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Sarcopenia in People Aging with HIV: A Cross-Sectional Study From Türkiye

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Abstract

Objective: This study aims to determine the prevalence and risk factors of sarcopenia in people living with human immunodeficiency virus (PLWH) aged 50 years and over.

Materials and Methods: Ninety individuals who live with human immunodeficiency virus (HIV) aged 50 years and over, who were under follow-up in our outpatient clinic between May 2021 and October 2021, were included in the study. Demographic, clinical, laboratory data, and drug information of the patients, were reviewed from medical records. Sarcopenia tests were conducted, and fracture risk assessment tool scores of the patients were calculated.

Results: In our study, the prevalence of sarcopenia in PLWH aged 50 years and over was found to be 40% (8.9% definite sarcopenia, 31.1% probable sarcopenia). No association was found between elapsed time since diagnosis of HIV infection, initial CD4 T lymphocyte count, rate of antiretroviral therapy (ART) usage, duration of ART usage, ART regimens with sarcopenia. In our study, 10-year probability of major osteoporotic fracture risk and hip fracture risk was significantly higher in the male group with sarcopenia compared to the non-sarcopenic group.

Conclusion: The prevalence of sarcopenia in PLWH aged 50 years and over, was found to be higher compared to the general population. It was observed that individuals with sarcopenia had a higher risk of fractures. Since sarcopenia is associated with falls, fractures, disability, hospitalization, and mortality, screening for sarcopenia in PLWH aged 50 years and over may be beneficial in preventing adverse outcomes.

Keywords: Antiretroviral therapy, FRAX, HIV, people over 50 years old, sarcopenia

Introduction

With the extension of life expectancy resulting from antiretroviral therapy (ART), age-related comorbidities have become more frequently observed in people living with human immunodeficiency virus (HIV). Geriatric syndromes, such as frailty, osteoporotic fractures, and physical and cognitive impairments, tend to emerge at comparatively younger ages. Consequently, HIV is thought to exhibit a phenotype of "accelerated aging" (1). Some studies indicate that this "accelerated aging" phenotype may be attributed to chronic inflammation associated with HIV and prolonged exposure to specific antiretroviral drugs (2).

Accelerated muscle mass and function loss is another indicator of the aging phenotype in individuals living with HIV (1). Data on the prevalence of sarcopenia in these patients are limited. Similar to other chronic diseases, sarcopenia in this population is more prevalent and tends to occur at a younger age compared with individuals in the general population (3,4).

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A systematic review and meta-analysis led by Oliveira et al. (5), which reviewed 13 studies, reported a sarcopenia prevalence of 24.1% among people living with HIV (PLWH).The findings indicated that PLWH had a sixfold increased risk of sarcopenia relative to HIV-negative controls. Additionally, sarcopenia occurs around 15 years earlier in PLWH compared with HIV-negative individuals. (5). Despite these findings, current sarcopenia guidelines do not yet identify HIV as a recognized risk factor. (6)

Risk factors for sarcopenia in PLWH include increasing age, female sex, and reduced body mass index (BMI), and prolonged exposure to HIV infection (2). Furthermore, long-term exposure to nucleoside reverse transcriptase inhibitors (NRTIs)—known for their mitochondrial toxicity, such as zidovudine, didanosine, and stavudine—has also been identified as a risk factor for sarcopenia (7).

As life expectancy rises among PLWH, the prevalence of sarcopenia is anticipated to increase. In HIV-negative individuals, sarcopenia results in health issues such as falls, morbidity, mortality, and disability. These problems may be more frequent among PLWH than in HIV-negative individuals. Consequently, sarcopenia is anticipated to pose a notable socioeconomic challenge among PLWH. Therefore, diagnosing, preventing, and treating sarcopenia in PLWH is crucial (5).

This study aimed to assess sarcopenia status and identify risk factors in PLWH aged 50 years and older.

Materials and Methods

Patients Included in the Study

This observational study, conducted at a single center with a cross-sectional design, evaluated 90 individuals aged 50 years and older living with HIV between May 2021 and October 2021. Participants were followed up at the İstanbul University-Cerrahpaşa, Cerrahpaşa Medical Faculty Hospital, Infectious Diseases and Clinical Microbiology outpatient clinic from 2008 to 2021. All participants provided signed informed consent prior to study participation. The study was approved by the Ethics Committee of İstanbul University-Cerrahpaşa (decision number: E-83045809-604.01.02-70371, date: 04.07.2021).

Inclusion criteria: PLWH aged 50 years and older. Exclusion criteria: individuals under the age of 50 and those receiving steroid therapy.

