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The Effects of Sarcopenia and Fracture Risk on Kinesiophobia, Fear of Falling, Fall Risk and Quality of Life in Geriatric Individuals

Geriatrik Bireylerde Sarkopeni ve Kırık Riskinin Kinezyofobi, Düşme Korkusu, Düşme Riski ve Yaşam Kalitesi Üzerine Etkileri

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Abstract

Objective: This study aimed to determine the relationship between sarcopenia and fracture risk in older adults and to investigate the effects of increased fracture risk in individuals with sarcopenia on the fear of falling, fall risk, kinesiophobia, and quality of life (QOL).
Materials and Methods: The study involved 132 participants. Sarcopenia risk was assessed using the SARC-F questionnaire, fracture risk with the Fracture Risk Assessment Tool, QOL with the "World Health Organization Quality of Life Scale" short form, presence of kinesiophobia with the TAMPA Kinesiophobia scale, and fall risk with the "Berg Balance scale" and "International Fall Effectiveness scale".
Results: The study included 102 women (77.3%) and 30 men (23.7%). The average age of the individuals was 70.83±6.98. There was a risk of sarcopenia in 55.5% of patients, and those at risk of sarcopenia had a 33.3% risk of hip fracture and 22.2% risk of both hip and major fracture. With regard to the risk of sarcopenia, it was observed that the fall and fracture risks increased, and the QOL decreased (p-value <0.05). Fracture risk and sarcopenia risk were higher in women, increased with age, and negatively correlated with body mass index and education level (p-value <0.05). It has been observed that both fracture risk and sarcopenia risk with fracture risk increased the risk of falls, kinesiophobia, and decreased QOL (p-value <0.05).
Conclusion: Appropriate treatment and early intervention of these conditions in sarcopenic individuals with isarcopenia and increased fracture risk may provide clinical benefits to reduce the risk of falls and fractures and improve QOL.
Keywords: Fall risk, fracture, kinesiophobia, osteosarcopenia, quality of life, sarcopenia

Öz

Amaç: Bu çalışmanın amacı yaşlı erişkinlerde sarkopeni ile kırık riski arasındaki ilişkiyi belirlemek ve sarkopenik bireylerde artan kırık riskinin düşme korkusu, düşme riski, kinezyofobi ve yaşam kalitesi üzerine etkilerini araştırmaktır.
Gereç ve Yöntem: Bu çalışmaya 132 kişi katıldı. Sarkopeni riski SARC-F anketi, kırık riski Kırık Riski Değerlendirme Aracı, yaşam kalitesi "Dünya Sağlık Örgütü Yaşam Kalitesi Ölçeği" kısa formu, kinezyofobi varlığı TAMPA Kinezyofobi ölçeği, düşme riski ise "Berg Denge Ölçeği" ve "Uluslararası Düşme Etkinliği ölçeği" ile değerlendirildi.
Bulgular: Çalışmaya 102 kadın (%77,3) ve 30 erkek (%23,7) dahil edildi. Bireylerin yaş ortalaması 70,83±6,98 idi. Hastaların %55,5'inde sarkopeni riski mevcuttu ve sarkopeni riski taşıyanların %33,3'ünde kalça kırığı riski, %22,2'sinde ise hem kalça hem de majör kırık riski vardı. Sarkopeni riski ile birlikte düşme riskinin ve kırık riskinin arttığı, yaşam kalitesinin düştüğü gözlendi (p-değeri <0,05). Kırık riski ve sarkopeni riski ile birlikte kırık riski kadınlarda daha yüksekti, yaşla birlikte artıyordu ve vücut kitle indeksi ve eğitim düzeyi ile negatif korelasyon gösteriyordu (p-değeri <0,05). Hem kırık riskinin hem de kırık riskiyle birlikte sarkopeni riskinin düşme riskini ve kinezyofobiyi artırdığı, yaşam kalitesini düşürdüğü gözlendi (p-değeri <0,05).
Sonuç: Kırık riski artmış sarkopenik bireylerde bu durumların uygun tedavisi ve erken müdahalesi, düşme ve kırık riskinin azaltılması ve yaşam kalitesinin iyileştirilmesi yönünde klinik fayda sağlayabilir.
Anahtar kelimeler: Düşme riski, kırık, kinezyofobi, osteosarkopeni, yaşam kalitesi, sarkopeni

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Introduction

With the global aging of the population, the prevalence of osteoporosis and sarcopenia is rapidly increasing, which positively correlates with increased risk of fractures, decreased quality of life (QOL), and premature mortality (1). In 2010, the European Working Group on Sarcopenia in Older People (EWGSOP) defined sarcopenia as a syndrome characterized by progressive and widespread loss of skeletal muscle strength, mass, and functions that occurs with increasing age or secondary to a disease process and is associated with risks such as physical disability, poor QOL, and mortality (2,3). The prevalence of sarcopenia varies between populations and according to the definitions and thresholds used. Thus, while prevalences of 3% to 24% have been reported in individuals older than 65 years of age when assessed using criteria and thresholds defined by the EWGSOP, the prevalence is 7.1% when there is both loss of muscle mass and loss of muscle function, and 11% when there is loss of muscle mass only (3,4).

Osteoporosis, the most common metabolic bone disease in the elderly, is characterized by microarchitectural deterioration that predisposes to fragility fractures secondary to both low bone mass and low energy transfer. According to epidemiological studies and clinical experience, bone mineral density (BMD) is not always associated with fractures, and 40% of women with fractures have normal BMD. Therefore, in order to determine the risk of fracture development, it is necessary to determine both BMD and BMD-independent risk factors. For this purpose, Kanis et al. (5) investigated risk factors independent of BMD and their predictive values in 12 international studies involving 60,000 people. the World Health Organization Fracture Risk Assessment Tool (WHO-FRAX) was developed to calculate the 10-year probability of hip fracture and any major osteoporotic fracture, taking into account femoral neck BMD and clinical risk factors (5).

