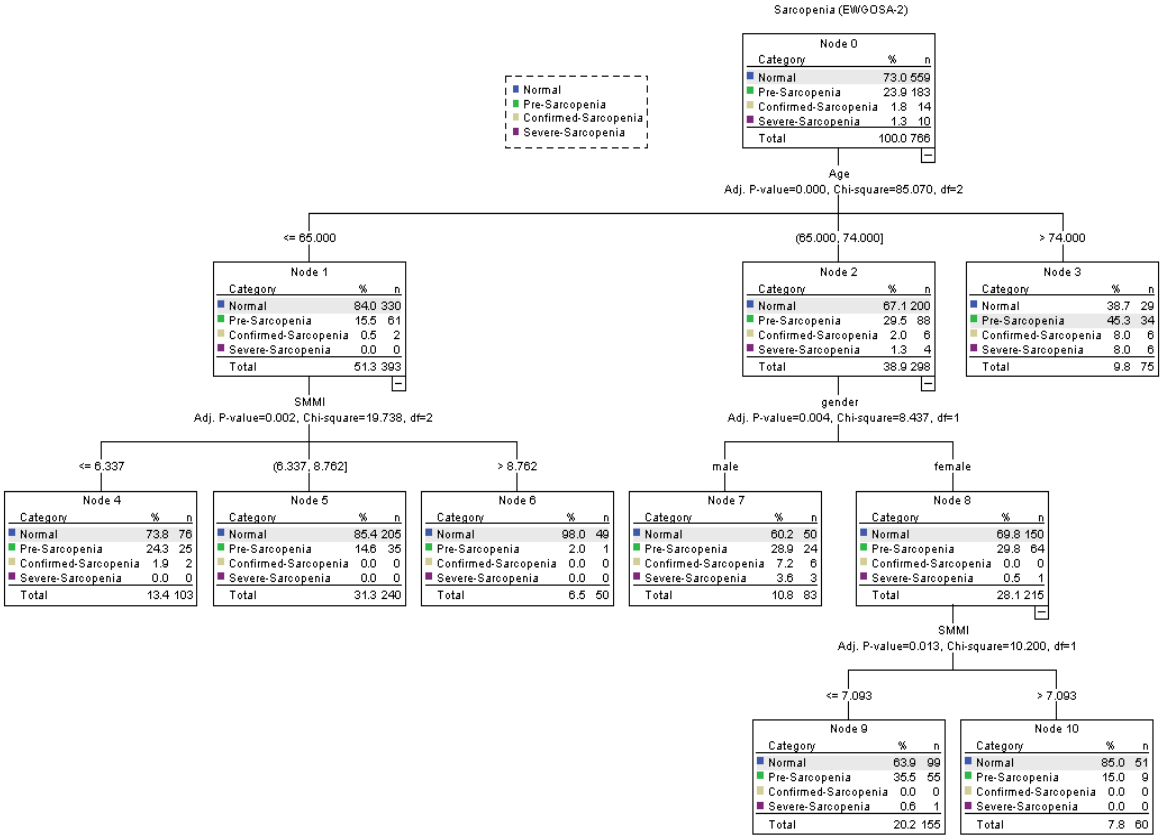

Figure 4. Gender, Age, SMMI (kg/m^2), and muscle performance (m/sec) added in the model. decision three of having sarcopenia (EWGSOP-2) shows age is the main predictor of sarcopenia. Within people 65 or less years old, the SMMI can predict the sarcopenia; while in people aged 65-74 years old, gender is the main predictor.

The prevalence of sarcopenia is reported in different countries (using different definitions) between 10 to 27% in ≥60 years old and from 8 to 36% in individuals <60 years old, with a mean of 10% worldwide (7, 28). In addition, the prevalence of severe sarcopenia is expected to be ranged between 2 and 9% (7). However, no systematic review reported the worldwide prevalence of pre-sarcopenia separately (7). Based on available data, the prevalence of sarcopenia and severe sarcopenia was considerably lower than the global range in the current population. However, the prevalence of pre-sarcopenia or losing muscle strength remained unknown.

