Original Article

ACTA FISIÁTRICA
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Study of functional capacity levels and their association with the Five-Repetition Sit-to-Stand Test and the Timed Up and Go as predictors of sarcopenia risk in older adults

Estudo dos níveis de capacidade funcional e da associação com o Teste de Sentar e Levantar de 5 Repetições e o Timed Up and Go como preditores de risco para sarcopenia em pessoas idosas

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ABSTRACT

Objective: To analyze functional capacity levels and the association between the Five-Repetition Sit-to-Stand Test (5STS) and the Timed Up and Go (TUG) as predictors of sarcopenia risk among older adults. **Method:** This descriptive, cross-sectional study included 91 participants, recruited through non-probabilistic convenience snowball sampling. Anthropometric and health data were collected via a questionnaire, in addition to administering the 5STS, TUG, and Handgrip Strength (HGS) tests, which were utilized to establish the Muscle Quality Index (MQI). Statistical analyses were conducted to evaluate data distribution, compare groups, and identify correlations between variables. **Results:** The sample was categorized into high (n= 66) and low (n= 25) functional capacity groups based on the 5STS, utilizing a 15-second cutoff point. The low functional capacity group demonstrated inferior performance on the TUG and HGS assessments and exhibited higher medication usage. Statistically significant negative correlations were identified between HGS and MQI with the 5STS duration, while a positive correlation was observed between the 5STS and TUG measures. **Conclusion:** The 5STS and TUG assessments demonstrated robust correlations with functional capacity, establishing them as sensitive instruments for the early detection of sarcopenia. This research emphasizes the significance of maintaining muscle strength and mass to sustain functional independence and metabolic regulation in older adults, and underscores the utility of straightforward and efficient tools in clinical settings and health initiatives directed at older adults.

Keywords: Functional Status, Sarcopenia, Aged

RESUMO

Objetivo: Analisar os níveis de capacidade funcional e a associação entre o Teste de Sentar e Levantar de 5 Repetições (TSL5) e o Timed Up and Go (TUG) como preditores de risco para sarcopenia em idosos. **Método:** Estudo descritivo e transversal composto por 91 participantes, recrutados por amostragem não probabilística por conveniência em bola de neve. Foram coletados dados antropométricos e salutares por meio de questionário, além da aplicação do TSL5, TUG e Força de Preensão Manual (FPM), utilizada na definição do Índice de Qualidade Muscular (IQM). A análise estatística avaliou distribuição dos dados, comparação entre grupos e correlações entre variáveis. **Resultados:** A amostra foi classificada em alta (n= 66) e baixa (n= 25) capacidade funcional pelo TSL5, considerando ponto de corte de 15 segundos. O grupo com baixa capacidade funcional apresentou desempenho inferior no TUG, FPM e maior uso de medicamentos. Foram observadas correlações negativas significativas entre FPM e IQM com o tempo no TSL5, e correlação positiva entre TSL5 e TUG. **Conclusão:** Os testes TSL5 e TUG mostraram forte associação com a capacidade funcional, revelando-se ferramentas sensíveis para identificação precoce da sarcopenia. O estudo reforça a importância da preservação de força e massa muscular para manutenção da autonomia funcional e do controle metabólico em idosos, destacando a utilidade de instrumentos simples e eficazes na prática clínica e em programas de saúde voltado.

Palavras-chaves: Estado Funcional, Sarcopenia, Idoso

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Conflict of Interests
Nothing to declare

Submitted: May 06, 2025
Accepted: August 29, 2025

How to cite
Ferreira GML, Silva KHCV, Mack CEB, Nascimento DC. Study of functional capacity levels and their association with the Five-Repetition Sit-to-Stand Test and the Timed Up and Go as predictors of sarcopenia risk in older adults. Acta Fisiatr. 2025;32(2):127-132.

DOI: 10.11606/issn.23170190.v32i3a236457

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Instituto de Medicina Física e Reabilitação – HCFMUSP

INTRODUCTION

The aging process entails a decline in functionality across various systems, particularly in muscle strength.[1-3] Muscle strength in older adults is a critically significant variable, as it is associated with functional capacity and overall mortality.[4-7]

The decline in muscle mass and strength among older adults results in diminished mobility, increased functional disability, and decreased independence during daily activities. This process often leads to more serious outcomes, including falls and fractures, and is known as sarcopenia.[8]

In this context, the significance of muscle quality (MQ), which is characterized as the amount of strength and/or power per unit of muscle mass, becomes evident. This notion has been established as a novel indicator of functional capacity and is extensively utilized as a vital biomarker of muscular health within adult populations and in pathophysiological investigations.[9]

