Isometric strength correlates with performance in functional tests in elderly

Força isométrica correlaciona-se com desempenho em testes funcionais em idosos

La fuerza isométrica se correlaciona con el rendimiento en pruebas funcionales en ancianos

RESUMO

Introdução: O envelhecimento acarreta mudanças fisiológicas significativas, incluindo o declínio da força e da resistência muscular, impactando a qualidade de vida do idoso Objetivo: Classificar idosos com diferentes níveis de força e comparar o desempenho deles em testes funcionais que expressam a capacidade de realizar atividade da vida diária. Metodologia: O estudo, envolveu 36 idosas com idade entre 60 a 84 anos. Foram realizados testes de preensão manual, flexão de cotovelo em 30 segundos, levantar e sentar da cadeira em 30 segundos e Time Up Go. As análises estatísticas incluíram testes de Shapiro-Wilk, Mann-Whitney, correlação de Pearson e d de Cohen, com nível de significância de 5%. Resultados: As voluntárias foram separadas em grupos por nível de força. Baixa força (BF) 11,94 quilograma força (kgf) e média força (MF) 19,00 kgf. Houve diferença estatística significante na flexão de cotovelo (P=0,015; d=0,867) entre os grupos. Foi encontrada uma correlação moderada e positiva (r=0,408; P=0,015; d=0,166) entre níveis de força e flexão de cotovelo. Uma fraca correlação negativa (r=-0,384; P=0,023; 0,147) foi observada entre Time Up Go e levantar e sentar. Conclusão: O Idosos do presente estudo, com diferentes níveis de força isométrica mostraram distinção nos resultados em testes funcionais, comprometendo a autonomia física e a qualidade de vida.

DESCRITORES: Preensão manual; Time Up Go; Força; Qualidade de vida.

ABSTRACT

Introduction: Aging leads to significant physiological changes, including the decline of muscle strength and endurance, impacting the quality of life of the elderly. Objective: To classify elderly individuals with different levels of strength and compare their performance in functional tests that express the ability to perform daily living activities. Methodology: The study involved 36 elderly women aged between 60 to 84 years. Tests included handgrip strength, 30-second elbow flexion, 30-second chair stand, and Time Up Go. Statistical analyses included Shapiro-Wilk, Mann-Whitney tests, Pearson correlation, and Cohen's d, with a significance level of 5%. Results: The volunteers were separated into groups based on strength levels: low strength (LS) with 11.94 kilogram-force (kgf) and medium strength (MS) with 19.00 kgf. There was a significant statistical difference in elbow flexion (P=0.015; d=0.867) between the groups. A moderate and positive correlation (r=0.408; P=0.015; d=0.166) was found between strength levels and elbow flexion. A weak negative correlation (r=-0.384; P=0.023; d=0.147) was observed between Time Up Go and chair stand. Conclusion: The elderly in this study, with different levels of isometric strength, showed distinctions in functional test results, compromising physical autonomy and quality of life.

DESCRIPTORS: Handgrip strength; Time Up Go; Strength; Quality of life.

RESUMEN

Introducción: El envejecimiento conlleva importantes cambios fisiológicos, entre ellos una disminución de la fuerza y la resistencia muscular, lo que repercute en la calidad de vida de las personas mayores Objetivo: Clasificar a las personas mayores con diferentes niveles de fuerza y comparar su rendimiento en pruebas funcionales que expresan la capacidad para realizar actividades de la vida diaria. Metodología: En el estudio participaron 36 ancianas de entre 60 y 84 años. Se realizaron las siguientes pruebas: agarre de manos, flexión de codo en 30 segundos, levantarse y sentarse de una silla en 30 segundos y Time Up Go. Los análisis estadísticos incluyeron las pruebas de Shapiro-Wilk, Mann-Whitney, correlación de Pearson y d de Cohen, con un nivel de significación del 5%. Resultados: Los voluntarios fueron separados en grupos por nivel de fuerza. Fuerza baja (LF) 11,94 kilogramos de fuerza (kgf) y fuerza media (MF) 19,00 kgf. Hubo una diferencia estadísticamente significativa en la flexión del codo (P=0,015; d=0,867) entre los grupos. Se encontró una correlación positiva moderada (r=0,408; P=0,015; d=0,166) entre los niveles de fuerza y la flexión del codo. Se observó una correlación negativa débil (r=-0,384; P=0,023; d=0,147) entre el Time Up Go y la bipedestación y sedestación. Conclusión: Los ancianos de este estudio, con diferentes niveles de fuerza isométrica, mostraron diferentes resultados en las pruebas funcionales, comprometiendo la autonomía física y la calidad de vida.

