

Relationship between Executive Function and Dual Task Physical Performance among Older Adults-A Cross Sectional Study

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Abstract

Background: Older adults with both physical and cognitive impairment are at higher risk for dementia, fall and disability. So, identifying whether physical performance decline is associated with executive dysfunction is important for developing physical therapy early intervention strategies for older adults.

Purpose: (1) To examine the relationship between executive functions and dual-task physical performances among older adults, (2) To confirm executive function as a useful predictor for functional limitation or disability process in older adults.

Methodology: To measure physical performance, first, reference gait speed on 10 m path was measured. Secondly, dual task gait speed was calculated from 20 m rectangular path with obstruction and picking up an object from it while walking at their comfortable pace. Participants had to cross the obstacles simultaneously picking the ball from bucket. The time to finish the task was measured and from that gait speed during dual task was calculated. The TMT-B test was used to evaluate the components of executive function. To complete this test, participant was asked to use a pencil to connect 25 encircled numbers and letters in numerical and alphabetical order, alternating between numbers and letters. Time to finish this test was recorded.

Results: After analyzing data, for dual task gait speed and TMT-B, we got the value of Spearman's correlation coefficient(r) is 0.698 and level of significance ($p < 0.05$). For reference gait speed and TMT-B, we got the value of Spearman's correlation coefficient(r) is 0.600 and level of significance ($p < 0.05$)

Conclusion: This points out that there is statistically significant correlation between executive function and dual-task physical performance among older adults.

Keywords: Executive function; Dual-task physical performance; Older adults

Introduction

An important goal of geriatric medicine is to reduce the gap between overall life expectancy and disability-free life expectancy. Two major geriatric problems contribute to this gap: cognitive impairment and gait impairment. Gait and cognitive impairment are prominent independent risk factors for falls. Falls are a common geriatric syndrome affecting about a third of older adults each year. A better understanding of the relationship between cognitive impairments and gait impairments may help clinicians and researchers to develop interventions and institute preventive measures to delay the transition to falls and dementia and promote disability-free life expectancy [1]. Studies on cognitive function and gait now include many areas of research, ranging from physiology and biomechanics to brain mapping, physics and neuropsychology [2].

Falls have been a pressing issue in our society. It leads to physical and psychological trauma. It is one of the leading causes of death due to unintentional injuries among older adults [3]. Falls are a major

cause of morbidity among older adults, especially for those with cognitive problems [4]. A key cognitive factor in gait and balance control seems to be executive functioning [5]. The consequences of falls in the population of demented older adults are very serious; fallers with cognitive problems are approximately five times more likely to be admitted to institutional care than people with cognitive issues who do not fall [6]. They are also at high risk of major fall-related injuries such as fractures and head injuries that increase mortality risk. In addition to indirect costs and caregiver burden, the direct costs of emergency, acute, rehabilitation and long-term care are substantial and increasingly unsustainable for the healthcare system [1].

Recurrent falls are more likely to be caused by intrinsic factors (e.g., vision) instead of extrinsic factors (e.g., environmental hazards). Second, recurrent falls are more predictable than single falls because of their stronger relationships with risk factors. Previous studies have shown that identifying risk factors of falling followed by proper interventions can successfully reduce the incidence of falling. It is, therefore, important to understand the risk factors for falling in order to promote falls prevention and improve public health [3].

The incidence of functional limitations and disability increases with age and chronic disease; over 34% of adults aged 65 or older, report

limitations with even the most basic activities of daily living (ADLs), such as bathing and dressing. Such decrements, coupled with the risk of decline in cognitive function as well age, can result in loss of independence and compromised quality of life. Although cognitive and functional declines typically manifest during the normal aging process and appear to be interrelated, a growing body of literature suggests that poor cognitive performance may be a precursor to functional limitations that lead to disability [7]. Research on the impact of cognitive status on functional limitations will help us to better understand the role cognitive function may play in the early stages of the disabling process. This would give weight to the assessment of cognitive function as a vital part of geriatric preventive measures to delay the onset of disability [8,9].