Nonetheless, muscle quality is influenced not only by the reduction in muscle mass associated with aging. Additional underlying factors, including muscle composition, aerobic capacity, metabolic function, fatty infiltration, insulin resistance, fibrosis, genetic predispositions, endocrine factors, low physical activity levels, smoking, and nutritional deficiencies, also significantly contribute to this process. Comprehending these variables aids in early identification of the risks for sarcopenia and dynapenia throughout life.[10]

Although there are challenges in quantifying these muscular adaptations, assessments of muscle quality ultimately represent the aggregate of complex physiological changes in response to physical training.[9]

Furthermore, certain assessments have been extensively employed to evaluate muscle strength in older adults. Handgrip strength and isometric knee extension strength, for instance, serve as significant predictors of functional performance within this demographic. Research indicates that, despite the reliability of knee extension strength in facilitated environments, both tests are efficacious in detecting muscle weakness associated with sarcopenia.[11]

In order to accurately diagnose sarcopenia, it is essential to assess not only skeletal muscle strength but also muscle mass and functional performance. Nonetheless, the absence of appropriate measurement tools and a standardized database—particularly regarding the determination of cutoff points for muscle strength—highlights the need for further methodological development in this domain.[8]

One of the indices employed in this context is the MQI, which is defined by the ratio between strength and muscle mass. However, muscle strength is not solely determined by this factor; it is also influenced by body weight, BMI, acceleration, and range of motion. Consequently, adjusting muscle strength for these variables may be relevant to attain a more accurate assessment.[12]

Among the tests extensively utilized for the indirect evaluation of lower limb muscle strength, the 5STS is particularly notable. This test has been recognized as one of the recommended parameters by the European Working Group on Sarcopenia in Older People (EWGSOP2), which designated a performance time exceeding 15 seconds as the threshold for identifying diminished muscle strength.[13] Furthermore, it is advised to evaluate the functional capacity related to locomotion, and among such assessments, the TUG is considered a simple, sensitive, specific, and cost-effective tool employed in clinical practice to identify older adults at risk of falls.[13]

Therefore, the present study aims to establish the relationship between 5STS repetitions and the TUG, incorporating markers of sarcopenia in older adults.

OBJECTIVE

This study aimed to investigate the levels of functional capacity and the association between 5STS and TUG as predictors of risk for sarcopenia among older adults.

METHOD

This descriptive, cross-sectional study was submitted to the Independent Ethics Committee of the Catholic University of Brasília and evaluated under the Certificate of Submission of Ethical Appraisal (Certificado de Apresentação de Apreciação Ética - CAAE) number 62742022.6.0000.0029, and approved with the registration number 5.680.704.

The estimated older adults population of the city of São Miguel do Iguaçu, Paraná, as reported by the IBGE (2022), was 4,915 individuals, accounting for 16.87% of the total municipal population of 29,122 inhabitants.[14]

The sample comprised 91 volunteers recruited via advertising in digital media, within the local community, churches, and through public and private initiatives, employing snowball sampling.[15] For this purpose, non-probability convenience sampling was utilized, which is advisable when it is impractical to access the entire population, focusing solely on individuals who are available and accessible for the study. All participants provided their informed consent by signing the Informed Consent Form (ICF).

Participants of both sexes, aged 60 or older and residing in São Miguel do Iguaçu, Paraná, were included in the study. Older adults classified as dependent, requiring assistance, full assistance, or specialized care, were excluded. Additionally, individuals exhibiting signs or symptoms indicative of cardiovascular, pulmonary, or metabolic diseases — such as chest pain, shortness of breath at rest or with mild exertion, dizziness, syncope, orthopnea, paroxysmal nocturnal dyspnea, ankle edema, palpitations, intermittent claudication, known heart murmur, unusual fatigue, chronic lung disease, kidney disease, or liver disease — were also excluded. Moreover, volunteers with consistently elevated resting blood pressure (>160/90 mmHg) before the start of the tests were excluded.

For the purpose of this investigation, a questionnaire was employed to gather participants' health profiles, social backgrounds, physical activity levels, and medication usage, thereby facilitating the discussion of the study outcomes. The 5STS test, which assesses lower limb strength and endurance through measuring the time taken to complete five consecutive sit-to-stand cycles, was administered. The TUG test, designed to evaluate functional mobility and fall risk by measuring the time required to stand from a chair, walk three meters, return, and sit down, was also employed. Additionally, handgrip strength (HGS) was measured with a dynamometer as a comprehensive indicator of strength. The IQM was calculated using anthropometric data.

