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ARTICLE

Age and education influence the performance of elderly women on the dual-task Timed Up and Go test

Idade e educação influenciam o desempenho de mulheres idosas no teste *Timed Up and Go* com dupla tarefa

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ABSTRACT

Gait variability is related to functional decline in the elderly. The dual-task Timed Up and Go Test (TUG-DT) reflects the performance in daily activities. **Objective:** To evaluate the differences in time to perform the TUG with and without DT in elderly women with different ages and levels of education and physical activity. **Method:** Ninety-two elderly women perfomed the TUG at usual and fast speeds, with and without motor and cognitive DT. **Results:** Increases in the time to perform the TUG-DT were observed at older ages and lower educational levels, but not at different levels of physical activity. More educated women performed the test faster with and without DT at both speeds. When age was considered, significant differences were found only for the TUG-DT at both speeds. **Conclusion:** Younger women with higher education levels demonstrated better performances on the TUG-DT.

Keywords: elderly, gait, Timed Up and Go, dual task.

RESUMO

Alterações da marcha são indícios de declínio funcional em idosos. O TUG com dupla tarefa (TUG-DT) reflete o desempenho das atividades do cotidiano. **Objetivo:** Avaliar as diferenças no tempo de execução do TUG com e sem DT em idosas com diferentes faixas etárias, e níveis de escolaridade e atividade física. **Método:** Noventa e duas idosas foram avaliadas pelo TUG nas velocidades usual e máxima, sem e com DT cognitiva e motora. **Resultados:** Houve aumento no tempo de execução do TUG-DT em idosas com maior faixa etária e menor escolaridade, mas não para diferentes níveis de atividade física. Aquelas com maior escolaridade realizaram o teste mais rápido com e sem DT nas duas velocidades. Com relação à faixa etária, foram obervadas diferenças apenas nos testes com DT nas duas velocidades. **Conclusão:** Idosas mais jovens com maior escolaridade demonstraram um melhor desempenho no TUG com DT.

Palavras-chave: idosos, marcha, teste *Timed Up and Go*, dupla tarefa.

The aging rate has been growing rapidly worldwide in the last decades, and this has exerted strong influences on the dynamics of the society development[1], with increases in chronic and degenerative diseases, higher dependency indices, and high rates of institutionalization and hospitalization[1].

Functional capacity (FC) refers to the competence of the individuals to preserve their physical and mental abilities necessary for an independent life. FC is an important marker of healthy, independent, and successful aging and has a positive impact on quality of life, especially regarding motor abilities[2]. Changes in gait patterns and speeds are related to difficulties in performing everyday activities, and indicate functional declines and hospitalization in individuals above 75 years of age[3,4].

Several studies have shown increased activation and inter-relations of brain structures related to cognition and

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motor function during gait[5,6]. In daily activities, people usually need to perform simultaneous tasks, such as walking and communicating with another person, and carrying objects. These tasks require adequate balance, coordination, attention, and reasoning; thus, greater interactions between the motor and cognitive systems[6].

The dual-task (DT) paradigm, created to study these inter-relations between the motor and cognitive systems is determined by a primary task, such as gait associated with cognitive or motor secondary tasks[6]. When both tasks are simultaneously executed, one may hinder the performance of the other or the performance of both may be affected[7]. Most falls occur when elderly individuals perform cognitive or motor tasks associated with gait during daily activities[5,7]. There is evidence that DT changes motor patterns[3,7,8] and that gait should no longer be considered a mere motor activity for the elderly, as it is for young adults[9].

Elderly without neurological impairments may also exhibit gait instabilities of unknown causes, which would be risk factors for falls[9,10]. This shows the importance of studies regarding DT activities and how they change motor development patterns, especially in the elderly, who already exhibit physiological declines[3,7,8].

Gait assessment may help define health promotion strategies aimed at delaying or preventing disabilities[7,8]. Clinical functional tests have been used to map the elderly who are at risk of falling. Balance evaluation should consider the performance of simultaneous tasks, usually associated with secondary tasks, which can be cognitive, motor, or motor-cognitive[3,7,8].