Method

Patient data were retrieved from outpatient records and systematically recorded in standardized information forms. This information comprised demographic data, underlying comorbidities, acquired immune deficiency syndrome (AIDS)-defining illnesses, and initial CD4 T lymphocyte, and HIV RNA levels at the time of HIV diagnosis. Additionally, it included current CD4 T lymphocyte and HIV RNA levels, complete blood counts, biochemical results, and details of ART administered to the patients.

Sarcopenia diagnoses were based on guidelines from the European Working Group on Sarcopenia in Older People (EWGSOP2). The strength, assistance with walking, rising from a chair, climbing stairs, and falls (SARC-F) questionnaire, incorporating five components–SARC-F served as a screening tool for sarcopenia. Each component was scored on a scale of 0 to 2 points. The total SARC-F score ranged from 0, indicating the best outcome, to 10, indicating the worst.

Anthropometric measurements such as bodyweight, height, BMI, and calf circumference, were recorded. Height (in centimeters) and weight (in kilograms) were measured while patients wore light clothing and no shoes. A threshold value of less than 31 centimeters was used for calf circumference (8). BMI was categorized as underweight for values less than 18.5 kg/m^2, normal weight for values between 18.5 and 24.9 kg/m^2, overweight for values of 25 kg/m^2 or greater, and obese for values of 30 kg/m^2 or more (9).

The TANITA TBF-300 bioimpedance analysis (BIA) system was employed to measure the muscle mass of patients. Measurements were conducted in the morning, following a fasting period of at least four hours. Fat-free mass (FFM) was assessed using BIA, and total skeletal muscle mass (SMM) was derived through the formula SMM = FFM×0.566. To account for body size, skeletal muscle index (SMI) was calculated as SMM divided by height squared (SMM/height^2) (10). Threshold values for SMI in diagnosing sarcopenia are typically established for elderly patients. However, as most participants in our study were under 65 years old, we adopted the threshold values specified by Yazar and Olgun-Yazar (11) for the Turkish population: 10.5 kg/m^2 for males and 8.89 kg/m^2 for females. Values below these thresholds were classified as "low muscle mass".

To assess muscle strength, we conducted grip strength tests using a Jamar brand hand dynamometer. For each arm, we performed three separate measurements and recorded the highest value. Measurements below 27 kg for males and 16 kg for females were classified as "low muscle strength" (8).

Physical performance was assessed by measuring overall walking speed. Patients participated in a 6-meter walking test, during which the time taken to complete the distance was recorded in seconds using a stopwatch. A walking speed greater than 0.8 m/s was classified as normal for both males and females. In contrast, a walking speed of 0.8 m/s or less indicated "decreased muscle function" (8).

Patients were categorized based on muscle strength, muscle mass, and physical performance. Participants demonstrating

only reduced muscle strength were considered to have probable sarcopenia, whereas those with concurrent declines in both muscle strength and muscle mass were identified as having definite sarcopenia. Those with concurrent reductions in muscle strength, muscle mass, and physical performance were defined as having severe sarcopenia (8).

To estimate fracture risk in patients, the fracture risk assessment tool (FRAX) score was calculated. The version of the FRAX tool adapted for Turkey was accessed through the website (https://www.shef.ac.uk/FRAX/tool.aspx?country=6). A 10-year risk of a major osteoporotic fracture of 20% or more, or a hip fracture risk of 3% or higher, was deemed high (12).

Statistics

Continuous variables are presented as mean ± standard deviation and median (minimum-maximum) values, while categorical variables are displayed with frequencies and percentages. To determine whether continuous variables followed a normal distribution, the Shapiro-Wilk test was employed. Comparisons between two groups were conducted using the independent two-sample t-test for normally distributed data and the Mann-Whitney U test for non-normal data. For comparisons across three or more groups, one-way ANOVA was utilized for data with a normal distribution, while the Kruskal-Wallis test was used for data that did not follow a normal distribution. Comparisons between categorical variables were conducted using the chi-square test or Fisher's exact test. Factors associated with sarcopenia were assessed using univariate logistic regression analysis. Analyses were interpreted as statistically significant when the p-value was below 0.05. Statistical analyses were performed using IBM SPSS (Version 21, Chicago, IL) and NCSS (Version 21.0.3, LLC, Kaysville, Utah, USA).

Results

The study enrolled 90 individuals who met the predefined inclusion criteria. Participants had a median age of 56 years, ranging from 53 to 62 years. Of the total participants, 84% (n=76) were male and 16% (n=14) were female. All female participants in the study were postmenopausal.