According to the current study, the prevalence of confirmed and severe sarcopenia was lowest of all studies that considered pre-sarcopenia. The prevalence of one of three stages of sarcopenia was reported in most studies between 8 to 58% that fit the current study (7, 8, 28-32). Various factors can explain this range of prevalence rates, including health, lifestyle, diagnostic cut-offs, and consideration of pre-sarcopenia (2, 3). Although pre-sarcopenia can develop into sarcopenia and severe sarcopenia, this lack of pre-sarcopenia information in other studies can be considered the most significant limitation of studies.

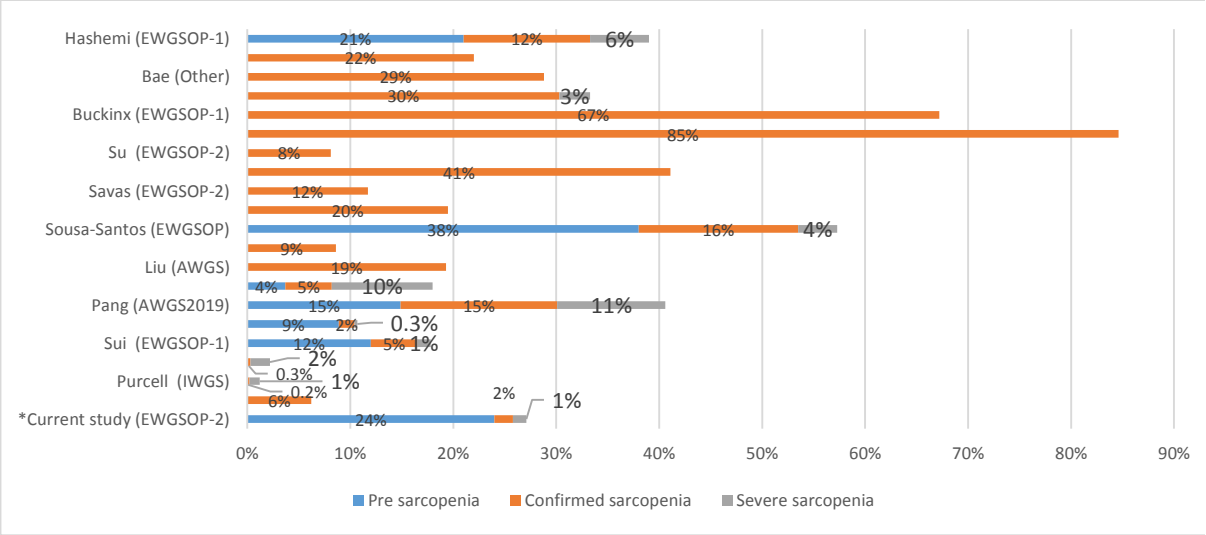

Figure 5. Illustrated comparison of the prevalence of sarcopenia in people with no considerable diseases in the world in the recent years according to finding in the table 2

One study in Japan (33) (2019) showed a prevalence of 8% and another study in Canada (34) (2020) reported 6.2% sarcopenia in big sample sizes. Both studies ignored the pre-sarcopenia assessment, which may significantly affect the reported prevalence. The prevalence of sarcopenia in all studies, which disregarded pre-sarcopenia was not limited to >10%. For example, Pelegrini et al. (35) reported a high prevalence of 30.3 and 3% for confirmed and severe sarcopenia in a Brazilian population. However, few studies considered pre-sarcopenia. Among them, one study by Sousa-Santos (32) with a sample size of 1459 individuals reported a prevalence of nearly 50% of one of three stages of sarcopenia in Portuguese people (32). Another study reported prevalence of Pre-, confirmed-, and severe-sarcopenia as much as 21%, 12.3%, and 5.7%, respectively, in Tehran-Iran within 300 individuals (31). Table 2 and Figure 5 show the comparison of the prevalence of some studies with a close population with the current study (31-44).

Some studies already use different cut-off values. In this study, changing the sarcopenia definition to other guidelines also has been considered. The narrative comparisons of limited available data revealed that Iranians' body shape, weight, height, and composition are closer to the European population than East Asians (45-47). In addition, prioritizing strength over mass in the EWGSOP is the other advantage of this guideline. This simple comparison show that EWGSOP can be a better tool for this population than Asian cut-off points (1, 2, 45-47). Nevertheless, establishing a more comprehensive worldwide guideline based on EWGSOP-2 with a focus on cut-off points variety can be helpful.