In recent years, the association of osteoporosis or osteopenia and sarcopenia has been called "osteosarcopenia" and the prevalence rates of osteosarcopenia in individuals aged ≥65 years vary between approximately 5-37% (6). Both sarcopenia and osteoporosis are chronic diseases that occur for many reasons and varying results and can be seen more in the elderly than in young adults. It can result in frailty, a decrease in QOL, a decrease in mobility and functional independence, deterioration in the immune system, deterioration in respiratory functions, falls, disability, loss of strength, and sometimes death (3,7,8). Since this condition causes a serious global public health problem by placing a significant clinical and economic burden on society, identifying these individuals who may be vulnerable to the negative consequences of musculoskeletal aging is important from a clinical and public health perspective. Therefore, in our study, we aimed to determine the relationship between sarcopenia and fracture risk in older adults and to investigate the effects of increased fracture risk in sarcopenic individuals on fall risk, fear of falling, kinesiophobia, and QOL.

Materials and Methods

Study Participants

This study is a descriptive cross-sectional study conducted at Kütahya Health Sciences University, Evliya Çelebi Training and Research Hospital Physical Medicine and Rehabilitation Clinic between 1 May and 30 July 2023. All data were collected by the same evaluator at the same facility.

This study included 132 independently ambulatory individuals over the age of 65 who applied to the physical medicine and rehabilitation outpatient clinics of our hospital, whose sarcopenia risk was evaluated with the SARC-F questionnaire, and whose BMD was measured in the last 6 months. Those who refused to participate in the study, those with vestibular system disease, uncontrolled hypertension and diabetes, those with severe cognitive impairment, fully dependent or semi-dependent patients, those with advanced cerebrovascular, cardiovascular and rheumatological diseases, and those with abnormalities in blood tests that could cause loss of balance were excluded from the study.

All individuals' blood tests performed in the last 3 months and BMD measurements with dual-energy X-ray absorptiometry in the last 6 months were evaluated. In blood tests, vitamin D, vitamin B12, parathyroid hormone, calcium, albumin, and total protein levels, which are effective on sarcopenia, osteoporosis, and balance, were measured.

Before being included in the study, all individuals signed the informed consent form stating that they participated in the study voluntarily, and ethical approval was received from the Kütahya Health Sciences University Non-interventional Clinical Research Ethics Committee (decision no: 2023/01-20, dated: 11.01.2023).

Assessment of Fracture Risk

The fracture risk of all patients whose BMD was measured in the last 6 months was calculated using WHO-FRAX. The risk of fractures varies significantly across different parts of the world. Therefore, FRAX is calibrated to countries where the epidemiology of fractures and deaths is known. A FRAX model for Turkey has been available since 2008. However, in 2012, it has been updated to include newer fracture and death rates (9). FRAX® is a web-based algorithm that calculates the 10-year probability of experiencing a hip fracture and major osteoporotic fracture (hip, clinical vertebra, wrist, proximal humerus). According to the FRAX calculation table, individuals with a major osteoporotic fracture risk of over 20% and a hip fracture risk of over 3% were evaluated as high fracture risk groups (5).

Assessment of Sarcopenia Risk

In clinical practice, SARC-F is recommended as a screening test to determine the risk of sarcopenia. The SARC-F questionnaire consists of 5 questions based on self-report (strength, walking, getting up from a chair, climbing stairs, and falling). The total score varies between 0-10, and a score of ≥4 indicates a risk of

sarcopenia. SARC-F is one of the best tests that can be used in clinical practice to predict the adverse events that may occur due to sarcopenia (10). The validation of the Turkish version of the SARC-F questionnaire was conducted by Bahat et al. (11).

Questionnaire

Participants filled out surveys consisting of sociodemographic questions, including age, gender, occupation, education level, height, and body weight. In individuals participating in the study, QOL with the World Health Organization Quality of Life Scale Short Form (WHOQoL-Bref) (12,13), presence of kinesiophobia with the TAMPA kinesiophobia scale (14,15), fall risk with the Berg balance scale (16,17) and fear of falling with International Fall Effectiveness scale (18,19) were evaluated.

First of all, the relationship between sarcopenia or fracture risk and QOL, kinesiophobia, fall risk, and fear of falling was evaluated separately in the study population. All patients were then divided into 7 groups:

Group 1: No sarcopenia and fracture risk,
Group 2: Only sarcopenia risk,
Group 3: Only hip fracture risk,
Group 4: Only major fracture risk,
Group 5: Risk of both major fracture and hip fracture,
Group 6: Sarcopenia risk with hip fracture risk,
Group 7: Sarcopenia risk with risk of both major and hip fractures.

With the evaluations between the groups, the relationship between the presence of accompanying fracture risk and QOL, kinesiophobia, fall risk and fear of falling in individuals with and without risk of sarcopenia was evaluated.

Statistical Analysis

Statistical analysis was conducted using SPSS 22.0 (Statistical Package for the Social Sciences 22.0). The normal distribution suitability of the variables was assessed through visual methods such as histograms and probability graphs, as well as analytical methods including the Kolmogorov-Smirnov and Shapiro-Wilk tests. Descriptive statistics were presented as the mean and standard deviation for numerical data and as numbers and percentages for nominal data. For numerical variables exhibiting a normal distribution between two groups, the "independent samples t-test" was employed. In cases where numerical variables did not display a normal distribution, the "Mann-Whitney U test" was utilized. For numerical variables demonstrating a normal distribution among three groups or more, analysis was performed using "ANOVA (Analysis of Variance)". Conversely, numerical variables not adhering to a normal distribution were subjected to the "Kruskal-Wallis H test". The nominal data was compared using the "chi-square test". Correlation analyses were conducted using the "Pearson correlation test" for numerical variables with a normal distribution, and the "Spearman correlation test" for numerical variables lacking a normal distribution. A significance level of $p<0.05$ was considered statistically significant in the study's analysis.

