

Correlation between muscle power and cognitive function in older adults Community-dwelling: a cross-sectional study

Correlação entre potência muscular e função cognitiva em idosos comunitários: um estudo transversal

Correlación entre la potencia muscular y la función cognitiva de ancianos que viven en comunidad: un estudio transversal

Juliana Daniele de Araújo Silva¹, Diógenes Candido Mendes Maranhão², André Luiz Torres Pirauá³

ABSTRACT | Aging is a natural process in which physiologically functions decline. Overall, cognitive and functional aspects are intertwined, parameters such as decreased walking speed and impairment of subjective memory may represent health complications, such as motor cognitive risk syndrome. However, the literature lacks evidence on cognitive and functional relationships. Thus, this study aimed to verify the correlation of two levels of muscle power with the cognitive function of community-dwelling older adults. This is a correlational cross-sectional study. The sample consisted of 38 older adults (68±7 years; 81.6% women), assessed for muscle power via the chair rise test, for the assessment of cognitive functions the Montreal Cognitive Assessment (MoCA) was used and adapted versions of the Trails Test A and B (TTA and TTB), animal category verbal fluency test and Stroop test. Spearman's correlation was used to assess the relationship between the power variable and the cognitive variables. For all analyses, a 5% significance level was established. Our results showed an association of the best power levels with a positive direction for global cognition ($\rho = 0.35$; $p = 0.02$) and with a negative direction as reading conditions ($\rho = -0.35$; $p = 0.02$) and Stroop color test ($\rho = -0.39$; $p = 0.01$). In community-dwelling older adults, higher levels of muscle power are associated with higher global cognition scores and greater agility in the attention involved in reading words and naming colors.

Keywords | Aging; Physical aptitude; Cognition; Dementia.

RESUMO | O envelhecimento é um processo natural em que, fisiologicamente, as funções começam a diminuir. De modo geral, aspectos cognitivos e funcionais relacionam-se entre si, e parâmetros como a diminuição na velocidade da marcha e queixa subjetiva de memória podem representar complicações de saúde, a exemplo da síndrome do risco cognitivo motor. Entretanto, a literatura carece de mais investigações acerca dessas relações cognitivas e funcionais. Este artigo pretende verificar a correlação dos níveis de potência muscular com a função cognitiva de idosos comunitários. Para tal, realizou-se um estudo transversal correlacional. A amostra foi composta por 38 idosos (68±7 anos; 81,6% mulheres), avaliados quanto à potência muscular por meio do *chair rise test*; para a avaliação das funções cognitivas utilizou-se o *Montreal cognitive assessment* (MoCA) e versões adaptadas do teste de trilhas A e B (TTA e TTB), do teste de fluência verbal categoria animal e do teste de Stroop. Utilizou-se a correlação de *Spearman* para avaliar a relação entre a variável potência com as variáveis cognitivas. Para todas as análises foi estabelecido um nível de significância de 5%. Os resultados observaram associação de melhores níveis de potência com direção positiva para a cognição global ($\rho = 0,35$; $p = 0,02$) e com

¹University of Pernambuco, Petrolina (PE), Brazil Graduate Program in Rehabilitation and Functional Performance.

University of Pernambuco, Petrolina (PE), Brazil. E-mail: julianadanielearaujo@gmail.com. ORCID: 0000-0002-3610-0754

²Federal Rural University of Pernambuco. University of Pernambuco, Department of Physical Education, Recife, PE, Brazil.

E-mail: diogenesmendes.maranhao@upe.br. ORCID: 0000-0002-4320-0227

³Federal Rural University of Pernambuco. University of Pernambuco, Department of Physical Education, Recife, PE, Brazil.

ORCID: 0000-0001-5257-4610

direção negativa com as condições leitura ($\rho=-0,35$; $p=0,02$) e cor do teste de Stroop ($\rho=-0,39$; $p=0,01$). Em adultos mais velhos que vivem na comunidade, níveis mais altos de potência muscular estão associados a maior pontuação de cognição global e a maior rapidez na capacidade de atenção envolvida com a leitura de palavras e nomeação de cores.

Descritores | Envelhecimento; Aptidão física; Cognição; Demência.

