Original Article

DOI: 10.4274/haseki.galenos.2026.60352
Med Bull Haseki 2026;64(2):147-154

Association Between Sarcopenia Risk, Disease Severity, and Functional Mobility in Parkinson's Disease: A Cross-Sectional Study

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Abstract

Aim: Sarcopenia and Parkinson's disease (PD) share pathophysiological mechanisms that may synergistically accelerate functional decline. This study aimed to investigate the relationship between sarcopenia risk and functional mobility in patients with PD and to compare the clinical and demographic characteristics of patients with low and high sarcopenia risk.

Methods: This cross-sectional study enrolled 29 patients with idiopathic PD between October and December 2025. Sarcopenia risk was assessed using the SARC-F questionnaire (cut-off ≥4) and functional mobility using the Timed Up and Go (TUG) test. Disease severity was staged using the Hoehn-Yahr (H-Y) scale. Spearman rank correlation, the Mann-Whitney U test, and independent t-tests were applied; normality was evaluated using the Kolmogorov-Smirnov test.

Results: Of 29 participants (mean age 70.59±12.61 years), 65.5% were classified as high sarcopenia risk. The high-risk group was significantly older (75.42 vs. 63.00 years; p=0.008) and had more advanced H-Y staging (2.37 vs. 1.50; p=0.005). Timed Up and Go time was significantly longer in the high-risk group (27.58 vs. 18.30 seconds; p=0.018). SARC-F score correlated strongly with TUG time (r=0.709, p<0.001) and moderately with H-Y stage (r=0.440, p=0.016).

Conclusion: Sarcopenia risk is highly prevalent in PD and is strongly associated with disease severity and impaired functional mobility. Combined SARC-F and TUG screening may facilitate early identification of at-risk patients to guide targeted rehabilitation interventions.

Keywords: Sarcopenia, Parkinson disease, muscle weakness, postural balance, functional status, geriatric assessment

Introduction

Parkinson's disease (PD) is a chronic, progressive neurodegenerative disorder and the second most prevalent neurodegenerative condition globally, impacting approximately 8.5 million individuals worldwide (1,2). It is marked by the loss of dopaminergic neurons in the substantia nigra pars compacta, which leads to major motor symptoms like rigidity, bradykinesia, postural instability, and resting tremor, as well as major non-motor symptoms (1). Sarcopenia is a progressive and generalized skeletal muscle disorder characterized by diminished muscle strength, reduced muscle mass or quality, and compromised physical performance. It was officially recognized as an independent disease entity (ICD-10 M62.84) and subsequently updated by the European Working Group on Sarcopenia in Older People (EWGSOP2) in 2019 (3). The pathophysiological mechanisms underlying both conditions—such as aging, chronic inflammation, oxidative stress, hormonal changes, and physical inactivity—exhibit significant overlap, indicating a synergistic relationship that may expedite functional decline in affected individuals (4).

The prevalence of sarcopenia in patients with PD varies significantly across studies, ranging from 10.9% to 55.8%, contingent upon diagnostic criteria and assessment

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Received: 02.01.2026 **Accepted:** 09.03.2026 **Publication Date:** 27.03.2026

Cite this article as: Asik, HK, Zure M, Un Oguzhanasilturk D, Karakuzu Gungor Z. Association between sarcopenia risk, disease severity, and functional mobility in Parkinson's disease: a cross-sectional study. Med Bull Haseki. 2026;64(2):147-154

methodologies (5-7). Meta-analytic data demonstrate that the prevalence of sarcopenia in PD is roughly threefold greater than that in age-matched controls, with aggregated estimates around 29% (4,8). In addition to decreased muscle mass, sarcopenia in PD is closely linked to a higher frequency of falls, functional disability, cognitive decline, reduced quality of life, and an increased risk of mortality (8,9). Recent rehabilitation research shows that exercise-based treatments, especially progressive resistance training combined with intensive programs from different fields, can significantly improve muscle strength, physical performance, and functional outcomes in patients with PD (10,11).