Results

Relationship Between Sarcopenia Risk and Data

One hundred thirty two individuals, 102 women (77.3%) and 30 men (23.7%), were included in the study. The average age of the individuals participating in the study was 70.83±6.98. There was a risk of sarcopenia in 72 (55.5%) of the study population. No statistically significant relationship was found between demographic data in individuals with and without risk of sarcopenia. The data are given in Table 1.

No statistically significant relationship was found between the risk of sarcopenia, and kinesiophobia and fall risk. A statistically significant relationship and a moderate positive correlation were found between the risk of sarcopenia and fear of falling (rho value: 0.491). A statistically significant relationship and moderate negative correlation were found at risk of sarcopenia and in all domains of QOL (total, physical health, psychological well-being, social relationships, environment health) (rho values respectively -0.382, -0.435, -0.381, -0.386, -0.435). The data are given in Table 2.

Table 1. Relationship between sarcopenia risk and demographic data

	Total n=132 (100%)		Without sarcopenia n=60 (45.5%)		With sarcopenia n=72 (55.5%)		p-value
	n (%)	Mean ± SD	n (%)	Mean ± SD	n (%)	Mean ± SD	
Gender							0.324#
Female	102 (77.3%)		44 (73.3%)		58 (80.6%)		
Male	30 (22.7%)		16 (26.7%)		14 (19.4%)		
Age		70.83±6.98		70.20±6.22		71.36±7.56	0.533¥
Height (cm)		159.62±8.28		160.27±8.51		159.08±8.11	0.416*
Body weight (kg)		73.14±11.51		72.93±10.37		72.93±10.37	0.826¥
BMI (kg/m^2)		28.78±4.71		28.46±4.05		29.05±5.21	0.470¥
Under ideal weight (<18.5)	2 (1.5%)		0 (0%)		2 (2.8%)		0.490#
Normal (ideal) (18.5-24.9)	26 (19.7%)		14 (23.3%)		12 (16.7%)		

Table 1. Continued

	Total n=132 (100%)		Without sarcopenia n=60 (45.5%)		With sarcopenia n=72 (55.5%)		p-value
	n (%)	Mean ± SD	n (%)	Mean ± SD	n (%)	Mean ± SD	
Overweight (25.0-29.9)	52 (39.4%)		22 (36.7%)		30 (41.7%)		
First degree obesity (30.0-34.9)	42 (31.8%)		20 (33.3%)		22 (30.6%)		
Second degree obesity (35.0-39.9)	8 (6.1%)		4 (6.7%)		4 (5.6%)		
Third degree obesity (>40.0)	2 (1.5%)		0 (0%)		2 (2.8%)		
Education level							0.254#
Unschooled-literate	24 (18.2%)		8 (13.3%)		16 (22.2%)		
Primary/middle school	92 (69.7%)		44 (73.4%)		48 (66.7%)		
High school	14 (10.6%)		8 (13.3%)		6 (8.3%)		
University	2 (1.5%)		0 (0%)		2 (2.8%)		
Occupation							0.211#
Housewife	90 (68.2%)		38 (63.3%		52 (72.2%)		
Desk worker	2 (1.5%)		2 (3.3%)		0 (0%)		
Retired	40 (30.3%)		20 (33.4%)		20 (27.8%)		

Data presented as mean (± SD) or number (n/%) of patients. BMI: Body mass index, cm: Centimeter, m: Meter, kg: Kilogram, SD: Standard deviation. The p-value refers to the difference between the groups. P<0.05 statistically significant. *Independent samples t-test, #chi-square test, ¥Mann-Whitney U test

Table 2. Relationship between sarcopenia risk and kinesiophobia, balance and fall risk and quality of life

	Total n=132 (100%)		Without sarcopenia n=60 (45.5%)		With sarcopenia n=72 (55.5%)		p-value
	n (%)	Mean ± SD	n (%)	Mean ± SD	n (%)	Mean ± SD	
TSK		41.23±9.05		40.43±8.99		41.89±9.12	0.431¥
FES-I		29.53±10.60		28.70±10.49		30.22±10.72	0.309¥
BBS		45.86±8.71		50.83±5.38		41.72±8.82	**<0.001¥**
High fall risk (>21)	0 (0%)		0 (0%)		0 (0%)		**<0.001#**
Medium fall risk (21-40)	34 (25.8%)		4 (6.7%)		30 (41.7%)		
Low fall risk (41-56)	98 (34.2%)		56 (93.3%)		42 (58.3%)		
WHOQoL-BREF							
Total		54.55±19.37		61.67±21.82		48.61±14.77	**<0.001¥**
PH		50.54±20.34		60.11±19.15		42.55±17.79	**<0.001¥**
PS		59.40±18.85		66.94±19.47		53.12±15.89	**<0.001¥**
SR		65.53±18.98		71.94±19.22		60.18±17.14	**<0.001¥**
EH		69.41±15.87		76.98±14.08		63.11±14.53	**<0.001¥**

Data presented as mean (± SD) or number (n/%) of patients. BBS: Berg balance scale, EH: Environment health, FES-I: Falls Efficacy Scale-International, PH: Physical health, PS: Psychological well-being, SD: Standard deviation, SR: Social relationships, TSK: TAMPA scale for kinesiophobia, WHOQoL: World Health Organization Quality of Life Scale Brief Version. The p-value refers to the difference between the groups. P<0.05 statistically significant. #Chi-square test, ¥ Mann-Whitney U test

Of the 72 individuals at risk of sarcopenia, 24 (33.3%) had only a hip fracture risk, and 16 (22.2%) had both a hip and major fracture risk. A statistically significant and low-level positive correlation was found between the risk of sarcopenia and the risk of major osteoporotic fracture and hip fracture (p-values respectively <0.01, 0.014; rho values respectively 0.277, 0.298). The risk of sarcopenia was significantly higher in individuals with both major fracture and hip fracture risk compared to individuals without fracture risk and with only hip fracture risk.