Time elapsed since HIV diagnosis had a median of 3.9 years, with a range of 2.2 to 8.1 years. The median baseline CD4 count was 283 cells/mm^3, ranging from 100 to 458 cells/mm^3. HIV RNA levels were undetectable in 90% of patients. AIDS-defining illnesses were observed in 14.8% of cases. A total of 92.2% of patients were on ART, with a median duration of 3.6 years, ranging from 2 to 7.1 years. Among these regimens, 68.9% were based on tenofovir disoproxil fumarate (TDF).

According to the EWGSOP2 criteria, definite sarcopenia was identified in one female (7.1%) and seven male patients (9.2%). Probable sarcopenia was found in five females (35.7%) and 23 males (30.3%). No sarcopenia was observed in eight females (57.2%) and 46 males (60.5%).

Participants were stratified into two main groups according to their gender: female and male. Within both groups, participants were stratified into two categories depending on the presence or absence of sarcopenia. The sarcopenia group included patients diagnosed with either probable or definite sarcopenia. Three comparison groups were established: sarcopenic females vs. non-sarcopenic females, sarcopenic males vs. non-sarcopenic males, and sarcopenic females vs. sarcopenic males.

The median BMI for sarcopenic females was 26 kg/m^2, with a range of 22.9 to 27.8 kg/m^2, whereas non-sarcopenic females had a median BMI of 31 kg/m^2, ranging from 26.4 to 39.7 kg/m^2. There was a statistically significant difference in median BMI between females with and without sarcopenia (p=0.005).

The groups did not differ significantly in terms of time since HIV diagnosis, baseline CD4 count, ART usage rate, duration of ART use, or ART regimens.

Table 1 presents the clinical, demographic, and immunological data of the patients.

All patients were categorized into two groups based on their initial CD4 count: ≤350 cells/mm^3 and >350 cells/mm^3. We then compared sarcopenia tests between these groups.

In the group with an initial CD4 count of ≤350, the median SARC-F score was 1, with a range of 0 to 9. Conversely, in the group with an initial CD4 count of >350, the median score was 0, ranging from 0 to 3. The comparison between the two groups yielded a statistically significant result (p=0.038). The mean walking speed was 1.2±0.3 m/s in patients with an initial CD4 count ≤350, compared to 1.4±0.2 m/s in those with a CD4 count >350. A statistically significant difference in mean walking speed was observed between the two groups (p=0.045). Table 2 presents a comparison of sarcopenia tests based on initial CD4 levels.

We conducted a logistic regression analysis to examine variables that might influence sarcopenia in patients. The results indicated that several factors-BMI, gender, the time since HIV diagnosis, duration of ART, baseline CD4 count, initial HIV RNA levels, presence of an AIDS-defining illness at baseline, and the duration of total use of TDF, TDF + protease inhibitor, TDF + integrase inhibitor, and TDF + non-NRTI - did not affect sarcopenia. Table 3 presents the findings from the univariate logistic regression analysis of potential risk factors associated with sarcopenia.

The study compared laboratory data among different sarcopenia groups. The analysis revealed no significant differences in laboratory parameters, including Vitamin D, urea, creatinine,