Table 2. Literature report of the comparison of the prevalence of sarcopenia in people with no considerable diseases in the world by the time of this study.

Study first author	Country / city	Year	Total sample size	Men/ women	Population age (yr)	Diagnosis method	Prevalence			
							normal	Pre-sarcopenia	Confirmed-sarcopenia	Severe sarcopenia
Current study (Shadmand)	Iran/ Mashhad	2021	766	256/510	65.1±6.7	EWGSOP-2	559 (73%)	183 (23.9%)	14 (1.8%)	10 (1.3%)
Purcell	Canada	2020	12592	6260/6221	≥ 65	EWGSOP-2	11067 (93.8%)	**NA**	727 (6.2%)	0 (0%)
						IWGS	10574 (98.5%)	**NA**	23 (0.2%)	136 (1.3%)
						FNIH	10479 (97.6%)	**NA**	35 (0.3%)	213 (1.9%)
Sui	Australia	2020	665	342/323	70[1]	EWGSOP-1	546 (82.2%)	80 (12%)	30 (4.5%)	9 (1.3%)
						EWGSOP-2	594 (89.4%)	59 (8.9%)	10 (1.5%)	2 (0.3%)

Study first author	Country / city	Year	Total sample size	Men/ women	Population age (yr)	Diagnosis method	Prevalence			
							normal	Pre-sarcopenia	Confirmed-sarcopenia	Severe sarcopenia
Pang	Singapore	2020	542	228/314	58.5±18.8	AWGS2019	325 (59.3%)	82 (14.9%)	83 (15.2%)	58 (10.5%)
						EWGSOP-2	449 (81.9%)	20 (3.7%)	25 (4.5%)	54 (9.8%)
Liu	China	2020	4500	1627/2873	62.4 ± 8.3	AWGS	2071 (80.69%)	**NA**	869 (19.31%)	**NA**
Martone	Italy/ Rome	2020	11,253	4897/6356	55.6±11.5	EWGSOP-2	10280 (91.4%)	**NA**	973 (8.6%)	**NA**
Sousa-Santos	Portugal	2020	1454	613/841	65 to 100[1]	EWGSOP	620 (42.6%)	553 (38%)	225 (15.5%)	55 (3.8%)
Kim	Korea	2019	2099	1053/1046	75.9 ± 4.0	EWGSOP-2	1618 (80.5%)	**NA**	411 (19.5%)[2]	**NA**
Savas	Turkey	2019	248	55/193	70[1]	EWGSOP-2	219 (88.3%)	**NA**	29 (11.7%)	**NA**
						EWGSOP-2-T	146 (58%)	**NA**	102 (41.1%)	**NA**
Su	Japan/ Sapporo	2019	310	89/221	76±5.8	EWGSOP-2	285 (91.9%)	**NA**	25 (8.1%)	**NA**
Benjumea	Colombia / Manizales	2018	534	131/403	74.4 ± 8.2	EWGSOP-1	154 (15.4%)	**NA**	380 (84.6%)	**NA**
Buckinx	Belgium	2018	662 (247)[2]	249/413	83.2 ± 8.99	EWGSOP-1	81 (32.7)	**NA**	166 (67.2%)	**NA**
Pelegrini	Brazil/ Florianópolis	2018	439	69/369	79.9±6	Janssen et al.	292 (66.7%)	**NA**	133 (30.3%)	13 (3%)
Bae	Korean	2017	17968	7746/10222	Over 20[1]	Other (standard deviation of normal population)	12785 (71.2%)	**NA**	5183 (28.8%)	**NA**
Men	Australia / Sydney	2017	419	212/ 207	81.2 ± 4.5	EWGSOP-1	322 (78 %)	**NA**	88 (22 %)	**NA**
Hashemi	Iran/ Tehran	2016	300	150/150	66.8 ± 7.72	EWGSOP-1	183 (61%)	63 (21%)	37 (12.3%)	17 (5.7%)

NA: not assigned

[1] mean age or CI was not reported

[2]The prevalence is estimated according to the reported prevalence of Handgrip strength, Chair stand test, Gait speed, and SMMI.