Relationship Between Fracture Risk and Data

Of the study population, 66 (50%) were at risk of fracture, including 48 (36.4%) at risk of only hip fracture and 18 (13.6%) at risk of both major fracture and hip fracture. Considering the demographic data, while the risk of major fracture was significantly higher in the female gender, no statistically significant relationship was found between the risk of hip fracture and gender (p-values respectively <0.01, 0.678). It has been observed that the risk of fracture increases with age. In particular, a statistically significant relationship and a moderate positive correlation were found between age and hip fracture risk (p-value <0.001, rho value 0.528). There is a statistically significant negative correlation between fracture risk and height, body weight, and body mass index (BMI) (rho values respectively -0.266, -0.371, -0.380). Especially in shorter individuals, the risk of both hip and major fractures was significantly higher. There was a statistically significant low negative correlation between education level and risk of major fracture and hip fracture (rho values respectively -0.098, -0.077). No statistically significant relationship was found between occupation and fracture risk. Data are given in Table 3.

While there was no statistically significant relationship between fracture risk, and kinesiophobia, and fall risk, there was a significant positive correlation was found fear of falling (rho value 0.206). Especially in individuals at risk of hip fracture, fear of falling was significantly higher. When we look at relationship between the risk of fracture and the QOL, while there was no significant the total, social relationships, environment health domains, there was a significant negative correlation the physical health and psychological well-being domains (rho values respectively -0.231, -0.215). Data are given in Table 4.

Table 3. Relationship between fracture risk and demographic data

	Total (n=132)		**No risk of fracture (n=66)**		**Risk of hip fracture (n=48)**		**Risk of major fracture and hip fracture (n=18)**		**p-value**
	n (%)	**Mean ± SD**	**n (%)**	**Mean ± SD**	**n (%)**	**Mean ± SD**	**n (%)**	**Mean ± SD**	
Gender									**0.039#**
Female	102 (77.3%)		50 (49%)		34 (33.4%)		18 (17.6%)		
Male	30 (22.7)		16 (53.3%)		14 (49.7%)		0 (0%)		
Age		70.83±6.98		67.27±5.49		74.88±6.07		73.11±7.57	**<0.001¥**
Height (cm)		159.62±8.28		161.61±5.61		158.54±11.03		155.22±5.71	**<0.01***
Body weight (kg)		73.14±11.51		77.61±9.06		70±11.16		65.11±13.73	**<0.001¥**
BMI (kg/m^2)		28.78±4.71		29.80±3.89		28.01±5.01		27.08±5.91	**0.012¥**
Under ideal weight (<18.5)	2 (1.5%)		0 (0%)		0 (0%)		2 (100%)		**<0.001#**
Normal (ideal) (18.5-24.9)	26 (19.7%)		6 (23.1%)		14 (53.8%)		6 (23.1%)		
Overweight (25.0-29.9)	52 (39.4%)		28 (53.8%)		22 (42.3%)		2 (3.8%)		
First degree obesity (30.0-34.9)	42 (31.8%)		28 (66.7%)		6 (14.3%)		8 (19%)		
Second degree obesity (35.0-39.9)	8 (6.1%)		4 (50%)		4 (50%)		0 (0%)		
Third degree obesity (>40.0)	2 (1.5%)		0 (0%)		2 (100%)		0 (0%)		

Table 3. Continued

	Total (n=132)		No risk of fracture (n=66)		Risk of hip fracture (n=48)		Risk of major fracture and hip fracture (n=18)		p-value
	n (%)	Mean ± SD	n (%)	Mean ± SD	n (%)	Mean ± SD	n (%)	Mean ± SD	
Education level									**<0.00[1#]**
Unschooled-literate	24 (18.2%)		8 (33.3%)		10 (41.7%)		6 (25%)		
Primary/ middle school	92 (69.7%)		54 (58.7%)		32 (34.8%)		6 (6.5%)		
High school	14 (10.6%)		4 (28.6%)		6 (42.9%)		4 (28.6%)		
University	2 (1.5%)		0 (0%)		0 (0%)		2 (100%)		
Occupation									0.589[#]
Housewife	90 (68.2%)		44 (48.9%)		32 (35.6%)		14 (15.6%)		
Desk worker	2 (1.5%)		2 (100%)		0 (0%)		0 (0%)		
Retired	40 (30.3%)		20 (50%)		16 (36.4%)		4 (13.6%)		

Data presented as mean (± SD) or number (n/%) of patients. BMI: Body mass ındex, cm: Centimeter, m: Meter, kg: Kilogram, SD: Standard deviation. The p-value refers to the difference between the groups. P<0.05 statistically significant. *ANOVA, #chi-square test, ¥ Kruskal-Wallis H test

Table 4. Relationship between fracture risk and kinesiophobia, balance and fall risk and quality of life