PALABRAS CLAVE: Handgrip; Time Up Go; Fuerza; Calidad de vida.

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INTRODUCTION

Aging is a natural and inevitable process that brings about several physiological changes in the human body. With advancing age, it is common for muscle strength and endurance to decline, which can significantly impact the quality of life of older adults (1). Loss of muscle mass, known as sarcopenia, is often associated with an increased risk of falls, fractures, and functional dependence, also compromising the ability to perform activities of daily living (ADLs) (2). This muscle decline not only affects mobility and autonomy, but is also correlated with several chronic conditions, such as cardiovascular and metabolic diseases.

These factors not only increase the need for medical care and social support, but can also lead to greater social isolation and mental deterioration. Such factors pose several challenges to public health (3). Given this scenario, knowledge and understanding of the factors that affect functional performance associated with muscle loss are essential to support interventions that contribute to healthy aging and improve the quality of life of older individuals.

The importance of investigating the relationships between aging, strength and muscular endurance lies in the need to understand the mechanisms that interact and interfere in the quality of these physical capacities, as well as their effects on the quality of life and daily life of the elderly. Understanding these factors can contribute to the implementation of public health policies aimed at prevention and the well-being of the elderly population.

Thus, this study aimed to classify elderly people with different levels of strength and compare their performance in functional tests that express the ability to perform ADLs.

METHOD

This is a cross-sectional exploratory study of an analytical nature. The study included the participation of 36 elderly women aged between 60 and 84 years. The research was carried out in the months of September and October 2018. The volunteers were part of the senior group of SESC Pernambuco (SESC-PE). The inclusion criteria for participating in the study were: being enrolled in the SESC-PE social group, not having motor limitations that would compromise the performance of the tests, not using any supplement that would influence the improvement of the performance of the functional tests. Volunteers who did not finish or did not complete any of the functional tests were excluded from the study.

The volunteers signed the Informed Consent Form as established by the Declaration of Helsinki (466/2012) and the Resolution of the National Health Council

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of Brazil. The project was approved by the Human Research Ethics Committee of the Catholic University of Brasília: opinion no. 1,201,316.

The volunteers' blood pressure (BP) was measured using a Microlife® digital device, model BP 3BT0-A. Total body mass and height were measured using a Filizola® mechanical scale with an accuracy of 100 grams. After this stage, the volunteers underwent familiarization with the following functional tests: a) handgrip test (HGT); b) 30-second elbow flexion test (EFT); c) 30-second chair stand-up test (30CST); d) Time Up Go test (TUG).

The HGT was performed with the volunteers sitting on a chair with their arms flexed at 90º. The contraction was performed three times with both hands (right and left) respecting 1 minute of rest between repetitions. The EFT was performed with the right arm with the volunteers sitting on a chair without arms and holding a weight (dumbbell) of 2 kg. At the evaluator's signal, the volunteers performed the greatest number of arm flexions in 30 seconds. The CST was performed with the volunteers sitting with their backs touching the back of the chair and with both feet parallel and completely touching the ground. With their arms crossed over the trunk, at the evaluator's command, they began the movement of standing up and sitting down as many repetitions as possible for 30 seconds.

For the TUG, a chair with a backrest and no arms was placed at a distance of 2.44 meters from a cone (to mark the distance to be covered). At the evaluator's signal, the participants stood up without assistance, walked around the cone and sat down again (4).