Study volunteers were received at the Biodynamics Laboratory of the Sports Center (SC) of the Physical Education Program at Uniguaçu College in São Miguel do Iguaçu, Paraná.

They received an initial orientation regarding the study, reviewed the informed consent form, and were instructed on the

procedures for the assessments and tests. During this meeting, volunteers were dressed in sportswear. Regardless of their participation, they received two complimentary months at the SC gym and were given the opportunity to partake in the 60+ Project, an initiative dedicated to the older adults population supported by the institution.

After verifying the inclusion and exclusion criteria, participants signed the informed consent form, and anthropometric measurements and the HGS test were conducted in the laboratory. Subsequently, they were individually directed to the gymnasium of the SC, where a standardized space was designated for the 5STS and TUG assessments. Upon completion of the evaluations, each participant received their results and health guidance.

All specific criteria and protocols for conducting the interviews, anthropometric assessments, and HGS, 5STS, and TUG tests were meticulously adhered to, ensuring the preservation of each participant's integrity. Prior to the assessment, each participant was provided with standardized instructions regarding the procedures, thereby guaranteeing understanding, safety, and individual respect.

The MQI was calculated by using the ratio of the highest value obtained in the HGS handgrip strength test to the BMI. The validity and reproducibility of the MQI have already been established and are commonly used in large-scale studies.[16-18]

To analyze the association between functional capacity (categorized as low or high) and the presence of disease (hypertension and diabetes mellitus), the chi-square test was employed. Additionally, the correlation between sarcopenia indicators (TUG test, highest HGS, and MQI) and the 5STStest was evaluated utilizing Kendall's tau-b correlation coefficient. The effect size for this correlation was interpreted according to the cutoff points proposed by Cohen: 0.10 to 0.29 (small), 0.30 to 0.49 (medium), and ≥0.50 (large).

The Shapiro-Wilk test was employed to assess the normality of the data. Based on the outcomes of this analysis, the nonparametric Mann-Whitney test was selected for group comparisons. The effect size for the Mann-Whitney test was estimated using the rank-biserial correlation (r≥0.10), with the conventional cutoff points defined as follows: 0.10 to 0.29 (small), 0.30 to 0.49 (medium), and ≥0.50 (large).

To determine the sample power, the G*Power software was employed, utilizing the t-test - Means: Wilcoxon-Mann-Whitney test (two groups). In accordance with an a priori analysis, an effect size of 2.04, a significance level (α) of 0.05, a statistical power (1 - β) of 0.90, and a group ratio N_2/N_1 = 2.64 were assumed. The statistical power calculated for the TSL5 variable in this study was 0.89.

Statistical analyses were conducted using JASP, GraphPad, and G*Power software. A significance level of α ≤ 0.05 was adopted for all comparisons.[21-23]

RESULTS

Participants were categorized into two groups according to their functional capacity: low functional capacity (n= 25) and high functional capacity (n= 66). The group with low functional capacity was markedly older than the group with high functional capacity (see Table 1).

Statistically significant differences were also observed for the variables right and left-hand grip strength (HGS), higher hand grip strength (MQI), time to complete the 5STS, and TUG test, indicating poorer performance in the low functional capacity group. Furthermore, this group used significantly more medications. No significant differences were observed between the groups for BMI, body circumferences (waist, hip, neck, and calf), or waist-to-height ratio (Table 1).

Finally, the 5STS and TUG tests demonstrated the largest effect sizes, indicating a strong association with functional capacity. Age and higher HGS scores exhibited moderate effect sizes, thereby reaffirming their relevance in distinguishing the groups (Table 1).

Table 1. Characteristics of the sample presented as means and standard deviations (SD)

Variables	Low functional capacity (n= 25)	High functional capacity (n= 66)	TE†	P
Age, years	73.48 ± 7.28	67.91 ± 6.43	0.48	0.001*
Height, m	1.60 ± 0.05	1.58 ± 0.08	0.16	0.25
Weight, kg	77.06 ± 15.53	74.61 ± 15.90	0.11	0.44
BMI, kg/m²	29.99 ± 5.46	29.57 ± 2.84	0.07	0.61
Waist circumference, cm	98.32 ± 11.91	95.33 ± 12.58	0.14	0.61
Waist-to-height ratio, arb.unit	0.61 ± 0.06	0.60 ± 0.07	0.14	0.3
Hip circumference, cm	108.60 ± 11.09	105.64 ± 11.74	0.17	0.21
Neck circumference, cm	37.02 ± 3.66	36.78 ± 3.21	0.01	0.93
Right CC, cm	37.40 ± 3,49	36.90 ± 3.52	0.17	0.21
Left CC, cm	37.48 ± 3.51	36.57 ± 3.62	0.22	0.11
Mean CC, cm	37.44 ± 3.45	36.74 ± 3.52	0.19	0.16
Right HGS, kg	21.32 ± 6.10	26.74 ± 7.86	0.4	0.001*
Left HGS, kg	19.12 ± 5.37	25.30 ± 7.68	0.46	0.001*
Higher HGS, kg	21.48 ± 5.98	26.46 ± 7.29	0.38	0.001*
5STS, seconds	16.59 ± 4.08	10.31 ± 1.47	1	0.001*
MQIHGS, kg/BMI	0.73 ± 0.17	0.88 ± 0.28	0.35	0.01*
TUG, seconds	10.39 ± 2.32	7,42 ± 1.19	0.74	0.001*
Use of medication	3.72 ± 3.15	2.27 ± 1.69	0.31	0.02*