Despite the growing international literature addressing sarcopenia in patients with PD, comprehensive studies evaluating the interrelationship between sarcopenia risk, functional mobility, and disease severity in Turkish patient populations remain scarce. Early identification of individuals at risk of sarcopenia using validated screening instruments, such as the SARC-F questionnaire, in conjunction with objective functional mobility assessments, including the Timed Up and Go (TUG) test, may provide valuable clinical insights for the development of individualized rehabilitation strategies. Therefore, the present study aimed to investigate the association between sarcopenia risk and functional performance in patients with PD, to compare clinical and demographic characteristics between low- and high-sarcopenia-risk groups, and to explore the correlations among sarcopenia risk scores, disease severity, and functional mobility. We hypothesized that higher sarcopenia risk, as assessed by the SARC-F, would be significantly associated with impaired functional mobility and greater disease severity in patients with PD.

Materials and Methods

Compliance with Ethical Standards

This cross-sectional observational study was performed at the Physical Medicine and Rehabilitation Department of a tertiary training and research hospital between October and December 2025. The University of Health Sciences Türkiye, Istanbul Kanuni Sultan Suleyman Training and Research Hospital Institutional Clinical Research Ethics Committee examined and approved the study protocol (approval number: KAEK/2025.09.235, date: 25.09.2025). All procedures were conducted in compliance with the ethical principles of the Declaration of Helsinki and its subsequent revisions. Written informed consent was obtained from participants after comprehensively outlining the study's goal, procedures, potential benefits, and risks. Data privacy and participant anonymity were carefully preserved throughout the research process. The authors declare no conflict of interest and that no external funding was received for this study.

Study Design and Participants

A cross-sectional design was used to investigate the association between sarcopenia risk and functional status among individuals with PD. Participants were recruited consecutively from patients attending the outpatient clinic. The study flowchart is presented in Figure 1.

Inclusion criteria were (1) clinical diagnosis of PD according to Movement Disorder Society criteria; (2) age 40-80 years; (3) Hoehn-Yahr (H-Y) disease stage 1-4; (4) ability to stand and walk independently, with or without assistive devices; (5) stable medication regimen for at least four weeks before assessment; and (6) cognitive capacity to understand and follow test instructions.

Exclusion criteria included the following: (1) secondary or atypical parkinsonism; (2) severe cognitive impairment that prevents test comprehension; (3) acute medical conditions or infections; (4) severe cardiovascular, respiratory, or orthopedic comorbidities that limit test participation; (5) recent surgery or hospitalization within the past three months; and (6) presence of deep brain stimulation devices.

Demographic data, including age, sex, height, weight, and body mass index (BMI) (BMI, calculated as kg/m²), were recorded for all participants. Clinical information, including disease duration, current medications, and H-Y stage, was documented in medical records and during clinical examination.

Assessment Procedures

All assessments were performed while participants were in the "on" medication state to evaluate typical functional capacity. Measurements were performed by a single trained researcher using standardized protocols to ensure consistency and reliability. Given that all assessments were conducted by a single researcher following standardized protocols with prior training in each measure, intra-rater consistency was maintained throughout the study.

Disease severity was assessed using the H-Y staging scale, a widely used clinical tool that classifies PD progression based on motor symptom distribution and functional impact. The scale ranges from stage 1 (unilateral symptoms with minimal functional impairment) to stage 5 (wheelchair-bound or bedridden). This study included patients in stages 1-4, representing early to moderate-advanced disease (12).

The SARC-F was selected as the primary screening tool because it is a brief, validated instrument specifically recommended for case-finding in clinical settings by EWGSOP2, and because dual X-ray absorptiometry (DXA) or bioelectrical impedance analysis (BIA) muscle mass measurement was not feasible in this outpatient setting. (3,13). It consists of five items assessing strength, falls, the ability to rise from a chair, the need for assistance with walking, and the ability to climb stairs. Each element is scored

0-2 points, yielding a total score of 0-10. Scores ≥4 indicate high sarcopenia risk and demonstrate good sensitivity and specificity for identifying individuals requiring further assessment (13). Importantly, SARC-F identifies individuals at risk who require further comprehensive assessment, and results are herein interpreted as sarcopenia risk rather than a confirmed sarcopenia diagnosis (3,13). The Turkish version of the SARC-F has been validated for use in older adults.