The body mass index (BMI) was calculated using the equation weight/height2 (5). To estimate the body fat percentage (%BF), the following equation was used: %BF = (1.2 * BMI) + (0.23 * Age) – (10.8 * 1) – 5.4 (6). Lean weight was estimated using the equation: MP = total weight – fat weight (7).

STATISTICAL ANALYSIS

The data were statistically analyzed and presented as mean and standard deviation. The Shapiro-Wilk test was used to assess data normality. The Mann-Whitney test was used to test the normality of the means of the handgrip and elbow flexion tests. The Pearson correlation was used to verify the association between the level of strength and elbow flexion. The magnitude of the effect size was obtained using Cohen's d. The significance level adopted was 5% ($P \leq 0.05$). All statistical procedures were performed with the aid of Jamovi Software 2.3.28.

RESULTS

Table 1 describes the sample characterization data in terms of mean and standard deviation.

Table 1. Sample characterization data (n=36)

	MEAN	STANDARD-DEVIATION
Age (years)	72.03	8.96
SBP (mmHg)	127.50	15.37
DPB (mmHg)	74.72	8.44
Weight (kg)	64.46	10.30
Height (cm)	153.00	0.05
BMI (peso/altura)2	27.59	3.91
Fat (%)	32,23	4,39

Source: Own authorship.

The volunteers were separated into two groups: BF, which had an average of 11.94 kgf in the HGT, and MF, which had an average of 19.00 kgf in the respective test. Table 2 shows the averages of the anthropometric variables and functional tests separated by strength level.

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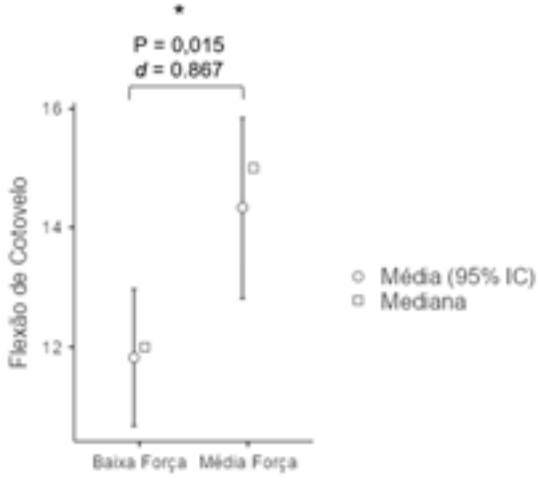
Table 2. Group averages by strength stratum (n=36)

	NÍVEL DE FORÇA	MÉDIA	DP
Weight (kg)	Low Strength	61.64	8.39
	Medium Strength	66.97	11.38
Height (cm)	Low Strength	152.0	0.05
	Medium Strength	154.0	0.06
BMI weight/(height)2	Low Strength	26.70	3.10
	Medium Strength	28.38	4.46
Average Handgrip (kgf)	Low Strength	11.94	4.57
	Medium Strength	19.00	3.62
Stand Up and Sit Down (rep)	Low Strength	11.76	2.30
	Medium Strength	12.11	1.88
Elbow Flexion (rep)	Low Strength	11.82	2.42
	Medium Strength	14.33	3.27
Come and Go (sec)	Low Strength	6.86	2.13
	Medium Strength	6.15	1.37
Lean Weight (kg)	Low Strength	41.42	2,01
	Medium Strength	42.05	5,80

Kgf: kilogram force; Rep: repetition; Sec: seconds. Source: Own authorship.

A statistically significant differen- ce was observed between the EFT means between the BF and MF

Figure 1. Average EFT of the BF and MF groups.



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A moderate and positive correlation was found between strength levels and elbow flexion. A weak negative correlation was also observed between TUG and CST.

Table 2. Correlation between functional tests.

