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Association Between Measures of Cognitive Function on Physical Function in Novice Users of a Lower Limb Prosthesis

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Association Between Measures of Cognitive Function on Physical Function in Novice Users of a Lower Limb Prosthesis

ABSTRACT

Background: Cognitive impairment is prevalent in people with lower limb amputations (PLLA) and is associated with adverse outcomes, such as falls and worse rehabilitation outcomes. Physical function tests are essential to examine abilities; however, no research in PLLA has clarified the magnitude of cognitive demands amongst available tests in users novice at walking with a prosthesis.

Research question: Is there an association between cognitive and physical function for PLLA novice at walking with a prosthesis?

Methods: People from inpatient prosthetic rehabilitation were recruited. Inclusion criteria were: age ≥50 years, unilateral transtibial amputation and able to walk independently. Gait velocity and the L Test under single-task (usual) and dual-task (walking while counting backwards) conditions assessed functional mobility. The Four Square Step Test (FSST) examined dynamic balance. The Montreal Cognitive Assessment (MoCA) and the Trail Making Test (TMT-B) assessed global cognitive and executive function, respectively. Multivariable linear regressions evaluated the association of cognition on physical function.

Results: Twenty-two people participated (age: 62.3 ± 8.9 years, male: 68.18%). The mean MoCA score was 26.23 ± 2.90. A 1-point MoCA increase was independently associated with faster gait velocity (cm/s) [single-task: 5.45 (95%CI: 2.35-8.54, AdjR^2=0.46), dual-task: 5.04 (95%CI: 1.33-8.75, AdjR^2=0.20) and a quicker L Test (s) [single-task: -4.75 (95%CI: 7.22-2.28,

$AdjR^2$=0.45), dual-task: -5.27 (95%CI: 8.74-1.80, $AdjR^2$=0.38)]. A 1-second TMT-B increase was also independently associated with worse L Test performance [single-task: 0.21 second (95%CI: 0.03-0.39, $AdjR^2$=0.20), dual-task: 0.29 second (95%CI: 0.06-0.51, $AdjR^2$=0.30)]. No association was observed between MoCA or TMT-B on the FSST (p>0.13).

Significance: Better global cognitive function and executive function were independently associated with faster gait velocity and improved functional mobility, but not dynamic balance. The present study demonstrates a unique relationship between cognition and physical function that warrants further research on the cognitive demands among clinical tests of physical function in PLLA.

Keywords: Amputation, cognition, executive function, fear, postural balance.

HIGHLIGHTS

- Better cognition was independently associated with faster gait and L Test times.
- No association was observed between cognitive function and dynamic balance.
- A unique relationship exists between cognition and physical function.
- The cognitive demands among tests of physical function merits further research.

INTRODUCTION

Undergoing a lower limb amputation is a life-changing event with serious implications for physical and psychological well-being.[1] For many people with lower limb amputations (PLLA), intensive rehabilitation is required to restore physical function and to provide training for the use of a prosthetic device. Nonetheless, falls are prevalent[2] and can result in serious injury that negatively affects daily life.[3] The majority of falls occur while walking,[4] and the ability to walk and be independent is known as the most important factor to life satisfaction after an amputation.[5] As a result, physical function assessments are encouraged for use by healthcare professionals during rehabilitation to track progress and for the prognostication of important outcomes, such as quality of life.[6]

Walking with a prosthesis is a cognitively demanding complex motor task[7,8] often described by PLLA as a cognitive burden.[9] Gait is intimately related to higher-order cognitive processes, such as executive functions, that allow for the planning, monitoring and adjustments required for mobility.[8] A greater cognitive load is observed when engaging in more complex activities or when simultaneously performing multiple tasks (i.e., dual-task testing). Cognitive resources are finite and each task requires a certain amount of these resources for cognitive processing. Thus, worse performance can be expected if the demands for a task exceeds an individual's cognitive capacity.[10] The ability to meet the increased demands of dual-task gait testing is believed to be limited in PLLA[11] as 52-56% demonstrate cognitive impairment.[12,13] Cognitive impairments in this population, and specifically poorer memory and executive dysfunction, are related to how likely someone is to receive a prosthesis, how much a prosthesis is used, and to physical function gains after rehabilitation.[14] The use of a prosthesis requires an ability to don on and doff the device and to be able to learn how to safely use a prosthesis for navigating environments.[14] Therefore, physical function tests that challenge cognitive-motor capacity and approximate real-life instances in which falls often occur may result in a better evaluation of abilities.