Methodology

This study is approved by Parul University Institutional Ethics Committee for Human Research. We performed a cross sectional correlation study in our community living older adults. We recruited 100 participants who fulfilling the inclusion and exclusion criteria from the "Vadil Visamo"-The Senior Citizen Association, Waghodia road, Vadodara, India by convenient sampling method.

Inclusion criteria: Age group: 65-75 year, Gender: Male and Female both, MMSE: \geq 24, Lower extremity muscle power \geq 4, Lower extremity (hip flexion-extension and ankle dorsiflexion-plantar flexion) range of motion should be in functional range [10].

Exclusion criteria: Participant unable to walk independently without an assistive device, Participant having neurological problems, poor mental function, any musculoskeletal problems, impaired vision. Participant had an uncontrolled chronic medical condition [10].

Tools and materials: MMSE chart, TMT test B paper, Data collection Sheet, Participant information sheet, Participant consent form, Weight caliper, Measure tape, Stop-watch, Four obstacles, Two Baskets, Different color balls (Pink, Green, and Yellow)-12 pieces, Pencil.

Procedure

An Informed consent had been taken from all the subjects to participate in the study.

General demographic data like name, age, gender, address and Baseline data like height, weight, and education were recorded from each selected subjects.

Firstly Reference gait speed on 10 m path was measured than; Dual task physical performance was measured via gait speed on 20 m rectangular path. Secondly Executive function was measured with the TMT- B test.



Figure 1: Measuring of dual task physical performance over 20 m rectangular path with obstruction and picking up object from the floor.

Executive function measures



Figure 2: Measuring of executive function by the Trail making test (TMT-B).

Dual task physical performance measures

Dual task gait speed was calculated from 20 m rectangular path with obstruction and picking up an object from it while walking at their comfortable pace. Obstructions were four and objects for picking up task were balls which kept in basket beside the path. Participant would have to cross the obstacles simultaneously picking the ball from basket. The time to finish the task was measured and from that gait speed during dual task was calculated (Figure 1) (11).

The TMT-B was used to evaluate the components of executive function like cognitive abilities of sequencing, visual scanning, processing speed, shifting attention and cognitive flexibility [12-14]. To complete this test, participant was asked to use a pencil to connect 25 encircled numbers and letters in numerical and alphabetical order, alternating between numbers and letters [15]. The maximum amount of time allowed to complete the TMT-B is 300 seconds; longer times indicate worse performance in executive function (Figure 2).

Results

Data are analyzed in software SPSS 21 version. After analyzing data, for Reference gait speed and TMT-B, we got the value of Spearman's correlation coefficient(*r*) is 0.600 and level of significance (*p*<0.05) which indicate that there is significant correlation between TMT-B and reference gait speed.

After analyzing data of dual task gait speed and TMT-B, we got the value of Spearman's correlation coefficient(*r*) is 0.698 and level of significance (*p*<0.05) which indicate that there is significant correlation between TMT-B and dual task gait speed.

In this study of older adults we selected total 100 subjects who fulfilled all inclusion criteria and had MMSE score greater than or equal to 24. Our sample has 53 male and 47 female subjects. Mean age of sample is 68.77(3.74). Each subject's height and weight are recorded. According to these data mean BMI of sample is 26.33(4.7). Among whole sample 2 subjects are underweight, 41 subjects are in normal range, 41 subjects are overweight and 16 subjects are in obese category (Table 1).

Variables	Mean (SD) Total n (%)	Range
Age (year)	68.77(3.74)	65-75
Subjects (N)	100	
Male	53	
Female	47	
Height (cm)	157.35(9.50)	138-185
Weight (kg)	65.03(11.76)	40.5-97.5
BMI (kg/m ²)	26.33(4.7)	17.80-38.75
Under weight	2%	<18.5
Normal	41%	18.5-24.9
Overweight	41%	25-29.9
Obesity Class 1	8%	30-34.9
Obesity Class 2	8%	35-39.9
Obesity Class 3	0%	>=40
Education		
<High school	25%	
High school	43%	
Graduate	31%	
Postgraduate	1%	
Physical Performance		
Reference gait speed (m/s)	1.08(0.16)	0.75-1.85
Dual Task gait speed (m/s)	1.27(0.22)	0.85-2.15
Executive Function		
	139.6(48.29)	54-258
	9%	0-75
TMT- B Score (sec)	53%	76-150
	33%	151-225
	5%	226-273

	0%	>273
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Table 1: Participant demographics.