CORRELATION	R	P	D
Strength Level / Elbow Flexion	0,408	0,015*	0,166
Time Up Go / Stand Up and Sit Down	-0,384	0,023*	0,147

*r = level of correlation, p = statistical value, d = magnitude of effect size, * statistically significant value. Source: Own authorship.*

DISCUSSION

The aim of this study was to classify elderly individuals with different strength levels and compare their performance in functional tests that expressed the ability to perform ADLs. The main findings of this study were the statistically significant difference and a large magnitude of the effect size (P=0.015; d=0.867) between the MF and BF groups in the EFT. A moderate positive correlation (r=0.408; P=0.015) was also observed between strength levels and the EFT. Furthermore, a small negative correlation (r=-0.384; P=0.023) was found between the TUG and CST tests.

Handgrip strength is a variable that expresses the level of isometric strength in kgf. The association of this physical capacity with the risk of morbidity and mortality in the elderly has been widely demonstrated in the literature (8); (9); (10). Furthermore, handgrip strength influences the performance of activities of daily living (handling objects, holding onto handrails, carrying bags, among other activities), which, at low levels, can compromise the quality of life and autonomy of the elderly (11).

The BF and MF groups in this study presented averages of 11.94 kgf and 19.00 kgf, respectively. The elbow flexion test is widely used in geriatric assessment to identify the levels of strength and muscular endurance of the upper limbs (12). In the elderly, maintaining muscular endurance helps to preserve autonomy in DLAs and quality of life (13); (14).

Muscular endurance also expresses the state of cardiovascular health and is influenced by body composition and muscle mass level (15). In the present study, volunteers classified as BF showed lower performance in the EFT, demonstrating lower strength and low muscular endurance when compared to the MF group. It was also observed that the BF group had a lower mean lean weight (MP=41.42 ± 2.01) than the MF group (MP=42.05 ± 5.80). It is possible to infer that the difference in body composition demonstrated in the BF group, due to the lower lean weight, may be a factor that contributed to the lower performance in the handgrip test (16). In the study by (17), the researchers found that, after 16 weeks of physical training, an improvement in body composition (increase in lean mass) and greater performance in handgrip strength were observed in elderly individuals. In turn, the moderate correlation (r=0.408; P=0.015) between strength in the HGT and EFT demonstrates the association of muscle mass with muscular resistance.

In a study conducted by (18), which included the participation of 1,575 elderly individuals with an average age of 74 years, a 7.06% decline in muscle mass and a 12.30% reduction in strength levels per decade were observed. The researchers also demonstrated a moderate correlation (r=0.576; P<0.001) between handgrip strength and muscle mass, in line with the findings of our study. The researchers concluded that, as lean mass decreases with age, handgrip strength decreases proportionally. In the study by (19), 49 elderly women aged between 60 and 84 years were evaluated. The researchers found a strong positive correlation (r=0.685; P=0.001) between the CST and the EFT. The study demonstrated that lower muscular resistance in the upper limbs may indicate a deficit in resistance in the lower limbs.

Regarding the averages of the volunteers in this study in the CST (BF: 11.76 repetitions and MF: 12.11 repetitions), a low muscular endurance capacity of the lower limbs is exposed, explaining the negative correlation (r=-0.384; P=0.023) observed between the TUG test and the CST. The TUG is a test widely used to assess dynamic balance and gait quality (20). This capacity is linked to the quality of daily physical actions, as well as being correlated with the risk of falls in the elderly (20); (21). Studies have shown that balance and gait quality are negatively influenced by the reduction in muscular strength and endurance (22). This compromises the locomotor and metabolic capacity of the elderly and impacts their functional autonomy, health and quality of life (23).

In the study by (24), researchers assessed peripheral muscle strength and correlated it with the distance covered in the 6-minute walk test and the quality of life measure. They found a strong correlation (r=0.719; P=0.0004) between quadriceps strength and performance in the 6-minute walk test. A moderate correlation (r=0.684; P=0.0009) was also observed between quadriceps strength and inspiratory pressure. The researchers concluded that reduced peripheral muscle strength influences respiratory fatigability and performance in

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the 6-minute walk test. Studies have also demonstrated the correlation between handgrip strength and lower limb strength (25). This fact helps to understand the relationship between the low strength level of the BF group and the longer walking time during the TUG.