*Legenda: †= Mann-Whitney test, effect size assessed by the ranked biserial correlation (ranks); * p ≤ 0.05; BMI, body mass index; arb. unit, arbitrary units; CC= calf circumference; HGS= handgrip strength; 5STS= sit-to-stand test of five repetitions; MQI= muscle quality index as measured by HGS; TUG = Timed-Up-and-Go test Timed Up and Go*

The results demonstrated a significant positive correlation between the 5STS and the TUG (r= 0.53, p= 0.001), indicating that a longer time to perform the 5STS is associated with a longer time on the TUG test.

Conversely, significant negative correlations were identified between HGS and the 5STS (rb= −0.21, p= 0.003), as well as between the MQI and the 5STS (rb= −0.25, p= 0.001).

These findings indicate that higher values of HGS and MQI are associated with a shorter duration on the 5STS. The results further support the association between functional capacity and muscular strength, demonstrating that individuals with lower muscular strength and muscle mass tend to perform poorly on functional capacity assessments (Table 2).

Table 2. Correlation between 5STS and Sarcopenia Markers

Variables		TSL5	TUG	FPM	IQM
TSL5	Kendall's Tau B	1			
	P value	-			
TUG	Kendall's Tau B		0.53		
	P value		0.001*		
FPM	Kendall's Tau B			-0.21	
	P value			0.003*	
IQM	Kendall's Tau B				-0.25
	P value				0.001*

**p ≤ 0.05; HGS= handgrip strength; 5STS= sit-to-stand test of five repetitions; MQI= muscle quality indexas measured by HGS; TUG= Timed-Up-and-Go test*

In the chi-square test, no statistically significant association was observed between functional capacity (yes or no) and arterial hypertension (yes or no, $\chi2(1) = 1.64$, p= 0.30), as well as between functional capacity and diabetes mellitus (yes or no, $\chi2(1) = 0.001$, p= 1.00).

DISCUSSION

The findings of this study indicate a correlation between 5STS and TUG, as well as markers of sarcopenia, demonstrating their efficacy as reliable risk predictors for sarcopenia in older adults. Sarcopenia is a geriatric syndrome of multifactorial origin, influenced by aspects of the endocrine system, growth factors, muscle protein turnover processes, behavioral mechanisms, and pathways associated with inflammation and oxidative stress.[24]

In addition to adverse physical effects such as increased falls and restrictions in activities of daily living, sarcopenia can induce systemic alterations resulting from an imbalance between protein synthesis and degradation.[8] Therefore, assessing functional capacity is crucial, as it differentiates between motor ability and disability, thereby directly impacting the execution of instrumental activities and daily living tasks in older adults. Moreover, its evaluation is warranted owing to its correlation with metabolic disorders.[25]

From a rehabilitation perspective, early identification of sarcopenia enables the implementation of targeted therapeutic strategies focused on muscle strengthening, balance enhancement, and fall prevention, thereby supporting the preservation of autonomy and quality of life. From a clinical standpoint, the findings of this study underscore the significance of utilizing simple and accessible tools that assist healthcare professionals in functional screening and the formulation of personalized intervention programs, thereby augmenting the efficacy of preventive and rehabilitative initiatives.

In this context, the findings demonstrate that age and an elevated HGS score are associated with functional capacity, exhibiting a moderate effect size. This correlation reinforces the importance of utilizing this parameter to categorize groups with high or low functional capacity (Table 1).

When the differences between the groups were analyzed, the variables BMI, waist, hip, neck, and calf circumferences, as well as the waist-to-height ratio, showed no significant differences. This shows that, alone, these variables were not effective in differentiating between groups with high and low functional capacity and sarcopenia.

Therefore, it is necessary to improve the diagnosis by combining these specific markers with the inclusion of functional tests, aiming to increase the robustness of the analysis.