Table 1. Clinical, demographic, and immunological characteristics of patients

	Total median (min-max) or %	Female median (min-max) or %			Male median (min-max) or %		
Variables	**Total n=90**	**Non-sarcopenic n=8**	**Sarcopenic n=6**	**p**	**Non-sarcopenic n=46**	**Sarcopenic n=30**	**p**
Age (years)	56 (53-62)	60.5 (52-66)	55.5 (52-67)	0.414	55 (50-67)	58 (50-73)	0.080
BMI (kg/m^2)	26.1 (23.9-28.7)	31 (26.4-39.7)	26 (22.9-27.8)	**0.005***	25.7 (19.8-34.3)	25.4 (19.1-33.6)	0.678
BMI, n (%) 18.5-24.9 (normal) 25.0-29.9 (overweight) ≥30 (obese)	 32 (35.6) 47 (52.2) 11 (12.2)	 0 (0) 3 (37.5) 5 (62.5)	 2 (33.3) 0 (0) 4 (66.7)	 **0.030**	 18 (39.1) 24 (52.2) 4 (8.7)	 12 (40) 16 (53.3) 2 (6.7)	 0.950
Alcohol use, n (%) Social drinker ≥3 U/day	19 (21.1) 18 (94.7) 1 (5.3)	0 (0) UD UD	0 (0) UD UD	UD UD	9 (19.6) 9 (100) 0 (0)	10 (33.3) 9 (90) 1 (10)	0.175 1.000
Smoking, n (%) Cigarettes (pack/year) (average ± SD)	44 (48.9) 13.6±17.5	1 (12.5) 1.8±5.3	2 (33.3) 6.6±10.3	0.538 0.491	23 (50) 13.1±16.3	18 (60) 19.1±20.6	0.393 0.180
Chronic diseases, n (%) Malignancy Hematological disease Rheumatological disease IBD CAD DM HT Hyperlipidemia CRF	8 (8.9) 3 (3.3) 5 (5.6) 3 (3.3) 6 (6.7) 11 (12.2) 20 (22.2) 20 (22.2) 14 (15.6)	2 (25) 1 (12.5) 0 (0) 0 (0) 1 (12.5) 2 (25) 3 (37.5) 1 (12.5) 0 (0)	0(0) 0 (0) 1 (16.7) 0 (0) 0 (0.0) 1 (16.7) 2 (33.3) 1 (16.7) 1 (16.7)	0.473 1.000 0.429 UD 1.000 1.000 1.000 1.000 0.429	3 (6.5) 2 (4.3) 1 (2.2) 2 (4.3) 5 (10.9) 8 (17.4) 10 (21.7) 10 (21.7) 6 (13)	3 (10) 0 (0) 3 (10) 1 (3.3) UD 0 (0) 5 (16.7) 8 (26.7) 3 (23.3)	0.675 0.516 0.294 1.000 0.150 0.019 0.587 0.621 0.244
Time elapsed since diagnosis of HIV infection (years)	3.9 (2.2-8.1)	5.5 (1.3-17.7)	8.5 (1.6-17.6)	0.282	3.9 (0-20)	2.9 (0-16.7)	0.416
Current HIV RNA, n (%) Undetectable	 81 (90)	 8 (100)	 5 (83.3)	 0.429	 42 (91.3)	 26 (86.7)	 0.705
Initial CD4 count (cell/mm^3)	283 (100-458)	181 (0-780)	279 (15-642)	0.852	292 (0-861)	313 (5-1140)	0.886
Current CD4 count (cells/mm^3)	651 (381-872)	594 (379-1360)	834 (112-1493)	0.897	614 (153-1428)	659 (44-1206)	0.862
AIDS-defining disease, n (%)	15 (14.8)	2 (25)	0 (0)	0.473	7 (15.2)	6 (20)	0.588
ART use, n (%)	83 (92.2)	8 (100)	6 (100)	UD	42 (91.3)	27 (90)	1.000
ART use duration (years)	3.6 (2-7.1)	5.4 (1.3-15.2)	6.3 (1.5-16)	0.439	3.6 (0-11.3)	2.9 (0-16.6)	0.848
TDF use, n (%)	62 (68.9)	6 (75)	6 (100)	0.473	30 (65.2)	20 (66.7)	1.000
Total TDF use (days) TDF + PI (days) TDF + INSTI (days) TDF + NNRTI (days)	730 (0-1522) 0 (0-0) 0 (0-868) 0 (0-0)	1037 (0-1551) 0 (0-1095) 242 (0-1551) 0 (0-374)	1050 (540-3684) 0 (0-3684) 634 (0-1188) 0 (0-3351)	0.438 0.746 0.893 0.751	702 (0-3301) 0 (0-3285) 99 (0-2166) 0 (0-2541)	693 (0-3358) 0 (0-3358) 303 (0-1513) 0 (0-2733)	0.914 0.639 0.732 0.431

HIV: Human immunodeficiency virus, RNA: Ribonucleic acid, AIDS: Acquired immune deficiency syndrome, ART: Antiretroviral therapy, NNRTI: Non-nucleoside reverse transcriptase inhibitors, SD: Standard deviation, min: Minimum, max: Maximum

Table 2. Sarcopenia tests according to initial CD4 levels

Variables	Initial CD4 ≤350/mm³ n=55 average ± SD median (min-max)	Initial CD4 >350/mm³ n=29 average ± SD median (min-max)	p
SARC-F questionnaire	1.3±1.8 1 (0-9)	0.5±0.9 0 (0-3)	**0.038**
Walking speed (m/s)	1.2±0.3 1.2 (0.6-2)	1.4±0.2 1.2 (0.8-2)	**0.045**
SMI (kg/m²)	11.3±1.2 11.4 (9.7-15.7)	11.2±1 11.4 (8.6-12.9)	0.921
Muscle strength (kg)	27.6±7.4 27.9 (12.5-43.2)	27.1±6.8 25.6 (14-39.6)	0.753