Although this study did not assess quality of life and functional autonomy in ADLs, it is possible to infer, based on scientific evidence, that the limitations in functional tests presented by the volunteers can have a strong impact on a lifestyle with motor impairment and physical dependence to perform ADLs. Therefore, promoting interventions that can mitigate the reduction in muscle mass with advancing age can be an important strategy for maintaining health and functional autonomy and contributing to a better quality of life for the elderly.

CONCLUSION

It was found that the elderly volunteers in the study, classified with different levels of isometric strength assessed by the HGT, presented distinctions in the functional tests, especially in those that assessed muscular endurance (EFT and CST). Furthermore, it was possible to infer that such performances may evidence limitations in functional physical autonomy and in the performance of activities of daily living, also impacting the quality of life of the elderly women classified as BF participating in the study. It is recommended that new studies be carried out with elderly individuals of both genders that include the assessment of activities of daily living, in order to ratify the findings of the present study.

REFERÊNCIAS

1. Souto Filho JM. PERFIL SOCIAL E DA APTIDÃO FUNCIONAL DE IDOSOS RESIDÊNTES NO MUNICÍPIO DE TRIUNFO - PE. Fiep Bull. 2015;85(1):33–9.

2. Barros JM, Moraes BTM, Barroso AC de S, Pinaty CMZ, Neto ZAM, Melo JO, et al. IMPACTO DA SARCOPENIA NA QUALIDADE DE VIDA E NA SAÚDE DO IDOSO: UMA REVISÃO INTEGRATIVA. Rev Científica Fac Educ E Meio Ambiente. 2023;14(2):1–19. DOI: 10.31072/rcf.v14i2.1247

3. Nishikawa H, Asai A, Fukunishi S, Nishiguchi S, Higuchi K. Metabolic Syndrome and Sarcopenia. Nutrients. 2021;13(10):2–12. DOI: 10.3390/nu13103519.

4. Rikili RE, Jones CJ. Development and Validation of a Functional Fitness Test for Community-Residing Older Adults. J Aging Phys Act. 1999;7(2):129–61. DOI: 10.1123/japa.7.2.129

5. Souto Filho JM, Silva KGCF da, Modesto IEG. Treino de força e estresse durante a pandemia do COVID-19. Saúde Coletiva Barueri. 2021;11(65):6000–11. DOI: 10.36489/saudecoletiva.2021v11i65p6000-6011

6. Vieira W de O, Rocha AC. Utilização do índice de massa corporal e equações preditivas para a estimativa do percentual de gordura corporal. ConScientiae Saúde. 2015;14(2):257–62. DOI: https://doi.org/10.5585/conssaude.v14n2.5428

7. Carnaval PE. Medidas e Avaliação em ciências do esporte. 5o ed. Rio de Janeiro: Sprint; 2002.

8. Gutiérrez-Hermosillo H, León-González ED de, Medina-Chávez JH, Torres-Naranjo F, Martínez-Cordero C, Ferrari S. Hand grip strength and early mortality after hip fracture. Arch Osteoporos. 2020;15(185):1–6. DOI: 5 https://doi.org/10.1007/s11657-020-00750-3

9. Hamasaki H. What can hand grip strength tell us about type 2 diabetes?: mortality, morbidities and risk of diabetes. Expert Rev Endocrinol Metab. 2021;16(5):237–50. DOI: 10.1080/17446651.2021.1967743

10. Liu G, Xue Y, Wang S, Zhang Y, Geng Q. Association between hand grip strength and stroke in China: a prospective cohort study. Longev Aging. 2021;13(6):8204–13. DOI: 10.18632/aging.202630

11. Hong YS, Kim H. Hand grip strength and health-related quality of life in postmenopausal women: a national population-based study. Menopause. 2021;28(12):1330–9. DOI: 10.1097/GME.0000000000001863

12. Medeiros I, Pereira L, Pinto V, Viana-Gomes D. Efeito do exercício físico no envelhecimento: diferenças nas aptidões físicas entre idosos ativos e sedentários. J Investig Médica. 2022;3(1):49–61. DOI: 10.29073/jim.v3i1.59

13. Yang S, Li T, Yang H, Wang J, Liu M, Wang S, et al. Association between muscle strength and health-related quality of life in a Chinese rural elderly population: a cross-sectional study. BMJ Ope. 2020;10(1):e026560. DOI: 10.1136/bmjopen-2018-026560

14. Rocha S vasconcelos, Santos SS dos, Vasconcelos L renata carneiro, Santos CA dos. Strength and ability to implement the activities of daily living in elderly resident in rural areas / Fuerza y capacidad de realizar actividades de la vida diaria en ancianos residentes en la zona rural. Colomb Medica. 2016;47(3):167–71.