Variable	Spearman Correlation Coefficient (r)	p value
Reference gait speed	0.6	0
Dual Task gait speed	0.698	0
% decline in gait speed from reference to dual task	0.548	0

Table 2: Correlation of various variables with TMT-B score.

[**Note:** Correlation is significant at p value less than 0.05. So the correlation between two variables is statistically significant]

Reference gait speed: Positive value of r suggests that the reference gait speed is positively correlated with TMT-B. The value of 0.600 shows moderate to good linear relationship and it is statistically significant.

Dual task gait speed: Positive value of r suggests that the dual task gait speed is positively correlated with TMT-B. The value of 0.698 shows moderate to good linear relationship and it is statistically significant.

% decline in gait speed from reference to dual task: Positive value of r suggests that the % decline in gait speed is positively correlated with TMT-B. The value of 0.548 shows moderate to good linear relationship and it is statistically significant.

Discussion

Current study was an attempt to correlate the executive function with dual-task physical performance among older adults. Many studies have identified the relationship of cognitive function and motor performance in older adults. Although it is well known that several cognitive processes are associated with walking speed and risk of falls.

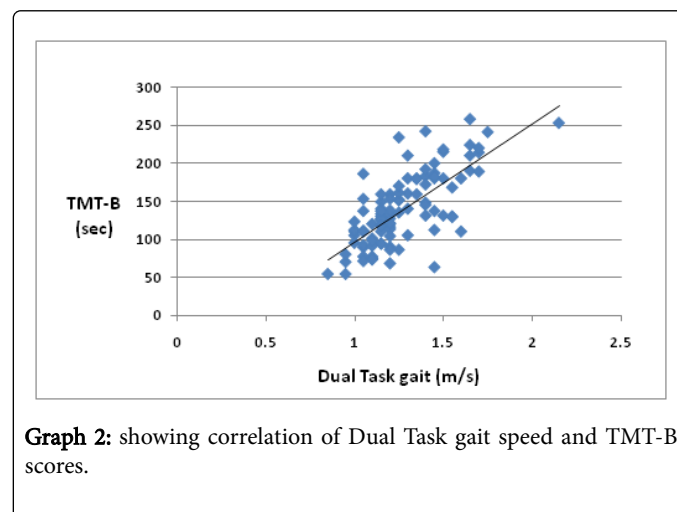
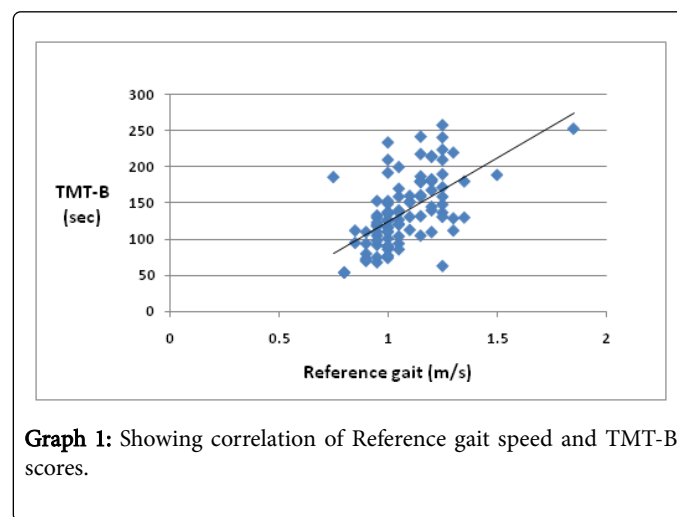
A systematic review and meta-analysis of 27 prospective cohort studies with at least one year of follow-up among healthy community-dwelling older adults found that executive dysfunction, a subtle cognitive deficit, was associated with an increased risk for any fall and falls associated with serious injury [16-18]. Similarly, early mobility decline, assessed as slowing of gait, has been found to co-exist or even precede the onset of clinically demonstrable cognitive decline in older adults [19]. This slowing of gait may have its onset up to 12 years before the clinical presentation of cognitive changes in older adults who later convert to mild cognitive impairment syndrome (MCI). This intriguing and provocative time course suggests that we may be able to augment the prediction of cognitive decline based on a simple and objective gait evaluation in the future [1].