SARC-F: Strength, assistance with walking, rise from a chair, climb stairs, and falls, SD: Standard deviation, min: Minimum, max: Maximum, SMI: Skeletal muscle index

Table 3. Univariate logistic regression of risk factors for sarcopenia

Variables	OR (95% CI)	p
BMI	0.907 (0.80-1.030)	0.132
Gender, male	0.870 (0.274-2.758)	0.812
Time elapsed since diagnosis of HIV infection (years)	1.015 (0.928-1.111)	0.740
Initial CD4	0.784 (0.355-1.732)	0.548
Duration of ART use	1.057 (0.948-1.177)	0.319
Initial HIV RNA	1.045 (0.647-1.689)	0.858
Presence of AIDS-defining illness	1.000 (0.323-3.101)	1.000
Total TDF use	1.300 (0.516-3.272)	0.577
Total TDF (years)	1.048 (0.897-1.223)	0.556
TDF + PI (years)	0.993 (0.813-1.214)	0.946
TDF + INI (years)	0.899 (0.684-1.180)	0.443
TDF + NNRTI (years)	1.178 (0.935-1.486)	0.165
Non-TDF (years)	1.122 (0.918-1.372)	0.261

CI: Confidence interval, BMI: Body mass index, HIV: Human immunodeficiency virus, RNA: Ribonucleic acid, AIDS: Acquired immune deficiency syndrome, TDF: Tenofovir disoproxil fumarate, NNRTI: Non-nucleoside reverse transcriptase inhibitors, ART: Antiretroviral therapy, OR: Odds ratio

albumin, calcium, magnesium, and hemoglobin, across the groups.

Sarcopenia test results were compared among the different sarcopenia groups. In sarcopenic females, the median SARC-F score was 3 (range: 0-9), while non-sarcopenic females had a median score of 1.5 (range: 0-4). For males, sarcopenic individuals had a median score of 1 (range: 0-8), whereas non-sarcopenic males had a median score of 0 (range: 0-3). No statistically significant differences were observed between the groups.

The median body fat (%) and median fat mass (kg) values differed significantly between sarcopenic and non-sarcopenic females (both p=0.010). Non-sarcopenic females had higher median body fat (%) and fat mass (kg) values at 40.2% (28.5-44.9) and 32.8 kg (21.4-43.6), respectively, compared to sarcopenic females, who exhibited median values of 33.8% (16.6-36.4) and 23.7 kg (11.2-25.7). In sarcopenic males, the median body fat (%) was 21.1 (9.5-33.2). A significant difference in median body fat (%) values was observed between sarcopenic males and females (p=0.02).

The median total body water FFM values were significantly higher in sarcopenic males compared to sarcopenic females (p=0.017 for both).

Table 4 presents the results of sarcopenia tests conducted on the study patients.

The FRAX scores were compared between sarcopenia groups. Among sarcopenic females, 50% had normal FRAX scores, while the other 50% had high scores. In contrast, 90% of sarcopenic males had normal FRAX scores, with only 10% having high scores. The incidence of high FRAX scores was significantly greater in sarcopenic females than in sarcopenic males (p=0.045).

The median 10-year risk of major osteoporotic fractures was 5.5% (range: 3.5-20) for sarcopenic males, compared to 4.4% (range: 2.8-15) for non-sarcopenic males. This difference was statistically significant (p=0.019). For hip fracture risk, the median was 0.8% (range: 0.2-16) in sarcopenic males and 0.5% (range: 0.2-3.2) in non-sarcopenic males, which was found to be statistically significant (p=0.007).

Table 5 presents the FRAX scores for both sarcopenic and non-sarcopenic patients in the female and male groups.

Discussion

The prevalence of sarcopenia has recently become a concern among PLWH (13). This study investigated the prevalence and associated risk factors of sarcopenia amongPLWH, who are experiencing longer life expectancies due to ART. According to the EWGSOP2 criteria, the prevalence of definite sarcopenia was 8.9%, while probable sarcopenia was 31.1%. No cases of severe sarcopenia were identified among the patients. Specifically, definite sarcopenia was observed in 7.1% of females and 9.2% of males, whereas probable sarcopenia was observed in 35.7% of females and 30.3% of males.