Among the 91 participants who completed the five-repetition sit-to-stand test, 66 exhibited high functional capacity, demonstrating preserved muscle mass, functional independence, and improved metabolic control, as indicated by a lower frequency of medication use. Participants categorized as having low functional capacity were significantly older, implying diminished muscle mass, increased functional dependence, and metabolic dysregulation (see Table 1).

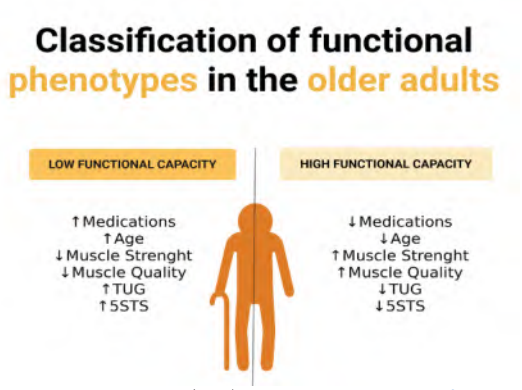
Numerous proteins synthesized by skeletal muscle are affected by muscle contraction; consequently, a deficiency in physical activity generally alters the secretion of myokines. This modification may constitute a potential mechanism elucidating the association between a sedentary lifestyle and the onset of various chronic illnesses. Furthermore, myokines may serve a protective function in physical activity against diseases associated with inactivity.[26]

A meta-analysis involving 62,273 individuals with sarcopenia and 740,749 without sarcopenia demonstrated that nine metabolic risk factors (BMI, fasting blood glucose, systolic blood pressure, diastolic blood pressure, triglycerides, Homeostasis Model Assessment of Insulin Resistance, HDL-C, LDL-C, and total cholesterol) are directly related to sarcopenia.[27] Therefore, maintaining muscle mass and strength is essential to ensure physical independence and quality of life in older adults.[28]

It is now understood that even brief periods of physical inactivity can induce changes in metabolic homeostasis, leading to diminished insulin sensitivity, impaired postprandial lipid clearance, loss of muscle mass, and an increase in visceral fat.[29]

The findings of the present study were reinforced by the observed differences between right and left handgrip strength (HGS), as well as higher HGS, MQI, and exercise performance times in the 5STS and TUG tests. These correlations suggest poorer performance within the group exhibiting lower functional capacity, characterized by diminished muscle mass preservation, increased functional dependence, and suboptimal metabolic control. This latter aspect is further substantiated by the significantly higher medication usage observed in this group.

The analysis of the effect size of the 5STS and TUG tests associated with functional capacity revealed a large effect size, corroborating the findings of this study. Individuals with high functional capacity perform better on these tests, suggesting that this condition is related to muscle mass preservation and better metabolic control. Finally, it was found that the 5STS and TUG presented similar behaviors, with concomitant variations in their scores in the investigated population (Figure 1).



Created in BioRender. Nascimento, D. (2025) https://BioRender.com/undefined.TUG, Timed up and Go test; 5STS, five-repetition Sit-to-Stand Test

Figure 1. Phenotype classification of functional capacity of older adults

CONCLUSION

The analysis revealed that the 5STS and TUG tests are strongly associated with functional capacity and may be sensitive tools for the early identification of sarcopenia.

The disparities identified between groups exhibiting high and low functional capacity suggest that functional assessments, particularly the 5STS and TUG, strongly correlate with clinical and functional indicators of sarcopenia, even in the absence of notable alterations in conventional anthropometric measurements. This underscores the significance of employing specific and sensitive tools for the early diagnosis of this condition.

The analysis demonstrated that the classification of the functional capacity phenotype is also related to age, HGS, and the preservation of muscle mass, which are determining factors for autonomy and metabolic control in the population of older adults.

Furthermore, the lower utilization of medication among individuals with higher functional capacity suggests a direct relationship between preserved muscle strength and improved metabolic control. This underscores the importance of maintaining muscle strength and mass for the functional autonomy of older adults and highlights the utility of simple and effective instruments in clinical practice and health programs targeting this population.

Consequently, this study enhances the scientific evidence supporting the use of straightforward and accessible functional assessments within clinical settings and health promotion initiatives targeting older adults, especially in the context of an aging population.

From a rehabilitation perspective, early identification of sarcopenia permits the implementation of targeted strategies aimed at muscle strengthening, enhancement of balance, and prevention of falls, thereby promoting autonomy and improving quality of life. Clinically, the findings reinforce the value of simple and accessible instruments in functional screening and planning individualized interventions, increasing the effectiveness of preventive and rehabilitative actions.

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