	Total (n=132)		No risk of fracture (n=66)		Risk of hip fracture (n=48)		Risk of major fracture and hip fracture (n=18)		p-value
	n (%)	Mean ± SD	n (%)	Mean ± SD	n (%)	Mean ± SD	n (%)	Mean ± SD	
TSK		41.23±9.05		40.12±9.05		42.67±9.72		41.44±6.87	0.121[¥]
FES-I		29.53±10.60		27.94±11.02		32.00±10.00		28.78±9.86	**0.033[¥]**
BBS		45.86±8.71		46.61±7.98		46.13±13.16		42.44±9.72	0.172[¥]
High fall risk (>21)	0 (0%)		0 (0%)		0 (0%)		0 (0%)		0.138[#]
Medium fall risk (21-40)	34 (25.8%)		12 (18.8%)		16 (33.3%)		6 (33.3%)		
Low fall risk (41-56)	98 (34.2%)		54 (81.2%)		32 (66.7%)		12(66.7%)		
WHOQoL-BREF									
Total		54.55±19.37		55.30±17.27		53.64±22.91		54.16±17.14	0.892[¥]
PH		50.54±20.34		50.96±17.29		54.31±24.01		38.88±16.29	**0.023[¥]**
PS		59.40±18.85		60.35±15.40		61.80±22.98		49.53±15.71	**0.044[¥]**
SR		65.53±18.98		65.14±18.77		65.27±17.13		67.58±24.73	0.741[¥]
EH		69.41±15.87		68.74±13.31		70.96±16.77		67.70±21.75	0.651[¥]

BBS: Berg balance scale, EH: Environment health, FES-I: Falls Efficacy Scale-International, PH: Physical health, PS: Psychological well-being, SD: Standard deviation, SR: Social relationships, TSK: TAMPA scale for kinesiophobia, WHOQoL: World Health Organization Quality of Life Scale Brief Version. #Chi-square test, ¥Kruskal-Wallis H test

Relationship Between Sarcopenia Risk with Fracture Risk and Data

The patients were evaluated by dividing them into 7 groups according to the presence of sarcopenia and fracture risk. There was a statistically significant relationship between groups and gender. The association of sarcopenia and fracture risk was significantly higher in the female gender. Additionally, in the group with sarcopenia risk with both major and hip fracture risk (group 7), there was only female gender. It was observed that there was a statistically significant relationship and a moderate positive correlation between the groups and age (rho value 0.446). In particular, the mean age was significantly higher in the group with only hip fracture risk (group 3), in the group with sarcopenia risk and hip fracture risk (group 6), and in the group with sarcopenia risk and risk of both hip and major fracture (group 7). A statistically significant negative correlation was found between the groups and body weight and BMI (rho values respectively -0.285, -0.182). Especially in the group with sarcopenia risk and risk of both hip and major fracture (group 7), body weight was significantly lower compared to the other groups. A statistically significant relationship and low negative correlation were found between groups and education level (rho value -0.041). No statistically significant relationship was found between groups and occupation. Data are given in Table 5. A statistically significant relationship and positive correlation were found between the groups and kinesiophobia (rho value 0.153). A statistically significant relationship and positive correlation were found between the groups and the fear of falling and fall risk (rho values respectively 0.278, 0.274). Compared with other groups, the fear of falling was significantly higher in the group with only hip fracture risk (group 3), and the fall risk was significantly higher in the group with sarcopenia risk and hip fracture risk (group 6). A statistically significant relationship and low negative correlation were found between the groups and all domains of QOL (total, physical health, psychological well-being, social relationships, environment health) (rho values respectively -0.177, -0.194, -0.187, -0.154, -0.132). In comparisons between groups, the QOL total score was significantly lower in the group with sarcopenia risk and hip fracture risk (group 6). The physical health and psychological well-being scores were significantly lower in the group with only sarcopenia risk (group 2), in the group with sarcopenia risk and hip fracture (group 6), and in the group with sarcopenia risk and both major and hip fractures (group 7). The social relationship score was significantly lower in the group with only major fracture risk (group 4) and the group with sarcopenia + only hip fracture (group 6). The environment health score was significantly lower in the group with sarcopenia risk and hip fracture risk (group 6). Data are given in Table 6.

Discussion

The functions of muscle and bone tissues are closely related due to common mechanical and molecular mechanisms. The mechanical interaction between muscle and bone is described by the "mechanostat" theory, which states that muscles apply mechanical forces to bones. According to this theory, if these forces exceed a set threshold, the balance of bone turnover shifts from bone resorption in favor of bone formation. In this case, increases in muscle mass enhance bone mass and durability by intensifying tension on the bone (20).

Osteoporosis and sarcopenia have common risk factors, including aging, gender, physical inactivity, and decreases in certain vitamins and specific hormones (20). From the sixth decade of life, BMD decreases by 1-1.5% and muscle mass by 1% annually. This condition increases the risk of developing diseases such as osteoporosis and sarcopenia by two-fold (6). Studies have shown that osteoporosis increases the risk of sarcopenia, and, in addition, sarcopenia increases the risk of osteoporosis (6,20-22). The prevalence of sarcopenia is estimated to range from 5-13% in adults aged 60-70, increasing to 11-50% in those over 80 years old (23). In our study, it was observed that 55.5% of the study population had a risk of sarcopenia as assessed by SARC-F. We can state that, in our study, a higher prevalence was obtained compared to the literature because the presence of sarcopenia was not evaluated according to the criteria determined by EWGSOP, and the study population consisted of individuals over the age of 65.

A study evaluating 288 elderly individuals showed that sarcopenic individuals had a fourfold higher risk of concomitant osteoporosis compared to non-sarcopenic individuals (24). In another study, it was reported that individuals with sarcopenia had lower BMD values compared to those without sarcopenia (25). The prevalence of osteosarcopenia was found to be 14.3% in men aged 60-64 and 59.4% in men over the age of 75. In women, the prevalence was found to be 20.3% for those between the ages of 60-64 and 48.3% for those over the age of 75 (26). Reiss et al. (27) reported that osteoporosis is more prevalent in sarcopenic individuals (51.3%) compared to non-sarcopenic individuals (21.6%). In addition, in the Hertfordshire cohort study, the presence of sarcopenia in community-dwelling older individuals was shown to be associated with a higher prevalence of fractures (28). In our study, 40 individuals (30.30%) in the study population were identified to have both sarcopenia risk and fracture risk. Among these, 24 individuals (18.18%) were at risk for sarcopenia and hip fracture, and 16 individuals (12.12%) were at risk for sarcopenia, major fracture, and hip fracture.