Table 4. Results of sarcopenia tests

	Female median (min-max)			Male median (min-max)		
Variables	**Non-sarcopenic n=8**	**Sarcopenic n=6**	**p**	**Non-sarcopenic n=46**	**Sarcopenic n=30**	**p**
SARC-F questionnaire	1.5 (0-4)	3 (0-9)	0.237	0 (0-3)	1 (0-8)	0.081
SARC-F, n (%) <4 ≥4	 7 (87.5) 1 (12.5)	 5 (83.7) 1 (16.3)	1.000	 46 (100) 0 (0)	 27 (90) 3 (10)	0.058
Walking speed (m/s)	1.2 (0.8-1.8)	1.2 (0.6-1.5)		1.3 (0.8-2)	1.2 (0.7-1.6)	
Walking speed, n (%) Normal Low	 8 (100) 0 (0)	 5 (83.7) 1 (16.3)		 46 (100) 0 (0)	 28 (93.3) 2 (6.7)	
Body fat (%)	40.2 (28.5-44.9)	33.8 (16.6-36.4)	**0.010**	20.3 (6.3-32.3)	21.1 (9.5-33.2)	0.731
Fat mass (kg)	32.8 (21.4-43.6)	23.7 (11.2-25.7)	**0.010**	15.6 (4.4-29.5)	17 (5.7-27.5)	0.930
TBW (kg)	34.9 (32.4-48.4)	35.4 (31.4-44)	0.897	44.8 (33.5-55.6)	42.7 (32.4-60.9)	0.244
FFM (kg)	47.6 (44.3-66.1)	48.4 (42.9-60.1)	0.897	61.2 (45.7-76)	58.3 (44.2-83.2)	0.245
SMI (kg/m²)	10.8 (9-13.7)	9.9 (8.6-11.9)		11.5 (9.7-13.1)	11.3 (9.7-15.7)	
SMI, n (%) Normal Low	 8 (100) 0 (0)	 5 (83.3) 1(16.7)		 42 (91.3) 4 (8.7)	 23 (76.7) 7 (23.3)	
Muscle strength (kg)	21.3 (16.1-25.9)	14.5 (12.5-15.8)		32.9 (27.8-43.2)	22.3 (15.7-26.9)	
Muscle strength, n (%) Normal Low	 8 (100) 0 (0)	 0 (0) 6 (100)		 46 (100) 0 (0)	 0 (0) 30 (100)	
Calf circumference (cm)	38 (33-45)	37 (35-44)	0.434	38 (32-44)	36.5 (27-44)	0.193
Calf circumference, n (%) Normal Low	8 (100) 0 (0)	6 (100) 0 (0)	UD	46 (100) 0 (0)	29 (96.7) 1 (3.3)	0.395

SARC-F: Strength, assistance with walking, rise from a chair, climb stairs, and falls, TBW: Total body water, FFM: Fat-free mass, SMI: Skeletal muscle index, FFM: Fat-free mass, min: Minimum, max: Maximum

Table 5. FRAX scores of patients

	Female median (min-max)			Male median (min-max)		
Variables	**Non-sarcopenic n=8**	**Sarcopenic n=6**	**p**	**Non-sarcopenic n=46**	**Sarcopenic n=30**	**p**
Risk of major osteoporotic fracture (%)	7.3 (4.4-10)	9.9 (4.3-22)	0.438	4.4 (2.8-15)	5.5 (3.5-20)	**0.019**
Risk of hip fracture (%)	0.9 (0.4-2.2)	2.2 (0.4-5.4)	0.219	0.5 (0.2-3.2)	0.8 (0.2-16)	**0.007**
FRAX score[1], n (%) Normal High	 8 (100) 0 (0)	 3 (50) 3 (50)	 0.055	 45 (97.8) 1 (2.2)	 27 (90) 3 (10)	 0.294

[1]: p=0.045 for the comparison between sarcopenic males and sarcopenic females.
FRAX: Fracture risk in patients, the fracture risk assessment tool, min: Minimum, max: Maximum

In the literature, sarcopenia prevalence varies by ethnicity, diagnostic tests, age, and gender (11). For instance, a study by Ontan et al. (14) on the general population in Türkiye found that the prevalence of probable sarcopenia was 21.1%, definite sarcopenia was 13.7%, and severe sarcopenia was 16.2% in individuals aged 65 and older, according to EWGSOP2. Notably, the SMI thresholds used in that study (8.87 kg/m² for males and 6.42 kg/m² for females) were lower than those in our study. Another study involving 456 participants over 65 years of age in Türkiye reported a prevalence of probable sarcopenia at 19.7% in males and 9.8% in females, per EWGSOP2 criteria (15). Although participants in that study had a higher average age

(74.6 years) compared to our study (57.8 years), the prevalence of probable sarcopenia was greater in our cohort.