Abbreviation: IWGS: International Working Group on Sarcopenia, FNIH: Foundation for the national institutes of health, AWGS: Asian Working Group on Sarcopenia, EWGSOP-2-T: EWGSOP-2 adjusted for the Turkish population

Many factors affect the risk of sarcopenia regarding the risks. In addition, age is the most significant factor associated with sarcopenia (2, 3, 33). The current study also had the same result for age, the findings are varied for gender. In the current study, the female group was at higher risk of pre-sarcopenia than the male, while males felt at a considerably higher risk of confirmed and severe sarcopenia, confirming the results of previous studies (35, 48). Some other studies also find a higher prevalence of sarcopenia in females (32, 34). The review of evidence revealed that the range of findings about the effect of sex on sarcopenia is more related to consideration of pre-sarcopenia in studies. Despite no robust explanation for the current finding, it seems males are at a higher risk of confirmed sarcopenia, and females are at a higher risk of pre-sarcopenia. More studies with a higher follow-up length are still required to understand this relation.

This study also aimed to understand better the risk factors for sarcopenia in an isolated from catabolic condition population. Most of the studies assessed sarcopenia within populations with a disease, malnutrition, or at least one risk factor of sarcopenia, while sarcopenia can occur in all individuals (1-4). This study can provide considerable insight regarding the importance of sarcopenia health care and risk factors as one of the pioneers by excluding all catabolism-related high-risk individuals.

Finally, sarcopenia is a complex disorder influenced by many factors, directly or indirectly as a long-term disorder, requiring more research. The world is getting older each year, and sarcopenia can become one of the world's first concerns shortly because of an inactive lifestyle and poor diet patterns enhanced during the COVID-19 pandemic (49). However, pre-sarcopenia is defined as low skeletal muscle strength, which can be controlled (1-4). The interventions can begin at the pre-sarcopenia

stage before it becomes too late. The results strongly recommend considering pre-sarcopenia assessment in further works to reach the objective.

This study aimed to determine the effect of different main lifestyle factors on sarcopenia in a well-nourished population to prevent disease and enable early diagnosis. As one of the first studies investigating the predictive factors for sarcopenia in a well-nourished population, the data are now being analyzed and will be presented in the future as one of the first studies of its kind in a well-nourished population. The strengths of this study were the large sample size, recruiting of well-nourished subjects with no catabolic diseases, and considering most of the health-related factors in one population to better understand sarcopenia and risk factors.

The first limitation of this study was related to the population. Despite reducing the risk of bias in assessing risk factors, this study cannot represent the prevalence of sarcopenia in the city because a great portion of the population, the residents with chronic diseases, are not included. Furthermore, working with these age groups is a challenging process requiring exceptional personalities. Additionally, the short form of questionnaires were used at all steps to reduce the period and provide a better assessment, which limited the data. Nonetheless, the present study's main limitation is its observational nature which cannot evaluate the directions. However, these types of studies can provide a rationale for future evaluations.

Conclusion

According to EWGSOP-2, the prevalence of pre-, confirmed- and severe-sarcopenia was 27%. Age was associated with sarcopenia, and males were at a higher risk of confirmed and severe sarcopenia, while females were at a higher risk of pre-sarcopenia. In addition, further studies are suggested to assess pre-sarcopenia as well as sarcopenia and severe-sarcopenia in further studies.

Acknowledgment

This study was supported by Varastegan Institute for Medical Sciences. We want to thank Mr. Matin Etemadi, manager of online registration programs, the “Welfare Organization of Khorasan Razavi Provence” and Mr. Ramezani, the head of “The Khorasan Razavi Retirement Association,” and everyone who engaged in this study as well as the participants.

Conflict of Interest

There is no conflict of interest to declare.

Financial Support

The grant was provided by an in-house grant from the Varastegan Institute for Medical Sciences research committee.

Author Contribution

Study concept and design: ZH, MRSh, and PP; Drafting of the manuscript: MRSh, ZH; Study implementation: MRSh, SE, MA, RB, and KhKh; Data validation and dietary intake analysis; MRSH, SE and MA, Statistical analysis and interpretation of data: MRSh, MKhR, MGM; reviewing the manuscript, MGM, LS, FB, ZH, PP, GAF and managing the registry system: SE, MRSh. All authors approved the final version and agreed to publish the work. ZH is responsible for corresponding to the paper.

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