15. Shimizu Y, Kawashiri S-Y, Nobusue K, Yamanashi H, Nagata Y, Maeda TM. Associations between handgrip strength and hypertension in relation to circulating CD34-positive cell levels among Japanese older men: a cross-sectional study. Environ Health Prev Med. 2021;26(1):62–71. DOI: 10.1186/s12199-021-00982-w

16. Oliveira NC, Ribeiro AN, Salgueiro MMH de A de O, Alfieri FM, Padrão AMN, Padrão F de B, et al. ASSOCIAÇÃO ENTRE FORÇA DE PREENSÃO MANUAL, COMPOSIÇÃO CORPORAL E ESTADO NUTRICIONAL DE IDOSOS DA COMUNIDADE. Estud Interdiscip Sobre O Envelhec. 2022;26(3):227–40. DOI: 10.22456/2316-2171.83076

17. Garcia RC, Camilo MLA, Oliveira FM de, Bertolini SMMG, Araujo CGA, Branco BHM. EFEITOS DE UM PROGRAMA DE TREINAMENTO MULTICOMPONENTE NA COMPOSIÇÃO CORPORAL E NA CAPACIDADE FUNCIONAL DE IDOSOS COM EXCESSO DE PESO: UMA PROPOSTA DE INTERVENÇÃO. Estud Interdiscip Sobre O Envelhec. 2023;28(1):1–14. DOI: 10.22456/2316-2171.132940

18. Chan J, Lu YC, Yao MM-S, Kosik RO. Correlation between hand grip strength and regional muscle mass in older Asian adults: an observational study. BMC Geriatr. 2022;2(1):206–15. DOI:

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10.1186/s12877-022-02898-8

19. Lima DN de, Nascimento MAM do, Maia DF, Souto Filho JM. Envelhecimento e resistência muscular: impacto na capacidade funcional. Fédération Int D'Education Phys –FIEP. 2024;94(1):237–47. DOI: 10.16887/fiepbulletin.v94i1.6845

20. Bastidas PO, Gómez B, Aqueveque P, Luarte-Martínez S, Cuerda RC. Than Assessing Time to Predict Falls: A Systematic Review. Sensors. 2023;23(7):3426. DOI: 10.3390/s23073426

21. Jutharee W, Paengkumhag C, Limpornchitwilai W, Mo WT, Chan JH, Jennawasin T, et al. Fall risk assessment dataset: older-adult participants undergoing the time up and go test. Data Brief. 2023;51(1):109653–63. DOI: 10.1016/j.dib.2023.109653

22. Hassan EB, Phu S, Vogrin S, Duque G. Appendicular and mid-thigh lean mass are associated with muscle strength, physical performance, and dynamic balance in older persons at high risk of falls. Gait Posture. 2022;93(1):90–5. DOI: 10.1016/j.gaitpost.2022.01.022

23. Kashi SK, Mirzazadeh ZS, Saatchian V. A Systematic Review and Meta-Analysis of Resistance Training on Quality of Life, Depression, Muscle Strength, and Functional Exercise Capacity in Older Adults Aged 60 Years or More. Biol Res Nurs. 2023;25(1):88–106. DOI: 10.1177/10998004221120945

24. Lima TRL, Guimarães FS, Carvalho MN, Souza TLM, Menezes SLS, Lopes AJ. Lower limb muscle strength is associated with functional performance and quality of life in patients with systemic sclerosis. Braz J Phys Ther. 2015;19(1):129–36. DOI: 10.1590/bjpt-rbf.2014.0084

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