Functional mobility was evaluated using the TUG test, a valid and reliable assessment tool for functional mobility widely used in PD populations (14). Participants were seated in a standard chair with armrests. Upon the instruction "go," participants rose from the chair, walked three meters at their comfortable pace, turned 180 degrees, returned to the chair, and sat down. Time to complete the task was recorded in seconds using a digital stopwatch. The test was demonstrated to participants prior to the actual measurement, and participants were allowed one practice trial. Timed Up and Go times >12-13 seconds are generally associated with increased fall risk and mobility impairment in PD populations (14,15).

Safety precautions included positioning a researcher near the participant throughout testing to provide assistance as needed. Participants were instructed to use their usual walking aids when appropriate. Adequate rest periods (at least 5 minutes) were provided between assessments to prevent fatigue.

Statistical Analysis

Statistical analyses were conducted using IBM SPSS Statistics version 25.0 (IBM Corp., Armonk, NY, USA). Normality was assessed using the Kolmogorov-Smirnov test. Descriptive statistics are reported as mean ± standard deviation for continuous variables and as frequency (percentage) for categorical variables.

Participants were categorized into two groups based on SARC-F scores: high sarcopenia risk (SARC-F ≥4) and low sarcopenia risk (SARC-F <4). Between-group comparisons for continuous variables were performed using an independent t-test for normally distributed variables (age, BMI, height, weight) and the Mann-Whitney U test for non-normally distributed variables (SARC-F score, TUG time). Categorical variables were compared using Fisher's exact test.

Relationships among SARC-F score, H-Y stage, and TUG time were assessed using Spearman's rank correlation coefficient because of the ordinal nature of H-Y staging and potential non-normal distributions. Ninety-five percent [95% confidence intervals (CIs)] were calculated for key correlation coefficients to enhance statistical reporting. Correlation strength was interpreted as follows: 0.00-0.29 (weak), 0.30-0.49 (moderate), 0.50-0.69 (strong), and ≥0.70 (very strong). Due to the relatively small sample size, multivariable regression analysis was not performed, and the analyses were limited to bivariate comparisons and correlation analyses.

Statistical significance was set at $p<0.05$ (two-tailed) for all analyses. All tests were conducted with appropriate consideration of effect sizes and clinical meaningfulness alongside statistical significance.

Results

Participant Characteristics

A total of 29 individuals with idiopathic PD (17 women, 12 men) participated in this study. The mean age was 70.59±12.61 years, and the mean BMI was 24.67±1.75 kg/m². Women comprised 58.6% of the sample. The mean SARC-F score was 4.00±1.93 points, ranging from 2 to 8. Using the SARC-F cut-off of ≥4, 19 participants (65.5%) were classified as high-risk for sarcopenia, and 10 (34.5%) as low. The distribution of H-Y stages was as follows: stage 1 (n=8, 27.6%), stage 2 (n=14, 48.3%), stage 3 (n=4, 13.8%), and stage 4 (n=3, 10.3%). The mean TUG time for the cohort was 24.38±11.54 seconds. The distribution of SARC-F and TUG scores across H-Y stages is illustrated in Figure 2.

Comparison Between Sarcopenia Risk Groups

Table 1 compares demographic and clinical characteristics of the high- and low-sarcopenia-risk groups. Participants in the high-risk group were significantly older than those in the low-risk group (75.42±10.36 vs. 63.00±11.26 years; p=0.008). The high-risk group also had significantly more advanced disease severity, with a mean H-Y stage of 2.37±0.83, compared with 1.50±0.53 in the low-risk group (p=0.005).