RESUMEN | El envejecimiento es un proceso natural en que ocurre una disminución de las funciones fisiológicas. En general, los aspectos cognitivos y funcionales están interrelacionados, y los parámetros como la disminución de la velocidad de la marcha y quejas de problemas de memoria pueden representar complicaciones de salud, como el síndrome de riesgo cognitivo motor. La literatura carece de más investigación sobre estas relaciones cognitivas y funcionales. Este artículo tiene como objetivo identificar la correlación de los niveles de potencia muscular con la función cognitiva de los ancianos que viven en comunidad. Para ello,

se realizó un estudio transversal correlacional. La muestra estuvo conformada por 38 ancianos (68 ± 7 años; 81,6% mujeres), evaluados según la potencia muscular mediante la *chair rise test*; para la evaluación de las funciones cognitivas, se utilizaron la evaluación cognitiva de Montreal (MoCA) y las versiones adaptadas de la prueba A y B Trail (TTA y TTB), de la prueba de fluidez verbal de categoría animal y de la prueba de Stroop. Se utilizó la correlación de Spearman para evaluar la relación entre la variable de potencia y las variables cognitivas. Para todos los análisis, se estableció un nivel de significancia del 5%. Los resultados mostraron una asociación de mejores niveles de potencia con una tendencia positiva para la cognición global ($\rho=0,35$; $p=0,02$) y con una tendencia negativa con las condiciones de lectura ($\rho=-0,35$; $p=0,02$) y el color de la prueba de Stroop ($\rho=-0,39$; $p=0,01$). En los adultos mayores que viven en comunidad, los niveles más altos de potencia muscular estuvieron asociados con puntuaciones cognitivas más altas y una mayor rapidez en la capacidad de atención relacionada con la lectura de palabras y la denominación de colores.

Palabras clave | Envejecimiento; Aptitud física; Cognición; Demencia.

INTRODUCTION

Human aging is a natural, intrinsic, and irreversible process, in which every physiological function diminishes^{1,2}. The decrease in these functions can lead to physical and cognitive declines, which, associated with increasing age, result in worse long-term survival³, causing a high risk of decompensation and death^{1,4}.

Regarding prognosis, the deficits observed in neuromuscular activation during aging precede changes that help in the identification of significant alterations, such as the loss of muscle power⁵. Such alteration is the most discriminating predictor of functional performance, presenting early and faster declines with aging (-3% per year) compared with muscle strength (-2% per year) and muscle mass (-1% per year)^{5,6}. From a cognitive standpoint, even those who do not suffer from dementia or mild cognitive impairment can experience subtle cognitive changes associated with aging⁷.

During dementia, which can last for years before the onset of mild cognitive impairment, aspects such as subjective memory complaints and decreased gait speed are commonly observed⁸. The literature describes combination of these parameters is described in the literature as motoric cognitive risk syndrome⁸⁻¹⁰.

Both parameters are early indicators of cognitive decline and dementia⁸. They have several common factors, such as: cardiovascular disease, diabetes mellitus, vitamin D deficiency, and brain atrophy, with decreased hippocampal volume⁸.

In the clinical context, dual-task interventions seem promising since they focus on the task complexity and priority⁹. Evidence indicate that dual-task interventions, involving simultaneous cognitive and motor stimuli, can promote better outcomes on mobility in older adults¹⁰. However, more studies are necessary to improve the understanding of these relationships (cognitive and functional), especially between muscle power and cognitive function in older adults, as well as to guide future interventions¹¹. Thus, this study aimed to verify the correlation between levels of muscle power levels and cognitive function in community-dwelling older adults.

METHODOLOGY

Study characterization, recruitment, and eligibility

This cross-sectional study included older adults who completed baseline evaluation of a randomized

controlled trial registered in the Brazilian Registry of Clinical Trials (RBR-8qby2wt). This RCT aimed to investigate the effects of online supervision in a 12-week home-based exercise program on the functional capacity and cognition of community-dwelling older adults during the COVID-19 pandemic. The study was conducted remotely by videoconference throughout the Brazilian national territory. All stages were conducted by the participants and researchers, each in their own residence.

Volunteers were recruited from July to October 2021, including older adults with preserved cognitive and functional capacity, without sensory limitations and/or mental health disorders, literate, with access to electronic devices, allowed by professionals to exercise at home, and taking part in no physical exercise program for at least six months. As exclusion criteria, it was established that participants who were affected by a limiting condition during data collection and/or who were involved in another physical activity program in parallel with the study would be excluded.

Procedures and quantitative variables

All evaluations were conducted via videoconference, with details of the evaluation procedures, reproducibility, and reliability of the measures described elsewhere¹².