Physical function can be measured in many ways, such as the ability to transition from one location to another (i.e., mobility), being able to maintain balance while moving (i.e., dynamic balance), or as the ability to successfully complete daily tasks (i.e., functional mobility).[15] In PLLA new at walking with a prosthesis, better scoring on cognitive testing was independently associated with better performance on functional mobility and walking endurance.[12,16] However, such results were based on one cognitive test and none of the physical function testing involved dual-task or different levels of difficulty.[12,16] When examining the gradation of task difficulty using dual-task gait testing in older adults with mild cognitive impairment, Hunter et al.,[17] concluded that not all test protocols demand the same level of cognitive resources and are therefore non-interchangeable. An inappropriate physical function test selection may lead to being unable to properly challenge cognitive-motor capacity, thus creating floor or ceiling effects that limit the value of any inference. Healthcare professionals should understand the relative cognitive demands associated with the clinical tests that they commonly use, with a more appropriate examination of cognitive-motor ability likely eliciting an earlier response to accommodate for any deficits detected.

The main research objective was to evaluate the association of cognitive function on tests of physical function, including conditions of dual-task, in PLLA at discharge from inpatient prosthetic rehabilitation. Worse cognitive function was hypothesized to be independently associated with lower physical function, and that a stronger association would be observed in the more cognitively demanding tests.

METHODS

Study design

This was a cross-sectional study of PLLA from the inpatient prosthetic rehabilitation program at Parkwood Institute in London, Ontario, Canada (April 2016-September 2017). All participants provided informed consent. The initial study protocol was approved by the Health Sciences Research Ethics Board at the University of Western Ontario and by the Clinical Resources Impact Committee at the Lawson Research Institute.

Participants

Previous research has established that people with transtibial amputations, the most common amputation type,[18] demonstrate better physical function compared to those with transfemoral or bilateral amputations.[19] Therefore, only PLLA with unilateral transtibial amputations were considered to minimize sample heterogeneity. Inpatient prosthetic rehabilitation involved 3 to 4 weeks of daily work with an array of healthcare professionals to learn the use of a lower limb prosthesis to reattain independent function and to enhance quality of life. The following eligibility criteria were applied: ≥50 years of age, English-language proficiency, have a unilateral transtibial amputation and be able to walk ≥10 meters without the help from others although walking aids were allowed. Those presenting with non-amputation medical problems affecting gait were excluded.

Data collection

Clinical and demographic characteristics collected were: age, sex, height and weight, years of education, time since amputation and etiology, 12-month falls history as defined by Lamb et al.,[20] prescription medications and comorbidities. Information was either self-reported using a standardized questionnaire or extracted from a participant's medical chart. All outcomes were collected within 48 hours of discharge.

Outcome Measures

Spatiotemporal gait

An instrumented GAITRite® walkway (CIR System Inc, Franklin, NJ, USA) was used to record gait velocity on a 6-meter straight path. Gait velocity was selected based on its sensitivity for change upon dual-task,[11] and for its relationship to cognitive function and falls risk.[21] To record only steady state ambulation, participants walked one meter before and after the walkway boundaries. All walking trials were completed at a usual, self-selected pace. For dual-task testing, walking while subtracting threes from a random number between 100-150 out loud was performed. Responses were recorded to assess for accuracy and no task prioritization instructions were given. Two trials per condition were performed, which were averaged for results. This gait testing protocol has been shown increase cognitive load and results in gait interference.[22]

Dynamic balance

The Four Square Step Test (FSST) is a measure of dynamic balance involving rapid steps forwards, sideways and backwards while avoiding stationary obstacles.[23] (Figure 1a) A modified version of the FSST was used in which participants had to step over tape placed on the floor in a cross pattern creating four quadrants.[23] The use of tape instead of canes is believed to mitigate the floor effect observed with the original FSST.[6] Participants were encouraged to always be facing forwards during stepping, and to avoid touching the tape or starting a new stepping sequence without first having both feet contact the ground. Performance was recorded as the time to complete the test to the nearest hundredth of a second. A lower time is indicative of better dynamic balance. A practice trial was followed by two collection trials, but only the fastest trial was used.[23] The FSST has been shown to be valid and reliable.[24,25]