Comparing our findings with other studies on definite sarcopenia is problematic due to variations in threshold values and age groups. Nevertheless, considering that other studies involved older age groups and lower threshold values, the level of sarcopenia in PLWH aged 50 and over can be deemed relatively high.

A review of the literature shows that the prevalence of sarcopenia among PLWH ranges from 5% to 24% (7). A meta-analysis of 13 studies identified that PLWH have a sixfold higher risk of developing sarcopenia compared to HIV-negative controls (5). Risk factors contributing to sarcopenia include the duration of HIV infection, the use of antiretroviral drugs (notably thymidine analog NRTIs such as stavudine and zidovudine), smoking, alcohol consumption, advanced age, low BMI, and decreased CD4 count (5).

Low BMI has been linked to sarcopenia in both the general people living with HIV (PLWH) (16). In our study, we identified an association between low BMI and sarcopenia specifically in female patients.

The association between the duration of HIV infection and sarcopenia remains controversial. Echeverría et al (2). found that long-term exposure to HIV infection is associated with sarcopenia. Conversely, de Almeida et al (16). reported no association between the duration of HIV infection and sarcopenia. Our study similarly found no association between the duration of HIV infection and sarcopenia.

Several studies in the literature examine the association between initial CD4 count and sarcopenia. Abdul Aziz et al. demonstrated a relationship between high initial CD4 counts and sarcopenia, whereas Echeverria et al. (2) found no such association (6,7). In our study, we also observed no overall relationship between initial CD4 count and sarcopenia. However, when dividing patients into groups based on their initial CD4 count (≤350 and >350 cells/mm^3), we found that the group with an initial CD4 count ≤350 cells/mm^3 exhibited significantly lower walking speeds and higher SARC-F scores compared to those with an initial CD4 count >350 cells/mm^3.

Sarcopenia is recognized as a risk factor for falls and fractures in the general population (17). Matsumoto et al. (18) identified an association between high FRAX scores and sarcopenia. Correspondingly, our study found that male patients with sarcopenia had significantly higher 10-year major osteoporotic and hip fracture risks compared to their non-sarcopenic counterparts.

Study Limitations

Our study has several limitations. First, the absence of an HIV-negative control group precluded comparisons between PLWH and HIV-negative individuals. Second, as 92.2% of our patients were using ART, we were unable to assess ART's effect on sarcopenia. Lastly, the limited sample size necessitates further research with larger populations to validate these findings.

Conclusion

In conclusion, our study identified a sarcopenia prevalence of 40% among PLWH aged 50 years and older, with 8.9% having definite sarcopenia and 31.1% classified as probable sarcopenia. The prevalence of sarcopenia in PLWH may exceed that of the general population. We found no association between sarcopenia and factors such as the time elapsed since HIV diagnosis, initial CD4 count, ART usage rate, duration, or regimen. Screening for sarcopenia in PLWH aged 50 and over may be advantageous in preventing the adverse outcomes associated with this condition.

Ethics

Ethics Committee Approval: The study was approved by the Ethics Committee of İstanbul University-Cerrahpaşa (decision number: E-83045809-604.01.02-70371, date: 04.07.2021).

Informed Consent: All participants provided signed informed consent prior to study participation.

Footnotes

Authorship Contributions

Surgical and Medical Practices: G.A., N.S., P.K., H.Y., B.M., Ö.F.T., Concept: B.Ç., E.D., S.Y.K., P.K., H.Y., B.M., Ö.F.T., Design: B.Ç., E.D., R.K., İ.İ.B., S.Y.K., G.A., N.S., P.K., H.Y., B.M., Ö.F.T., Data Collection or Processing: B.Ç., Analysis or Interpretation: B.Ç., E.D., R.K., İ.İ.B., P.K., H.Y., B.M., Ö.F.T., Literature Search: B.Ç., R.K., İ.İ.B., S.Y.K., P.K., H.Y., B.M., Writing: B.Ç., E.D., Ö.F.T.