The chair rise test was used to evaluate lower limbs muscle power. For the testing, a armless chair with a backrest and a stopwatch were use. At the command of the evaluator, the participant should sit down and get up from the chair with the arms crossed over the chest as quickly as possible. For each complete movement—both sitting and standing—a repetition was counted¹³. The calculation for muscle power used the number of repetitions of the first 20 seconds of the chair rise test¹³, which was inserted into an equation¹⁴ to express the mean power (*Watts*) = $-504,845 + 10,793$ (body weight in kg) + $21,603$ (repetitions in the 20" chair rise test). The intra-rater intraclass correlation coefficient (ICC) indicated 0.98 (95% CI = 0.96 to 0.99) reliability for this test in virtual mode¹². For the evaluation of cognitive functions, videoconference versions of the Montreal cognitive evaluation (MoCA)¹⁵, and adapted versions of the A and B track tests (TTA and TTB), the verbal fluency test, animal category, and the Stroop test by videoconference were used in order to evaluate global cognition, processing speed, semantic memory, and inhibitory control, respectively.

Statistical methods

The data were analyzed using IBM SPSS Statistics 25. The Kolmogorov-Smirnov test was used to verify the data normality, and, if the non-normality was observed, the Spearman correlation was used to analyze the relationship between the power variable and the cognitive variables. For all analyses, a 5% significance level was established ($p < 0.05$). The sample size estimation was calculated *a posteriori* by G*Power 3.1.9.4, using a bivariate normal model, 5% significance level and coefficients of determination calculated for each possibility of association ranging from 0.001 to 0.361×10^{-5} , with a 0.05 test power in all analyses, with the minimum number of samples required for the observation of moderate (0.50) and high (0.70) effect sizes, also ranging from three to nine individuals.

RESULTS

Overall, of the 77 older adults evaluated for eligibility in the primary study, 38 participants were eligible and completed the baseline evaluation, being included in this study (Table 1). Table 2 shows that a positive correlation was observed between power and global cognition, and a negative correlation between the two initial conditions of the Stroop test.

Table 1. Descriptive data of the older participants (n=38)

Parameter	Value
Sex, n (% women)	31.00 (81.60)
Age, mean (SD), years ^a	68.00 (6.48)
Body mass, mean (SD), kg ^a	69.82 (12.15)
Height, mean (SD), m ^a	1.59 (0.06)
Body mass index, mean (SD), kg/m ²	27.82 (4.88)
Sarcopenia risk, mean (SD), score ^b	1.38 (1.12)
Average training attendance rate, %	72.44 (26.15)
Schooling, n (%)	
≥12 years	36.0 (94.7)
Regions of Brazil, n (%)	
Northeast	35.0 (92.1)
Southeast	3.0 (7.9)
Health conditions, n (%)	
Decreased in the last year	10.0 (26.3)
Hypertensive	8.0 (21.1)
Diabetics	2.0 (5.3)
Musculoskeletal conditions	11.0 (28.9)
Heart conditions	3.0 (7.9)
Use of medication for comorbidities	12.0 (31.6)

continues...

Tabela 1. Continuação

Parameter	Value
Internet and technologies adaptation, n (%) ^a	
Experience with video conferencing resources	29.0 (76.3)
Full familiarization with the internet and technologies	12.0 (31.6)
Daily use of the internet and technologies, but with difficulties	25.0 (6.8)
No familiarity with the internet and technologies	1.0 (2.6)
Evaluations, mean (SD)	
Chair Rise Test -Power, Watts	422.10 (134.19)
MoCA, score	23.08 (2.83)
TTA, seconds	15.00 (7.96)
TTB, seconds	79.68 (57.92)
Verbal Fluency, number of words	4.21 (2.37)
Stroop test (color condition), seconds	19.21 (6.57)
Stroop test (reading condition), seconds	13.45 (3.57)
Stroop test (reading condition), seconds	35.44 (10.84)
Stroop test (Stroop effect), seconds	16.23 (9.52)

SD: standard deviation.

^aSelf-reported by the participants.^b Obtained by applying the sarcopenia screening questionnaire (SARC-F) with a score of ≥ 4 indicating risk of sarcopenia.

Table 2. Results of correlations between the outcome of power and cognitive functions

Cognitive evaluation	rh0	p
MoCA	0.359	0.027*
TTA	-1.175	0.292
TTB	-0.316	0.054
Verbal Fluency	-0.016	0.923
Stroop test (color condition)	-0.396	0.014*
Stroop test (reading condition)	-0.358	0.027*
Stroop test (reading condition)	-0.206	0.214
Stroop test (Stroop effect)	0.019	0.911

*Statistical significance

DISCUSSION

The results showed an association of better power levels with positive direction for global cognition and with negative direction with reading and color conditions of the Stroop test. The results are favorable because they demonstrate that better performances in the evaluation of power are associated with better performances in tests that evaluate global cognition and inhibitory control. However, no relation was observed between power performance and other types of attention, processing speed and semantic memory.