Functional mobility

The L Test was developed to examine the minimal walking skills needed for independent living in PLLA.[19] (Figure 1b) Participants start seated on an armless chair, and when prompted, stood, walked forward three meters, turned 90^{o}, walked seven meters, turned 180^{o}, and then followed the same L-shaped path back to their initial position. Performance is the time to complete the course once, with a longer time indicating worse functional mobility. The single-task L Test was completed first, and after a seated break, participants performed the dual-task condition which involved serial subtractions by threes from a random number between 100-150 counted out loud. Responses were recorded to assess for accuracy and no instructions on task prioritization were given. The research assistant demonstrated the L Test prior to data collection and provided the participant with a standardized set of instructions. The single-task and dual-task L Test protocol used has been shown to be valid and reliable.[19,26]

Cognitive function

The MoCA evaluated global cognitive function.[27] The MoCA contains seven domains for assessing visuospatial/executive function, naming, attention, language, abstraction, delayed word recall, and orientation to time and space. Scores range from 0-30 with higher scores indicating better cognition and those ≤25 indicating cognitive impairment.[27]

Processing speed and executive function

The Trail Making Tests were used to evaluate processing speed and executive function.[28] The first part (TMT-A) requires participants to connect a series of numbers in ascending order. The second part (TMT-B) is more challenging, requiring memory and mental flexibility as participants alternate between numbers and letters in ascending order. Both parts are timed and completed as quickly as possible. A slower time indicates worse processing speed and executive function.

Balance confidence

The ABC assessed balance confidence.[29] Balance confidence is a form of falls-related self-efficacy that inquires about a person's belief of being able to complete tasks without losing balance or becoming unsteady.[30] Participants are asked to rate their level of confidence on 16 daily activities using a continuous response scale from 0% (no confidence) to 100% (completely confident). The mean across all items represents the total score and a higher score indicates greater balance confidence. The reliability and validity of the ABC has been established.[31] In older adults, decreased balance confidence is associated with higher anxiety about falling, which increases the cognitive load of gait and results in adverse performance.[32] Reduced balance confidence may be a cognitive distractor for PLLA as lower values are independently associated with worse physical function.[3]

Data Analysis

For clinical and demographic information, the normality of continuous data was assessed using Shapiro-Wilks tests, histograms, Q-Q plots and boxplots. Means and standard deviations, medians and interquartile ranges, or frequencies and percentages were used to summarize results, as appropriate.

Separate multivariable linear regressions were used to evaluate the independent association of global cognitive function (MoCA), processing speed (TMT-A), executive function

(TMT-B) and balance confidence (ABC) on: single-task and dual-task gait velocity, single-task and dual-task L Test, and the Four Square Step Test. Testing diagnostics were performed to ascertain that all linear regression assumptions were met. The first block of each regression examined univariate relationships, while the second block was adjusted for confounders [age (continuous) or sex (binary: male, female), etiology (binary: vascular, non-vascular) and number of comorbidities (continuous)]. The confounders were selected based on data availability, clinical significance, proven relationship to physical performance[12,33] and an observed change ≥10% in the unstandardized beta values of the exposure with the introduction of each.

An *a priori* analysis using G*Power (version 3.1.9.6)[34] estimated that 86% power could be attained assuming $\alpha=0.05$, the use of four predictors and an omnibus R^2 of 0.45 based on previous literature.[12,33] The statistical package SPSS (version 25.0; SPSS, Inc., Chicago, IL) was used to run all analyses with a 0.05 experiment-wise alpha.

RESULTS

Twenty-two people participated (mean age: 62.3 ± 8.9 years, 68.18% were male). The median time since amputation was 108.5 days (25^{th}, 75^{th} percentiles: 88.5, 159.3) and most (81.82%) had an amputation due to diabetes mellitus or peripheral vascular disease. (Table 1) The median MoCA score was 27.00 (25^{th}, 75^{th} percentiles: 24.00, 29.00) and 40.9% demonstrated cognitive impairment. (Table 2) Dual-task testing resulted in worse gait velocity and L Test performance. The median FSST was 26.64 seconds (25^{th}, 75^{th} percentiles: 20.76, 42.17).