Relationship Between Sarcopenia Risk and Data

Older postmenopausal women are at a higher risk of both osteoporosis and sarcopenia due to the diminished protective role of estrogens in musculoskeletal homeostasis (29). For this reason, women experience a more substantial and rapid decline in both bone and muscle performance compared to men. Studies have shown that sarcopenia is more common in female gender (26,27,29), and and that there is a positive correlation between age and sarcopenia prevalence (30-32). In our study, unlike the literature, no significant relationship

Table 5. Relationship between sarcopenia risk with fracture risk and demographic data

	Total (n=132)		Group 1 (n=30)		Group 2 (n=30)		Group 3 (n=24)	
	n (%)	Mean ± SD	n (%)	Mean ± SD	n (%)	Mean ± SD	n (%)	Mean ± SD
Gender								
Female	102 (77.3%)		26 (86.7%)		20 (66.7%)		14 (58.3%)	
Male	30 (22.7%)		4 (13.3%)		10 (33.3%)		10 (41.7%)	
Age		70.83±6.98		66.53±3.84		68.8±6.78		74.75±6.1
Height (cm)		159.62±8.28		160.8±4.54		162.07±5.8		159.5±12.35
Body weight (kg)		73.14±11.51		75.07±8.44		80±9.97		67.5±10.62
BMI (kg/m^2)		28.78±4.71		29.11±3.81		30.53±4.06		26.62±3.87
Under ideal weight (<18.5)	2 (1.5%)		0 (0%)		0 (0%)		0 (0%)	
Normal (ideal) (18.5-24.9)	26 (19.7%)		4 (13.3%)		2 (6.7%)		10 (41.7%)	
Overweight (25.0-29.9)	52 (39.4%)		12 (40%)		12 (40%)		10 (41.7%)	
First degree obesity (30.0-34.9)	42 (31.8%)		12 (40%)		14 (46.7%)		2 (8.3%)	
Second degree obesity (35.0-39.9)	8 (6.1%)		2 (6.7%)		2 (6.7%)		2 (8.3%)	
Third degree obesity (>40.0)	2 (1.5%)		0 (0%)		0 (0%)		0 (0%)	
Education level								
Unschooled-literate	24 (18.2%)		0 (0%)		8 (26.7%)		6 (25%)	
Primary/middle school	92 (69.7%)		30 (100%)		20 (66.7%)		12 (50%)	
High school	14 (10.6%)		0 (0%)		2 (6.7%)		6 (25%)	
University	2 (1.5%)		0 (0%)		0 (0%)		0 (0%)	
Occupation								
Housewife	90 (68.2%)		22 (73.3%)		18 (60%)		14 (58.3%)	
Desk worker	2 (1.5%)		2 (6.7%)		0 (0%)		0 (0%)	
Retired	40 (30.3%)		6 (20%)		12 (40%)		10 (41.7%)	

Table 5. Continued

	Group 4 (n=6)		Group 5 (n=2)		Group 6 (n=24)		Group 7 (n=16)		p-value
	n (%)	Mean ± SD	n (%)	Mean ± SD	n (%)	Mean ± SD	n (%)	Mean ± SD	
Gender									0.024#
Female	4 (66.7%)		2 (100%)		20 (83.3%)		16 (100%)		
Male	2 (33.3%)		0 (0%)		4 (16.7%)		0 (0%)		
Age		66.33±2.25		73±7.07		75±6.17		73.75±7.81	<0.001¥
Height (cm)		163.33±9.31		158.5±4.95		157.58±9.7		155.25±6.08	0.085*
Body weight (kg)		78.33±1.86		76.5±2.12		72.5±11.35		63.5±13.74	<0.001¥
BMI (kg/m^2)		29.6±3.35		30.56±2.74		29.41±5.68		26.42±5.94	0.011¥
Under ideal weight (<18.5)	0 (0%)		0 (0%)		0 (0%)		2 (12.5%)		<0.01#
Normal (ideal) (18.5-24.9)	0 (0%)		0 (0%)		4 (16.7%)		6 (37.5%)		
Overweight (25.0-29.9)	4 (66.7%)		0 (0%)		12 (50%)		2 (12.5%)		
First degree obesity (30.0-34.9)	2 (33.3%)		2 (%100)		4 (16.7%)		6 (37.5%)		
Second degree obesity (35.0-39.9)	0 (0%)		0 (0%)		2 (8.3%)		0 (0%)		
Third degree obesity (>40.0)	0 (0%)		0 (0%)		2 (8.3%)		0 (0%)		
Education level									<0.001#
Unschooled-literate	0 (0%)		0 (0%)		4 (16.7%)		6 (37.5%)		
Primary/middle school	4 (66.7%)		0 (0%)		20 (83.3%)		6 (37.5%)		
High school	2 (33.3%)		2 (100%)		0 (0%)		2 (12.5%)		
University	0 (0%)		0 (0%)		0 (0%)		2 (12.5%)		
Occupation									0.113#
Housewife	4 (66.7%)		0 (0%)		18 (75%)		14 (87.5%)		
Desk worker	0 (0%)		0 (0%)		0 (0%)		0 (0%)		
Retired	2 (33.3%)		2 (100%)		6 (25%)		2 (12.5%)		

Data presented as mean (± SD) or number (n/%) of patients. BMI: Body mass index, cm: Centimeter, m: Meter, kg: Kilogram, SD: Standard deviation. The p-value refers to the difference between the groups. P<0.05 statistically significant. Group 1= No sarcopenia and fracture risk, group 2= only sarcopenia risk, group 3= only hip fracture risk, group 4= only major fracture risk, group 5= risk of both major fracture and hip fracture, group 6= sarcopenia risk with hip fracture risk, group 7= sarcopenia risk with risk of both major and hip fractures. *ANOVA, #chi-square test, ¥Kruskal-Wallis H test