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References

1. Erlandson KM, Travison TG, Zhu H, Magaziner J, Correa-de-Araujo R, Cawthon PM, Bhasin S, Manini T, Fielding RA, Palella FJ, Kingsley L, Lake JE, Sharma A, Tien PC, Weber KM, Yin MT, Brown TT. Application of selected muscle strength and body mass cut points for the diagnosis of sarcopenia in men and women with or at risk for HIV infection. J Gerontol A Biol Sci Med Sci. 2020;75:1338-1345.
2. Echeverría P, Bonjoch A, Puig J, Estany C, Ornelas A, Clotet B, Negredo E. High prevalence of sarcopenia in HIV-infected individuals. Biomed Res Int. 2018;2018:5074923.
3. Bonato M, Turrini F, Galli L, Banfi G, Cinque P. The role of physical activity for the management of sarcopenia in people living with HIV. Int J Environ Res Public Health. 2020;17:1283.
4. de Almeida TS, Cortez AF, da Cruz MR, de Almeida VP. Predictors of sarcopenia in young hospitalized patients living with HIV. Brazilian J Infect Dis. 2021;25:101574.

5. Oliveira VHF, Borsari AL, Webel AR, Erlandson KM, Deminice R. Sarcopenia in people living with the human immunodeficiency virus: a systematic review and meta-analysis Eur J Clin Nutr. 2020;74:1009-1021.
6. Oliveira VHF, Borsari AL, Cárdenas JDG, Alves Junior CM, Castro NF, Marinello PC, Padilha CS, Webel AR, Erlandson KM, Deminice R. Low agreement between initial and revised european consensus on definition and diagnosis of sarcopenia applied to people living with HIV. J Acquir Immune Defic Syndr. 2021;86:106-113.
7. Abdul Aziz SA, Mcstea M, Ahmad Bashah NS, Chong ML, Ponnampalavanar S, Syed Omar SF, Sulaiman H, Azwa I, Tan MP, Kamarulzaman A, Rajasuriar R, Kamaruzzaman SB. Assessment of sarcopenia in virally suppressed HIV-infected Asians receiving treatment. AIDS. 2018;32:1025-1034.
8. Cruz-Jentoft AJ, Bahat G, Bauer J, Boirie Y, Bruyère O, Cederholm T, Cooper C, Landi F, Rolland Y, Sayer AA, Schneider SM, Sieber CC, Topinkova E, Vandewoude M, Visser M, Zamboni M; Writing Group for the European Working Group on Sarcopenia in Older People 2 (EWGSOP2), and the Extended Group for EWGSOP2. Sarcopenia: revised European consensus on definition and diagnosis. Age Ageing. 2019;48:16-31.
9. Weir CB, Jan A. BMI classification percentile and cut off points. StatPearls. 2019, [Internet]. Available from: http://www.ncbi.nlm.nih.gov/pubmed/31082114.
10. Erdogan T, Eris S, Avci S, Oren MM, Kucukdagli P, Kilic C, Beaudart C, Bruyere O, Karan MA, Bahat G. Sarcopenia quality-of-life questionnaire (SarQoL)®: translation, cross-cultural adaptation and validation in Turkish. Aging Clin Exp Res. 2021;33:2979-2988.
11. Yazar T, Olgun-Yazar H. Prevalance of sarcopenia according to decade. Clin Nutr ESPEN. 2019;29:137-141.
12. Türkiye Endokrinoloji ve Metabolizma Derneği. Osteoporoz ve Metabolik Kemik Hastalıkları Tanı ve Tedavi Kılavuzu. 2020. [Internet]. Available from: https://temd.org.tr/kilavuzlar
13. Hawkins KL, Brown TT, Margolick JB, Erlandson KM. Geriatric syndromes: new frontiers in HIV and sarcopenia. AIDS. 2017;31:137-146.
14. Ontan MS, Dokuzlar O, Ates Bulut E, Soysal P, Isik AT. The relationship between osteoporosis and sarcopenia, according to EWGSOP-2 criteria, in outpatient elderly. J Bone Miner Metab. 2021;39:684-692.
15. Sacar DE, Kilic C, Karan MA, Bahat G. Ability of SARC-F to find probable sarcopenia cases in older adults. J Nutr Heal Aging. 2021;25:757-761.
16. de Almeida LL, Ilha TASH, de Carvalho JAM, Stein C, Caeran G, Comim FV, Moresco RN, Haygert CJP, Compston JE, Premaor MO. Sarcopenia and its association with vertebral fractures in people living with HIV. Calcif Tissue Int. 2020;107:249-256.
17. Scott D, Daly RM, Sanders KM, Ebeling PR. Fall and fracture risk in sarcopenia and dynapenia with and without obesity: the role of lifestyle interventions. Curr Osteoporos Rep. 2015;13:235-244.
18. Matsumoto H, Tanimura C, Kushida D, Osaka H, Kawabata Y, Hagino H. FRAX score and recent fall history predict the incidence for sarcopenia in community-dwelling older adults: a prospective cohort study. Osteoporos Int. 2020;31:1985-1994.