Multivariable linear regression modelling demonstrated an independent association between the MoCA and single-task ($p=0.002$, $AdjR^2=0.46$) and dual-task ($p=0.010$, $AdjR^2=0.20$)

gait velocity. (Table 3) A 1-point increase in the MoCA was associated with a 5.45 cm/s (95%CI: 2.35, 8.54) and 5.04 cm/s (95%CI: 1.33, 8.75) increase in gait velocity for the single-task and dual-task conditions, respectively. The MoCA was also independently associated with the L Test for single-task ($p=0.001$, $AdjR^2=0.45$) and dual-task ($p=0.005$, $AdjR^2=0.38$). (Table 4) For the L Test, a 1-point increase in the MoCA was associated with a 4.75 second (95%CI: 7.22, 2.28) reduction in the single-task and a 5.27 second (95%CI: 8.74, 1.80) reduction in the dual-task condition.

The TMT-B was independently associated only with the single-task ($p=0.03$, $AdjR^2=0.20$) and dual-task ($p=0.020$, $AdjR^2=0.30$) L Test. (Table 4) A 1-second TMT-B increase was associated with a 0.21 second (95%CI: 0.03, 0.39) increase in the single-task and a 0.29 second (95%CI: 0.06, 0.51) increase in the dual-task L Test. The TMT-A ($p>0.070$) or ABC ($p>0.150$) were not associated with any of the tests of physical function. (Tables 3-5)

DISCUSSION

Better global cognitive and executive function were independently associated with faster gait velocity and greater functional mobility, yet this was not observed for dynamic balance. No association was observed between processing speed or balance confidence and any of the physical function tests evaluated. This is the first study to examine the association between different measures of cognition and an array of clinical tests of physical function, including the FSST and dual-task testing, in novice users of a lower limb prosthesis.

Previous research with similarly experienced individuals only included the use of the MoCA to measure its association to functional mobility and walking endurance as per the L Test and Two-minute Walk Test, respectively.[12,16] Although an independent association was found between better global cognitive status and greater functional mobility and walking endurance,[12,16] it is important to note that these studies did not include different tests of cognitive function, or other tests of physical function that ranged in difficulty or that included dual-task conditions.[12,16] Moreover, the testing for cognitive function for these studies was performed as part of admission to inpatient prosthetic rehabilitation, while physical function testing was completed at discharge.[12,16] As prosthetic rehabilitation involved upwards of four weeks of intensive programming, it is reasonable to expect that a temporal misalignment for the collection of outcomes may have affected the association between the variables of interest.

In the present study, more measures of cognitive function were independently associated with L Test performance compared to gait velocity or the FSST. Relative to other assessments, such as walking a straight line, the L Test provides more challenge as it involves the ability to complete transfers and to turn towards both limbs.[19] A relationship exists between executive function and curved-path walking, suggesting ambulation in complex paths is more cognitively demanding.[35] Interestingly, global cognitive status was associated with straight path gait velocity, but no measurement of cognitive function was associated with the FSST. These results may be explained by the fact that we used the GAITRite® system, a more accurate methodology, to record only steady state gait over two trials per walking condition. Our protocol also relied on a modified FSST using tape to designate different quadrants as opposed to using canes,[23] which may have reduced the challenge for this test as participants did not have to think about lifting their feet to clear obstacles.

Instances of divided attention are often linked to falls or near-falls in PLLA.[36] The mental tracking task we used, involved remembering and manipulating information before each response. There is a growing body of dual-task research in PLLA that has been published in recent years,[11] with a variety of secondary tasks being used to successfully examine cognitive-motor capacity, such as serial subtractions by sevens,[37] the Stroop test,[38] listing items and spelling[37] and motor tasks (e.g., carrying a tray with cups[39]). The addition of a secondary task serves to increase cognitive challenge, but if too difficult it can result in people stumbling or stopping walking altogether. Moreover, different secondary tasks may be necessary if vision, hearing or cognitive function are impaired, or if other barriers exist (e.g., language). Healthcare professionals working with PLLA who have reduced cognitive function may elect to assess dual-task performance using the L Test. Dual-task training could be a treatment in instances where dual-task performance is low. Only one study has examined the effect of dual-task training on mobility in people with unilateral transfemoral amputations.[40] Individuals who underwent dual-task training over a 4-week period were shown to have a greater magnitude of improvements in functional mobility and static and dynamic balance than those who received single-task training.[40] Research examining the longitudinal relationship between dual-task testing and important outcomes such as falls, or specific protocols for dual-task training, do not currently exist for PLLA.