Functional mobility, as assessed by the TUG test, differed markedly between groups. The high-risk group took significantly longer to complete the TUG test (27.58±12.24 seconds) than the low-risk group (18.30±3.77 seconds; p=0.018). Notably, 73.7% (n=14) of participants in the high-risk group exceeded the 13-second TUG threshold, which is commonly considered indicative of increased fall risk in PD populations, whereas only 50.0% (n=5) of the low-risk group did so.

The gender distribution showed a trend toward a higher sarcopenia risk among women, with 70.6% (12/17) of women classified as high risk compared with 58.3% (7/12) of men; however, this difference was not statistically significant (p=0.694). No significant differences were observed in BMI between the two groups (24.70±1.80 vs. 24.61±1.71 kg/m²; p=0.902).

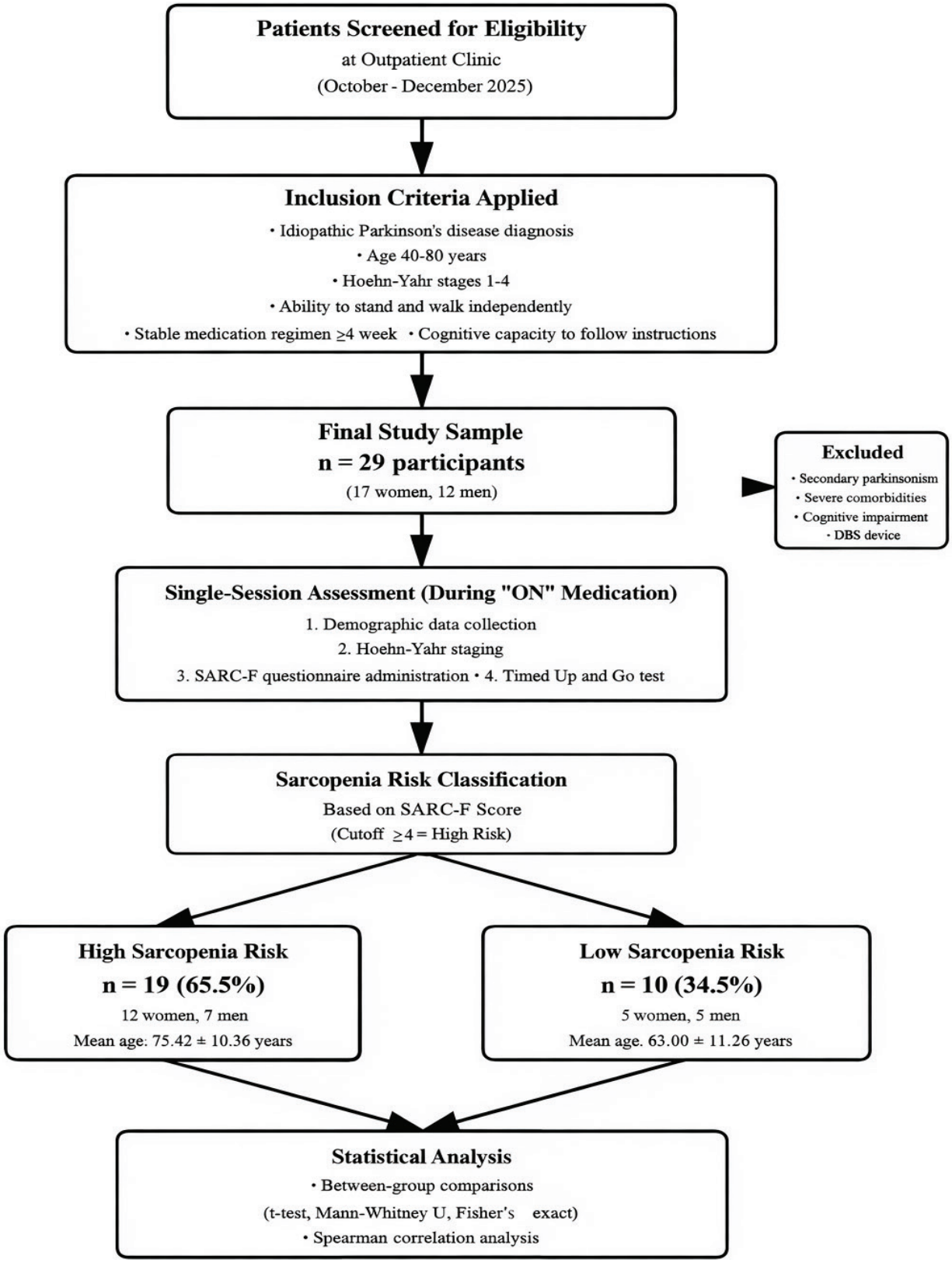

Figure 1. Study flowchart

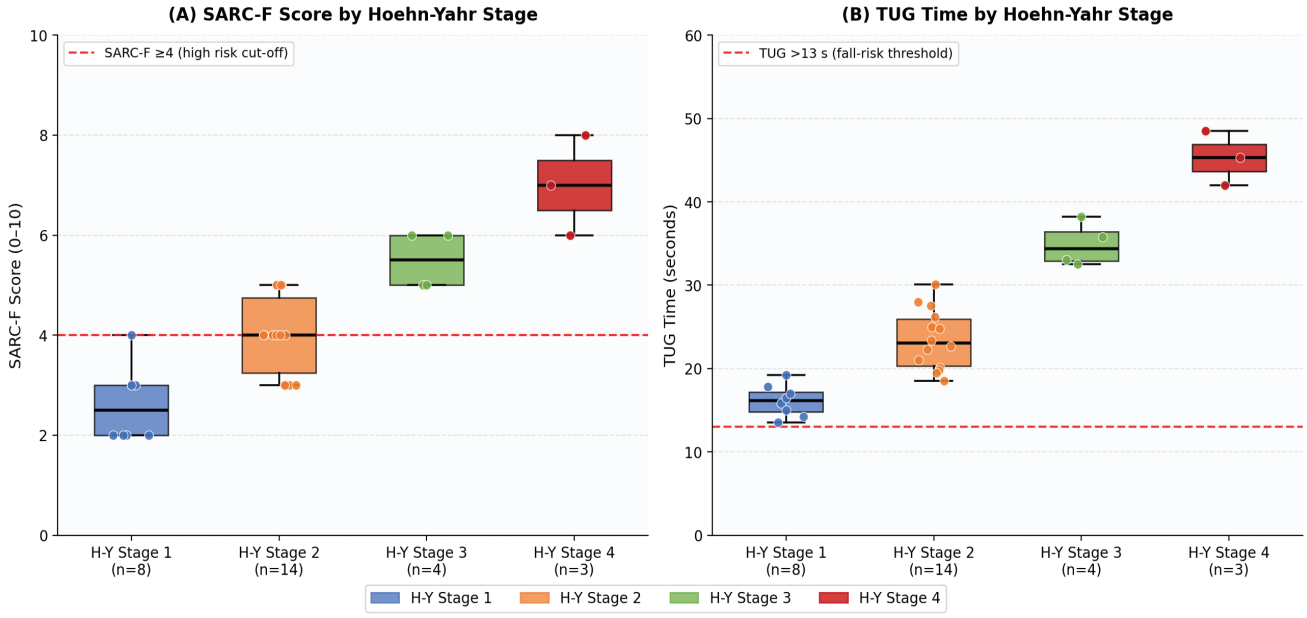

Figure 2. Box plots show median (horizontal line), interquartile range (box), and 1.5 × IQR (whiskers). Individual data points are overlaid. Red dashed lines indicate the SARC-F ≥4 high-risk cut-off (Panel A) and the TUG >13-second fall-risk threshold (Panel B)
SARC-F: Strength, assistance with walking, rise from a chair, climb stairs, and falls questionnaire, TUG: Timed Up and Go, H-Y: Hoehn-Yahr, IQR: Interquartile range