Table 6. Relationship between sarcopenia risk with fracture risk and kinesiophobia, balance and fall risk, and quality of life

	Total (n=132)		Group 1 (n=30)		Group 2 (n=30)		Group 3 (n=24)	
	n (%)	Mean ± SD	n (%)	Mean ± SD	n (%)	Mean ± SD	n (%)	Mean ± SD
TSK		41.23±9.05		37.13±6.90		42.53±10.5		44.42±9.44
FES-I		29.53±10.60		24.73±8.59		30.4±11.66		34±10.53
BBS		45.86±8.71		50.20±5.29		42.67±9.01		51.83±5.9
High fall risk (>21)	0 (0%)		0 (0%)		0 (0%)		0 (0%)	
Medium fall risk (21-40)	34 (25.8%)		2 (6.7%)		(33.3%)		2 (8.3%)	
Low fall risk (41-56)	98 (34.2%)		28 (93.3%)		20 (66.7%)		22 (91.7%)	
WHOQoL-BREF								
Total		54.55±19.37		59.17±19.95		53.33±13.51		62.5±25.54
PH		50.54±20.34		51.19±14.93		47.62±17.22		70.53±18.49
PS		59.40±18.85		61.11±15.14		57.5±16.25		73.61±23.97
SR		65.53±18.98		67.77±19.30		66.11±17.9		73.61±18.66
EH		69.41±15.87		71.25±12.67		66.04±14.49		82.29±12.92

was found between the risk of sarcopenia and gender or age. Studies have found conflicting results regarding the relationship between BMI and sarcopenia, osteoporosis, and osteosarcopenia. Some studies have indicated that the risk of sarcopenia is elevated in older adults with a low BMI, and BMI tends to be lower in sarcopenic women (33,34). In our study, no significant relationship was found between the risk of sarcopenia and height, weight, and BMI.

Increased systemic inflammation and oxidative stress have been found in sarcopenic individuals, which are associated with decreased endurance and strength of both muscle and bone tissue (35). Several studies have shown that sarcopenia is an independent predictive factor not only for increased fracture risk but also for BMD and other clinical conditions. Additionally, there is an association between sarcopenia, fall risk, and osteoporotic fractures (4,28,36-40). In a study, it was reported that patients with severe sarcopenia experienced a higher risk of falls secondary to impairment in both static and dynamic balance, and there was an increased occurrence of multiple fractures (41). In our study, it has been found that the risk of falls increases in individuals at risk of sarcopenia.

Eguchi et al. (42) reported that sarcopenia impaired the QOL by causing spinal deformity resulting from decreased muscle mass. Miyakoshi et al. (43) concluded that the poor QOL of osteoporosis patients may be related to spinal alignment deformity due to general muscle weakness. In studies, QOL was found to be significantly lower in sarcopenic individuals, in particular, it was found that the physical function domain of QOL was impaired (44,45). In a study evaluating the QOL with the SarQoL questionnaire, it was observed that physical and mental health, functionality, daily living activities, fears, and total SarQoL scores were significantly lower in women with definite sarcopenia than in women with probable sarcopenia (32). In our study, similar to the literature, it was observed that there was a decrease in all domains of QOL (total, physical health, psychological well-being, social relationships, and environment health) in individuals at risk of sarcopenia.

Relationship Between Fracture Risk and Data

In our study, it was observed that the risk of fractures is higher in the female gender, and this risk increases with age. When we look at the studies conducted, we see similar results (26,27,29-32) Looking at the relationship between fracture risk and BMI, a low BMI is considered a risk factor for low BMD and fragility fractures (46). Studies also suggest that obesity may act as a protective factor against bone loss (47,48). On the contrary, there are also studies showing that the risk of fractures increases in overweight and obese individuals (48,49). In our study, it was found that low BMI, height and body weight were associated with an increased risk of fracture.

Table 6. Continued

	Group 4 (n=6)		Group 5 (n=2)		Group 6 (n=24)		Group 7 (n=16)		p-value
	n (%)	Mean ± SD	n (%)	Mean ± SD	n (%)	Mean ± SD	n (%)	Mean ± SD	
TSK		43±7.09		43.05±2.12		40.92±9.87		41±7.19	**<0.01¥**
FES-I		31.67±15.81		20.5±2.11		30±9.22		30±9.79	**0.014¥**
BBS		48.33±4.5		51.5±2.12		40.42±8.29		41.12±9.51	**<0.001¥**
High fall risk (>21)	0 (0%)		0 (0%)		0 (0%)		0 (0%)		**<0.001#**
Medium fall risk (21-40)	0 (0%)		0 (0%)		14 (58.3%)		6 (37.5%)		
Low fall risk (41-56)	6 (100%)		2 (100%)		10 (41.7%)		10 (62.5%)		
WHOQoL-BREF									
Total		45.83±17.08		76.36±15.76		44.79±16.03		50±12.91	**<0.01¥**
PH		66.66±22.66		55.79±1.9		38.09±16.94		36.6±15.84	**<0.001¥**
PS		70.83±6.46		67.79±10.38		44.99±14.64		46.35±13.51	**<0.001¥**
SR		47.22±11.39		81.05±14.99		56.94±10.32		64.58±24.62	**<0.001¥**
EH		69.79±8.54		87.05±9.39		59.63±11.83		63.67±19.49	**<0.001¥**

BBS: Berg balance scale, EH: Environment health, FES-I: Falls Efficacy Scale-International, PH: Physical health, PS: Psychological well-being, SD: Standard deviation, SR: Social relationships, TSK: TAMPA scale for kinesiophobia, WHOQoL: World Health Organization Quality of Life Scale Brief Version. Group 1= no sarcopenia and fracture risk, group 2= only sarcopenia risk, group 3= only hip fracture risk, group 4= only major fracture risk, group 5= risk of both major fracture and hip fracture, group 6= sarcopenia risk with hip fracture risk, group 7= sarcopenia risk with risk of both major and hip fractures. #Chi-square test, ¥Kruskal-Wallis H test

Falls and fractures secondary to age-related deterioration of the musculoskeletal system are common in older individuals and can significantly reduce both QOL and the ability to perform activities of daily living. In a study, it has been stated that older osteoporotic postmenopausal women with a history of falls have lower scores in the domains of physical and mental health, functionality, and daily living activities (32). In our study, it was observed that individuals at an increased risk of both major fractures and hip fractures exhibited lower QOL scores in the domains of physical health and psychological well-being.