As demonstrated through our work, reduced global cognitive status, or low processing speed or executive function performance, should not deter the use of the FSST as an assessment of dynamic balance. On the other hand, low global cognitive status or executive dysfunction were independently associated with worse L Test performance and slower gait velocity in both single-task and dual-task; thus, these tests of physical function may be preferred for clinicians trying to understand how reduced cognitive functions may be affecting functional mobility and gait. Of course, a caveat remains that cognitive impairment was present in 41% of our sample, which is lower than what is typically reported (52-56%)[12,13] and indicates that our results are likely a conservative estimate of the strength of associations. Future research for the creation of a framework for the progressive increase in complexity within tests of physical function, including dual-task conditions, would be valuable to help minimize instances of under- or over-challenging individuals; thus, optimizing the falls risk-related information that can be gathered from testing.

There are several limitations that should be mentioned. The results of the present study are not generalizable to all PLLA as we included only those with unilateral transtibial amputations who were able to complete all the physical function testing. Moreover, we excluded people who presented with non-amputation related medical issues affecting gait, such as Parkinson's disease, which further limits applicability. A strength to our study was the testing of not only global cognition, but also of processing speed and executive function and that we included the more well-known tests of physical function which varied in complexity[6]

CONCLUSIONS

The present study is the first to report that better global cognitive status and executive function were independently associated with improved performance on gait velocity and the L Test for both conditions of single-task and dual-task in people who recently learned to walk using a prosthesis. Importantly, no association was observed between cognitive function and the FSST, or between processing speed and balance confidence and any of the tests evaluated. Future research should seek to develop a framework that outlines a gradation of complexity among clinical tests of physical function to minimize instances of under- or over-challenging PLLA.

CONFLICT OF INTEREST STATEMENT

The authors have no conflict of interest to report.

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Table 1: Sociodemographic and clinical characteristics of a sample of people with unilateral transtibial level amputations discharged from inpatient prosthetic rehabilitation. (n=22)

Variable	Mean ± SD, Median [25th, 75th percentiles] or n (%)
Age (years)	62.3 ± 8.9
Sex, n (% male)	15 (68.18)
Body Mass Index (kg/m^2)	28.43 ± 6.72
Years of Education (years)	12.77 ± 2.72
Etiology of Amputation, n (%)	
Diabetes Mellitus	15 (68.18)
Peripheral Vascular Disease	3 (13.64)
Other (cancer, congenital, etc.)	4 (18.18)
Time Since Amputation (days)	108.5 [88.5, 159.3]
12-Month Falls History, n (% yes)	18 (81.82)
Number of Prescription Medications	8.96 ± 4.53
Number of Comorbidities	4.0 [2.0, 5.0]
Summary of Comorbidities, n (% yes)	
Diabetes Mellitus	17 (77.3)
Hypertension	14 (63.6)
Dyslipidemia	9 (40.9)
Osteoarthritis	7 (31.8)
Other	17 (77.3)

Table 2: Values for cognitive function, balance confidence, dynamic balance, functional mobility and gait velocity in a sample of people with unilateral transtibial amputations. (n=22)

Outcome	Median [25^{th}, 75^{th} percentiles]
Montreal Cognitive Assessment Score	27.00 [24.00, 29.00]
Trail Making Test Part A	40.56 [27.83, 57.02]
Trail Making Test Part B	95.87 [78.70, 124.92]
Activities-specifics Balance Confidence Scale (%)	75.94 [63.13, 81.25]
Four Square Step Test (s)	26.64 [20.76, 42.17]
L Test of Functional Mobility, single-task (s)	45.07 [33.02, 57.03]
L Test of Functional Mobility, dual-task (s)	56.62 [36.09, 72.43]
Gait velocity, single-task (cm/s)	57.75 [47.93, 75.90]
Gait velocity, dual-task (cm/s)	49.00 [41.65, 67.68]

Table 3: Multivariable linear regression modeling for the association of the Montreal Cognitive Assessment, Trail Making Test and Activities-specifics Balance Confidence Scale on Gait Velocity. (n=22)