Table 1. Demographic and clinical characteristics of study participants

Variable	Total (n=29)	High-risk (n=19)	Low-risk (n=10)	p-value	Statistical test
Age (years)	70.59±12.61	75.42±10.36	63.00±11.26	0.008	Independent t-test
Gender, n (%)				0.694	Fisher's exact test
- Female	17 (58.6%)	12 (63.2%)	5 (50.0%)		
- Male	12 (41.4%)	7 (36.8%)	5 (50.0%)		
Height (cm)	164.24±6.54	163.47±7.12	165.70±5.31	0.384	Independent t-test
Weight (kg)	68.28±8.28	67.74±8.95	69.40±7.14	0.619	Independent t-test
BMI (kg/m²)	24.67±1.75	24.70±1.80	24.61±1.71	0.902	Independent t-test
SARC-F score	4.00±1.93	5.37±1.54	2.70±0.48	<0.001	Mann-Whitney U test
H-Y stage	1.97±0.85	2.37±0.83	1.50±0.53	0.005	Mann-Whitney U test
TUG time (seconds)	24.38±11.54	27.58±12.24	18.30±3.77	0.018	Mann-Whitney U test

Data presented as mean ± standard deviation or frequency (percentage)
BMI: Body mass index, H-Y stage: Hoehn-Yahr stage, TUG: Timed Up and Go

Correlation Analysis

Spearman correlation analysis revealed significant relationships among sarcopenia risk, disease severity, and functional mobility (Table 2). The SARC-F score showed a moderate positive correlation with H-Y stage (r=0.440, 95% CI: 0.08-0.70, p=0.016), indicating that a higher sarcopenia risk was associated with greater disease severity. A very strong positive correlation was observed between the SARC-F score and TUG time (r=0.709, 95% CI: 0.44-0.87, p<0.001). The relationship between disease severity and functional mobility was also robust, with H-Y

Table 2. Spearman correlation coefficients among study variables

Variables	r	p-value
SARC-F score × H-Y stage	0.440	0.016
SARC-F score × TUG time	0.709	<0.001
H-Y stage × TUG time	0.774	<0.001
Age × SARC-F score	0.427	0.020
Age × H-Y stage	0.377	0.044
Age × TUG time	0.477	0.009

All correlations calculated using Spearman's rank correlation coefficient
H-Y stage: Hoehn-Yahr stage, TUG: Timed Up and Go

stage showing a very strong positive correlation with TUG time (r=0.774, 95% CI: 0.55-0.90, p<0.001). Additionally, age showed a moderate positive correlation with the SARC-F score (r=0.427, p=0.020), confirming the age-related nature of sarcopenia risk in PD patients.

Discussion

The principal findings of this cross-sectional study demonstrate that 65.5% of PD patients are at high-risk of sarcopenia based on SARC-F screening; patients in this high-risk group are significantly older, have more advanced disease severity, and have substantially impaired functional mobility compared with the low-risk group. Very strong correlations were observed between sarcopenia risk and TUG performance (r=0.709) and between H-Y stage and TUG time (r=0.774), indicating that both disease progression and sarcopenia risk independently contribute to functional mobility impairment. To our knowledge, this is one of the first studies conducted in a Turkish PD cohort to demonstrate a strong quantitative relationship between SARC-F-based sarcopenia risk and objective functional mobility performance measured by the TUG test.

The observed sarcopenia risk prevalence of 65.5% in this cohort is notably higher than many previously reported estimates but falls within the broad range documented in the literature (5-7). Several factors likely contribute to this elevated estimate. First, the SARC-F questionnaire is a screening tool that identifies individuals at risk who require further assessment rather than confirming sarcopenia through comprehensive body-composition analysis. Therefore, findings should be interpreted as indicating sarcopenia risk rather than confirmed sarcopenia. Studies using SARC-F in PD populations have reported highly variable results: one study found 20% with confirmed sarcopenia and 34.5% screening positive on SARC-F (16), while others reported 47.2% probable sarcopenia and 55.5% screening positive using SARC-F (17,18). Second, the cohort's mean age (70.59 years), and particularly the high-risk group's mean age (75.42 years), indicate an elevated risk for both age- and disease-related muscle dysfunction. Age-stratified analyses reveal that sarcopenia prevalence in PD patients aged ≥70 years is substantially higher than in younger patients (8). Third, the SARC-F questionnaire, while demonstrating high specificity (typically 83-94%), exhibits relatively low sensitivity (13-31%) in many populations (13,16), yet paradoxically may capture functional limitations in PD that extend beyond pure sarcopenia to encompass disease-specific motor impairments such as bradykinesia and rigidity. This phenomenon, whereby PD-related motor impairment inflates SARC-F scores beyond what would be expected from muscle loss alone, represents a critical methodological consideration when interpreting SARC-F-based prevalence estimates in PD cohorts.