Kelly et al. said in their study that physical performance is particularly challenged when older adults are asked to concurrently perform a cognitive task, suggesting that allocation of attention is necessary in older adults with and without cognitive impairment [21,22] (Graphs 1 and 2).

Hashimoto R et al. (2006) tried to investigate the effect of age and education on the TMT in 155 healthy elderly adults with clinical dementia rating 0 (healthy) [16]. They suggested in their study that the

In this study education of subject was recorded as a baseline data. Among whole sample, 25 subjects studied under high school level, 43 subjects studied up to high school level, 31 subjects were graduate and 1 subject studied up to post graduate level (Table 2).

time to complete TMT-B is affected by educational level. They said that TMT scores are not affected by aging until the subjects are >or=85 years old. In our study older adult subjects are within 65-75 years range which is less than 85.



Among these majority of subjects can perform TMT- B test without any memory problem regarding English alphabetical order. We marked that those who studied less than high school level and not good in English alphabetical order required some hint in TMT-B test.

In this study average reference gait speed of sample is 1.08(0.16) meter per second. For that we instructed subject to walk on simple 10 meter path from starting point to end point and again come back at starting point. For dual task model we painted 8 m long and 2 m wide rectangular path on floor, than kept four obstacles inside the path. Besides rectangular path we put two baskets with different color balls inside it. Once we demonstrate subject how to perform dual task, than ask them to perform like walk on rectangular path, clear the obstacles simultaneously bring the color balls from each basket. To negotiate learning error we not gave any trial to subject for dual task performance.

In this study average dual task gait speed is 1.27(0.22) m/s. We calculated difference between dual task gait speed and reference gait speed. From this value we calculated how many percentage of gait speed decrease during dual task gait speed. We correlate percentage decrease in gait speed with TMT-B scores. The value of correlation coefficient is 0.548 which shows moderate to good linear relationship and it is statistically significant.

Complex walking tasks measure the ability to walk in diverse and challenging environments and may provide a better indication of the ability to function in daily life than simple standardized gait speed measurement [11]. Thus, the findings of this study suggest that executive function significantly affects older adults' ability to appropriately adapt to environmental challenges and that this effect varies by the complexity of the task. These results highlight the importance of cognitive flexibility and psychomotor speed for the physical performance of complex dual tasks.

Conclusions

After analyzing the results we can see that there is statistically significant correlation between TMT-B score and dual-task gait speed. This points out that there is relationship between executive function and dual-task physical performance among older adult.

This study provides useful information that we can take executive dysfunction as a useful predictor for functional limitation or disability in older adult population.

We can take preventive measures for incidence of fall among older people with poor executive function.

Limitations

Our study is cross sectional and therefore we cannot establish a causal association between executive function impairment and its effect on limitation in dual task physical performance.

Limitations of this study include the lack of control over variables like education, gender. As we used TMT-B test for assessing executive function, which is significantly affected by level of education. In our study sample size and mean age of older adults are less as compare to previous study.

Suggestions

In our study we assessed executive function solely with the TMT-B. Although this is a widely used test, there are other measures of executive control that in conjunction with the TMT-B would have provided a more comprehensive evaluation of executive functions.

Further studies should be performed using more number of complex dual tasks for assessing physical performance. It can be conducted in old older age group and with big sample size.

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