Cognitive test	Unadjusted unstandardized β (95% CI)	p-value	Adj R^2	Adjusted unstandardized β (95% CI)*	p-value	Adj R^2
Outcome: Gait Velocity (Single-task)						
Montreal Cognitive Assessment Score	**4.79 (2.58, 7.00)**	**<0.001**	0.48	**5.45 (2.35, 8.54)**	**0.002**	0.46
Trail Making Test Part A	**-0.40 (-0.76, -0.04)**	**0.030**	0.18	-0.29 (-0.78, 0.20)	0.230	0.10
Trail Making Test Part B	**-0.21 (-0.35, -0.07)**	**0.005**	0.29	-0.20 (-0.44, 0.03)	0.080	0.18
Activities-specific Balance Confidence Scale	0.74 (-0.01, 1.49)	0.050	0.13	0.63 (-0.25, 1.50)	0.150	0.03
Outcome: Gait Velocity (Dual-task)						
Montreal Cognitive Assessment Score	**3.56 (0.95, 6.18)**	**0.010**	0.25	**5.04 (1.33, 8.75)**	**0.010**	0.20
Trail Making Test Part A	-0.17 (-0.56, 0.22)	0.380	0.00	-0.13 (-0.68, 0.43)	0.640	0.00
Trail Making Test Part B	-0.13 (-0.28, 0.03)	0.110	0.08	-0.21 (-0.46, 0.05)	0.100	0.00
Activities-specific Balance Confidence Scale	0.52 (-0.25, 1.30)	0.180	0.05	0.36 (-0.52, 1.23)	0.400	0.01

Footnote: CI: confidence interval. *, regression modeling adjusted for age (continuous), etiology (binary: non-vascular, vascular) and number for comorbidities (continuous) for the Montreal Cognitive Assessment and Trail Making Tests, while for the Activities-specifics Balance Confidence Scale, sex (binary: male, female) was used instead of age. Statistical significance was $p < 0.05$.

Table 4: Multivariable linear regression modeling for the association of the Montreal Cognitive Assessment, Trail Making Test and Activities-specifics Balance Confidence Scale on the L Test of Functional Mobility. (n=22)

Cognitive test	Unadjusted unstandardized β (95% CI)	p-value	Adj R^2	Adjusted unstandardized β (95% CI)*	p-value	Adj R^2
Outcome: L Test of Functional Mobility (Single-task)						
Montreal Cognitive Assessment Score	**-3.79 (-5.55, -2.03)**	**<0.001**	0.48	**-4.75 (-7.22, -2.28)**	**0.001**	0.45
Trail Making Test Part A	0.22 (-0.09, 0.52)	0.155	0.05	0.13 (-0.30, 0.55)	0.540	0.00
Trail Making Test Part B	**0.17 (0.06, 0.28)**	**0.005**	0.30	**0.21 (0.03, 0.39)**	**0.030**	0.20
Activities-specific Balance Confidence Scale	-0.46 (-1.08, 0.16)	0.140	0.06	-0.24 (-0.91, 0.43)	0.460	0.10
Outcome: L Test of Functional Mobility (Dual-task)						
Montreal Cognitive Assessment Score	**-4.80 (-7.21, -2.40)**	**<0.001**	0.44	**-5.27 (-8.74, -1.80)**	**0.005**	0.38
Trail Making Test Part A	0.30 (-0.10, 0.70)	0.130	0.07	0.14 (-0.39, 0.68)	0.590	0.02
Trail Making Test Part B	**0.24 (0.10, 0.38)**	**0.002**	0.37	**0.29 (0.06, 0.51)**	**0.020**	0.30
Activities-specific Balance Confidence Scale	-0.48 (-1.31, 0.36)	0.250	0.02	-0.22 (-1.14, 0.71)	0.630	0.01

Footnote: CI: confidence interval. *, regression modeling adjusted for age (continuous), etiology (binary: non-vascular, vascular) and number for comorbidities (continuous) for the Montreal Cognitive Assessment and Trail Making Tests, while for the Activities-specifics Balance Confidence Scale, sex (binary: male, female) was used instead of age. Statistical significance was $p < 0.05$.

Table 5: Multivariable linear regression modeling for the association of the Montreal Cognitive Assessment, Trail Making Test and Activities-specifics Balance Confidence Scale on the Four Square Step Test. (n=22)