The high-risk group exhibited significantly more advanced H-Y staging (2.37 vs. 1.50, p=0.005), aligning with studies indicating that muscle strength diminishes and sarcopenia prevalence escalates with disease progression (8,9). Nevertheless, the correlation between sarcopenia and disease duration or severity is inconsistent among studies, with some indicating robust associations while others report no significant correlation (5). This variability probably shows how many different things can cause muscle problems in people with PD. In addition to disease-specific motor impairments such as bradykinesia, rigidity, and postural instability, other factors include decreased physical activity, nutritional deficiencies, chronic inflammation, oxidative stress, and possible effects of dopaminergic treatment (4,19). A recent 2025 prospective cohort study revealed that sarcopenia was independently correlated with functional degeneration in PD, even after controlling for age, sex, and comorbidities. This indicates that sarcopenia constitutes a unique and supplementary pathway to functional decline, extending beyond the progression of motor symptoms alone (9). The significant age difference between the risk groups in our study (75.42 vs. 63.00 years) underscores that age-related sarcopenia mechanisms may compound disease-related muscle changes, creating a synergistic effect that disproportionately affects older PD patients.

The very strong correlation between the SARC-F score and TUG performance (r=0.709, 95% CI: 0.44-0.87, p<0.001) is among the study's most clinically significant findings. The high-risk group took 51% longer to complete the TUG test (27.58 vs. 18.30 seconds), with mean times substantially exceeding established fall-risk thresholds (14,15,20). Previous research has confirmed that sarcopenia in PD is significantly associated with increased fall risk, with individuals screening positive on SARC-F experiencing falls more frequently than those screening negative (18,20,21). The current findings extend this evidence by demonstrating, in a Turkish PD cohort, that the magnitude of sarcopenia risk, as measured by SARC-F, is linearly related to TUG performance. This suggests that SARC-F is not merely a binary risk classifier but provides clinically meaningful graded information about functional mobility status in PD.

The robust correlation between H-Y stage and TUG time (r=0.774, 95% CI: 0.55-0.90, p<0.001) indicates that disease progression directly compromises functional mobility, consistent with established understanding of PD motor symptom evolution (12). The additional effect of sarcopenia risk on TUG performance—beyond disease severity alone—suggests that muscle dysfunction is an

independent contributor to mobility impairment. This has important clinical implications: while disease-modifying treatments for PD remain limited, sarcopenia is a potentially modifiable factor through targeted exercise interventions (10,11). Given that fall risk increases substantially with declining functional mobility, the combined use of SARC-F and TUG as a brief, non-instrumental screening battery could be integrated into routine neurological outpatient assessments without additional resources or time burden.

Screening should be integrated into routine neurological assessments, with positive results prompting referral to physical therapy or rehabilitation services. Exercise-based interventions, including progressive resistance training, balance exercises, and functional mobility training, have demonstrated efficacy in improving muscle strength and physical performance in PD populations (10,11,22,23). A recent Cochrane systematic review and network meta-analysis found that resistance and endurance training combined with balance exercises are some of the best ways to improve motor function in people with PD. This shows how important it is to find sarcopenia early on to help plan rehabilitation (10).