Relationship Between Sarcopenia Risk with Fracture Risk and Data

Studies have demonstrated that osteosarcopenia is more prevalent in women (26,27,29), and the prevalence of both sarcopenia and osteosarcopenia increases with age (30-32). In our study, similar to the literature, it was observed that the relationship between sarcopenia risk and fracture risk was significantly higher in female gender, and both the fracture risk and the relationship between sarcopenia risk and fracture risk increased with age. In a study, it was stated that sarcopenic, osteoporotic, and osteosarcopenic individuals had lower BMI compared to healthy controls and that BMI was lowest in osteosarcopenic people (27). In addition, studies have shown that the risk of developing sarcopenia is significantly reduced in osteoporotic postmenopausal women with a higher BMI (32,50). The conflicting results on the relationship between BMI and osteosarcopenia may be due to individual differences between muscle mass and body weight components (body fat and lean mass). In our study, it was found that both the risk of fracture and the combination of sarcopenia risk and fracture risk were associated with low BMI and body weight. In the literature, we could not find any study that evaluated the relationship between education level and sarcopenia, fracture risk, and osteosarcopenia. In our study, we concluded that both the risk of fracture and the combination of sarcopenia risk and fracture risk are higher in those with lower education levels. This may be related to increased awareness and economic status related to education level.

Osteoporosis and sarcopenia are independent risk factors for fractures and falls, and individuals with both sarcopenia and osteoporosis are at a significantly higher risk of experiencing falls, fractures, and hospitalizations (8). In addition, individuals with osteosarcopenia were found to have significantly higher rates of physical dysfunction, fall risk, fracture risk, and mortality than patients with osteoporosis or sarcopenia alone (8,41,51-53). In a study, it was reported that there was no difference in fracture risk between patients with osteoporosis and osteopenia. However, in patients with osteosarcopenia and severe sarcopenia, both static and dynamic balance were lower, the risk of falling was higher,

and there was a greater association with multiple fractures (41). In our study, it was observed that the fear of falling and fall risk increased in individuals with sarcopenia risk and fracture risk, and was significantly higher, especially in individuals with only hip fracture risk and in individuals with both sarcopenia risk and hip fracture risk.

In our study, the relationship between sarcopenia risk and fracture risk and kinesiophobia was evaluated. In the literature, no study on this could be found. However, studies evaluating the relationship between fracture risk and physical activity level have shown that physical activity prevents bone loss, and leads to improvements in muscle mass and physical performance. In addition, it has been stated that long-term immobilization is associated with decreased BMD and increased fracture risk (6,54,55). In a meta-analysis evaluating 14 prospective studies, it was stated that there was a significant negative relationship between increasing physical activity levels and the risk of hip fracture in older women (56). While no relationship was found between sarcopenia risk or fracture risk and kinesiophobia in our study, it was observed that kinesiophobia was higher in individuals with sarcopenia risk and fracture risk. These individuals may experience a decrease in physical activity levels secondary to kinesiophobia, which may lead to an increase in the risk of fracture.

Studies have shown that the QOL is low in osteoporotic patients with sarcopenia, and that age, fall history, and the presence of sarcopenia have a significant impact on the general QOL of postmenopausal osteoporotic women (22,32,57). In a study, it was stated that the physical and mental health, body composition, functionality, leisure activities, and total SarQoL scores of osteoporotic postmenopausal women with sarcopenia over the age of 70 were significantly lower than those of younger women (32). In our study, it has been observed that there is an impairment in all domains of QOL with the increase in the risk of sarcopenia accompanying the increase in fracture risk. In particular, impairment was evident in all domains of QOL in individuals at risk of sarcopenia and hip fracture, and in physical health and psychological well-being in individuals at risk of sarcopenia and both major and hip fractures.

Study Limitations

Our study has some limitations. This was a cross-sectional study conducted at a single center. In the sarcopenia evaluation, data obtained from the SARC-F survey were used, but the criteria determined by EWGSOP were not used.

Conclusion

In our study, it was observed that in older adults, the association of increased sarcopenia risk and fracture risk is more common in women, the risk increases with age and is associated with lower QOL and, higher fall risk, fear of falling and kinesiophobia. Appropriate treatment and early intervention of these conditions in sarcopenic individuals with increased fracture risk may provide a clinical benefit to reduce the risk of falls and fractures and improve QOL. Recent studies evaluating both the epidemiology of osteosarcopenia and its relationship with fracture risk, fall risk, and QOL will contribute to the development of future interventions and therapeutics to maintain the independence of older people.

Ethics

Ethics Committee Approval: Ethical approval was received from the Kütahya Health Sciences University Non-interventional Clinical Research Ethics Committee (decision no: 2023/01-20, dated: 11.01.2023).

Informed Consent: Before being included in the study, all individuals signed the informed consent form stating that they participated in the study voluntarily.

Authorship Contributions

Surgical and Medical Practices: H.T., Ç.Ö., Concept: H.T., Ç.Ö., Design: H.T., Ç.Ö., Data Collection or Processing: H.T., Ç.Ö., Analysis or Interpretation: H.T., Ç.Ö., Literature Search: H.T., Writing: H.T.

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