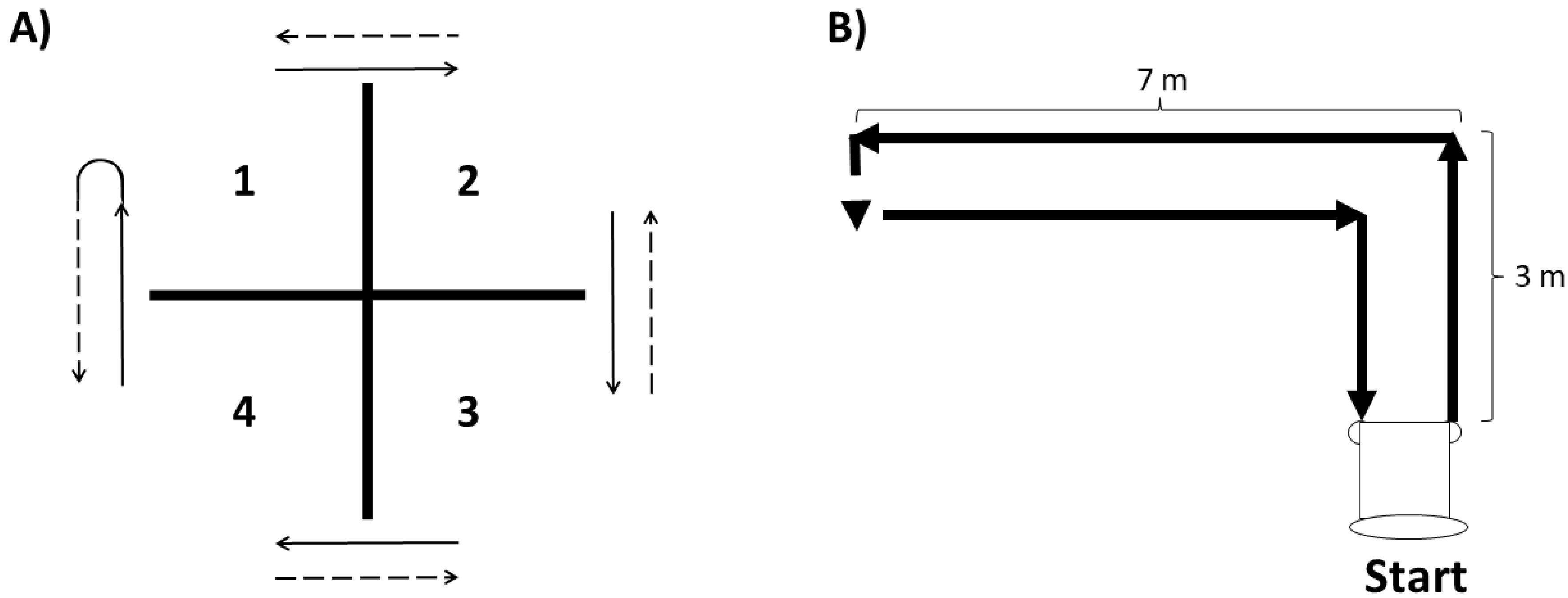
Cognitive test	**Unadjusted unstandardized β (95% CI)**	**p-value**	**Adj R^2**	**Adjusted unstandardized β (95% CI)***	**p-value**	**Adj R^2**
Outcome: Four Square Step Test						
Montreal Cognitive Assessment Score	**-3.19 (-5.14, -1.25)**	**0.003**	0.34	-2.07 (-4.78, 0.64)	0.130	0.31
Trail Making Test Part A	**0.42 (0.17, 0.67)**	**0.002**	0.35	0.30 (-0.03, 0.62)	0.070	0.35
Trail Making Test Part B	**0.17 (0.06, 0.28)**	**0.003**	0.33	0.11 (-0.06, 0.28)	0.190	0.29
Activities-specific Balance Confidence Scale	-0.13 (-0.77, 0.51)	0.680	0.00	-0.05 (-0.80, 0.69)	0.890	0.00

Footnote: CI: confidence interval. *, regression modeling adjusted for age (continuous), etiology (binary: non-vascular, vascular) and number for comorbidities (continuous) for the Montreal Cognitive Assessment and Trail Making Tests, while for the Activities-specifics Balance Confidence Scale, sex (binary: male, female) was used instead of age. Statistical significance was $p < 0.05$.

FIGURE LEGENDS

Figure 1: Illustration of the A) Four Square Step Test (FSST) and B) L Test of Functional Mobility (L Test).

Figure 1.



Footnote: For the Four Square Step Test, participants started in square #1 facing square #2. Upon being cued, participants stepped as fast as possible from Square #1 to #2, #3, #4, #1 and then back to #4, #3, #2, and #1. Participants were encouraged to always be facing forwards while completing the Four Square Step Test. For the L Test of Functional Mobility (B), participants started seated on an armless chair, and when prompted, stood up, walked forward three meters, turned 90°, walked seven meters straight, turned 180°, and then followed the same L-shaped path back to their initial position.