Study Limitations

Several limitations of this study must be acknowledged. First, the small sample size (n=29) and single-center design substantially limit the generalizability of findings to broader PD populations. Subgroup comparisons and correlation analyses performed with small sample sizes may be statistically fragile and should therefore be interpreted with caution. Future studies with larger samples are needed to confirm these findings. Second, sarcopenia risk was assessed using SARC-F screening without confirmatory muscle mass measurement by DXA or BIA, precluding a definitive diagnosis of sarcopenia according to EWGSOP2 criteria (3). Accordingly, results should be interpreted strictly as "sarcopenia risk" rather than as confirmed sarcopenia, and the term "sarcopenia risk" is used consistently throughout this manuscript. Third, the cross-sectional design precludes assessment of longitudinal relationships or causal inferences; the direction of the association between sarcopenia and functional decline cannot be established from this study alone. Fourth, data on potential confounding factors including nutritional status, physical activity levels, medication dosages, disease duration, and comorbidities were not systematically collected, and multivariable regression adjusting for these covariates was not performed; this represents an additional limitation. Fifth, the study was conducted at a single tertiary-care center in Türkiye, which may not be representative of the general PD population, including patients managed in primary- or secondary-care settings. Finally, SARC-F scores in PD may be inflated by disease-specific motor features (bradykinesia and rigidity), potentially overestimating true sarcopenia risk. Another limitation is that there is no a priori sample size or power calculation, which may limit the statistical robustness of subgroup comparisons and correlation analyses. Despite these limitations, this study provides novel evidence from a Turkish PD cohort that SARC-F-based sarcopenia screening is strongly correlated with functional mobility and disease severity. The use of two practical, validated, and non-instrumental tools (SARC-F and TUG) represents a clinically implementable approach that requires no specialized equipment and is therefore applicable to resource-limited outpatient settings. The robust correlations observed across multiple clinical parameters strengthen the internal validity of the findings within this sample.

These findings carry direct clinical implications. Routine incorporation of SARC-F screening and TUG assessment into PD outpatient follow-up visits requires minimal resources and can help identify patients at high-risk of functional decline who may benefit from timely referral to rehabilitation services. Given that sarcopenia is a modifiable condition, early detection could trigger preventive exercise interventions before significant functional loss occurs. Future research should use longitudinal designs with larger, multicenter samples and include objective diagnostic criteria for sarcopenia (DXA or BIA for muscle mass; handgrip strength for muscle strength) to clarify the temporal relationships between sarcopenia development and PD progression and to determine whether sarcopenia independently predicts fall incidence and hospitalization in this population.

Conclusion

In this Turkish PD cohort, sarcopenia risk assessed by SARC-F was highly prevalent and strongly associated with both disease severity and impaired functional mobility. These findings support the routine integration of SARC-F and TUG screening into PD clinical practice to enable early identification of at-risk patients and timely initiation of targeted, exercise-based rehabilitation. Sarcopenia is a changeable factor that can lead to functional decline, unlike the underlying neurodegenerative process. This means that rehabilitation strategies that focus on muscle dysfunction can help people with PD lower their risk of falling and maintain their quality of life. Longitudinal multicenter studies utilizing objective diagnostic criteria for sarcopenia are necessary to validate these associations and inform evidence-based clinical recommendations.

Ethics

Ethics Committee Approval: The University of Health Sciences Türkiye, Istanbul Kanuni Sultan Suleyman Training and Research Hospital Institutional Clinical Research Ethics

Committee examined and approved the study protocol (approval number: KAEK/2025.09.235, date: 25.09.2025).

Informed Consent: Written informed consent was obtained from participants after comprehensively outlining the study's goal, procedures, potential benefits, and risks.

Footnotes

Authorship Contributions

Surgical and Medical Practices: H.K.A., D.U.O., Z.K.G., Concept: H.K.A., D.U.O., Design: H.K.A., D.U.O., Data Collection or Processing: H.K.A., Z.K.G., Analysis or Interpretation: M.Z., Z.K.G., Literature Search: M.Z., D.U.O., Writing: M.Z.

Conflict of Interest: No conflict of interest was declared by the authors.

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

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