The finding that functional and cognitive parameters are related to each other corroborates with the literature. Recently, a study analyzing the relationship between functional capacity and cognition in older

adults—without dementia—observed that higher levels of muscle strength, dynamic balance, and cardiorespiratory fitness were positively related to global cognition and executive control measures¹⁶. Positive associations were observed between muscle strength and MoCA ($b = 0.84$, $SE = 0.40$, $95\%CI 0.05 - 1.64$) after covariates controlling (including age, gender, education level), and between the sit-to-stand test ($b = -0.63$, $SE = 0.26$, $95\%CI -1.15-0.12$), TUG ($b = -1.13$, $SE = 0.57$, $95\%CI -2.26-0.01$), *six-minute walk test* ($b=0.04$, $SE=0.02$, $95\%CI 0.01-0.07$), and lower limb muscle strength ($b=1.92$, $SE = 0.93$, $95\%CI 0.09-3.77$) with the verbal fluency test, and between the timed up and go ($b = -0.62$, $SE = 0.24$, $95\%CI -1.11-0.14$) and naming of animals.

In a recent systematic review with meta-analysis and meta-regression analysis, 20 high-quality studies showed that there is a positive correlation between the size of the exercise-induced effect on physical function and cognitive function ($b = 0.41$; $p = 0.002$)¹⁷. However, the authors discussed that the temporal aspect and the neural foundations of this relationship are not yet well established, and some possibilities are explainable: (1) neural plasticity is an important mechanism via which training promotes mobility; and (2) growth factors that aim at exercise, such as IGF-1, are involved with physical and cognitive functions, and the latter, as a consequence, respond with improvements to the stimulus of exercise.

Cognition influence on motor performance can be illustrated by the action of the central nervous system in coordinating sensory information, which generates signals for motor skills and reflexes, promoting integration between cognitive and postural controls¹⁸. Cholinergic system also plays a role on cognition, balance, motor production, and gait activity regulation by the cortex circuits that manage attention, executive control, and the neural networks of motor, sensory, and cognitive performance^{19,20}. The neural mechanisms that share cognitive functions and gait control are represented by the combination of the sensory processing system, the motor processing system, and the central processing system, which support motor and cognitive functioning, suggesting an influence on muscle strength and power. Changes in the coordination of the three systems lead to a marked imbalance, which is accompanied by a reduction in aging-related functions, increasing the risk of falls, imbalance, and movement difficulties²¹.

Curiously, although favorable correlations were found in the color and reading conditions of the Stroop test, no correlation was observed in the performance of the most important condition to evaluate inhibitory control, interference, or with the Stroop effect results. The same happened with semantic memory/verbal fluency test and for processing speed. A review study with cross-sectional studies noted, however, that individuals with better performance on functioning indicators perform better on evaluations of global cognition, executive function, memory, and processing speed, with the caveat that not all measures of mobility were equally associated with cognitive function²².

The results found by this study are relevant because cognitive decrease is associated with decreases in gait speed in community-dwelling older adults, impairing their physical and mental health²³. Another point is that neurocognitive and social cognition damages are associated with reduced functioning, as demonstrated in a systematic review with older adults with schizophrenia²⁴. The power test used in the study, as a low-cost, fast and reliable evaluation measure, can be incorporated into geriatric evaluation in the monitoring and screening of physical and cognitive performance in older adults¹⁶.

As limitations, the study nature can be mentioned, which may favor reverse causality bias and does not allow for a causal relationship, as well as the sample size, which is considered small when compared to other studies. It is noteworthy the impossibility of stratifying or analyzing the data considering covariates. In addition, the sample used here refers only to community-dwelling older adults, and it is therefore necessary to be cautious about generalizing the outcomes.

Future investigations are needed to clarify the mechanisms that explain the observed relationships and identify predictors of age-related impairments, and studies that improve analyses with regression tests are interesting to understand how much functional capacity can predict performance in cognition in older adults.

CONCLUSION

In community-dwelling older adults, higher levels of muscle power are associated with higher global cognition scores and faster attention span involved with word reading and color naming.

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