The DT Timed Up and Go Test (TUG-DT) is simple and very useful test within clinical settings[11,12]. To perform the TUG, the individuals are asked to stand from a chair, walk three meters, turn, walk back, and sit down. It assesses the major components of functionality, such as mobility, balance, and agility, and quantifies the performance based upon the time spent to perform the test[12]. When the test is performed under 20 seconds, the individuals are considered functionally independent and, therefore, have lower risks of falls[12].

A meta-analysis of 21 studies established reference values for the time to perform the TUG[13], according to age groups. Ages between 60 to 69, 70 to 79, and 80 to 99 had average TUG time values of 8.1, 9.2, and 11.3 seconds, respectively[13]. No studies were found which established reference values nor that investigated the influences of age, gender, DT types, for the TUG-DT[14].

The TUG associated with cognitive or motor DT has proven to be a valid test to evaluate gait disorders in the elderly[14,15,16]. Studies have shown changes in speed, step length, cadence, double support time, when executing and performing the primary or secondary task as adaptive strategies occurring during gait[7,8].

The TUG enables assessment of changes in execution time, so that a longer time implies a greater impairment of overall motor skills and, consequently, higher risks of falls[13]. Studenski reported declines in gait speed as major clinical signs in the elderly[4]. Normal gait speed of young adults are on average over 1 m/s and healthy elderly are expected to have similar values[4,6,15].

Shumway-Cook et al. evaluated the TUG time with community-dwelling elderly and proposed a cut-off value ≥ 13.5 seconds for risk of falls, with a 90% positive predictive value[15]. Hofheinz and Schusterschitz found cut-off values of ≥ 15 and ≥ 14.5 seconds for the cognitive and manual TUG-DT, with positive predictive values of 87% and 90%, respectively[16]. A series of secondary motor and cognitive tasks of varying complexity have been used for the evaluation of the elderly. Commonly used motor tasks include carrying a tray with three glasses of water, transferring coins from one pocket to another[15,16], and carrying a glass of water[17,18]. Commonly cognitive tasks include repeating sentences[19], days of the week in reverse order[19], forming words and sentences[12], counting down from every 3 or 7 numbers, adding 2 by 2[20], naming fruits, colors, or words with a predetermined letter[17,19], and responding to auditory stimuli by distinguishing high and low tones[3].

Several studies reported decreased performance of the primary, secondary, or both tasks in elderly individuals, when performing the TUG-DT[16,17,18]. Some peculiarities of the studied samples have been evaluated and gender has received greater attention. The TUG time was expected to be higher for women, but studies have not supported this pattern[16,20,21]. In turn, characteristics, such as high education levels and cognitive functioning may positively influence the TUG-DT performance, since higher cognitive reserve is observed with higher education[5,10,22]. It is also known that physical activity levels influence cognitive function; thus, people with higher levels of physical activity may perform DT activities with greater skills and speed[22]. However, there were not found any studies which evaluated the influences of age, and levels of education and physical activity on the performance of the TUG-DT. Therefore, this study aimed to investigate the influences of age, education, and physical activity on the performance of the TUG with and without motor and cognitive DT at both usual and fast speeds with community-elderly women.

METHOD

Design

For this cross-sectional study, all participants provided consent based upon approval from the research ethical review board of the *Universidade Federal de Minas Gerais*, in Belo Horizonte, Brazil.

Participants

Elderly women were recruited from the general community, according to the following criteria: age between 69 and 79 years, educational level above three years, and absence of cognitive deficits, as determined by the education-adjusted cut-off scores on the Mini-Mental State Examination (MMSE)[23,24]. Those who had osteomusculoskeletal disorders that could prevent the test performances, were taking medications that could interfere with motor or memory performances, and had degenerative neurological diseases, were excluded.

Measures

Initially, sociodemographics, such as age, schooling and clinical data (health conditions, physical activity levels and histories of falls over the last six months) were collected by interviews. The participants were grouped according to their physical activity levels into sedentary (did not practice any exercise) and active (performed at least two hours of exercise per week). Education was recorded as the number of years attended in formal school. The Fall Efficacy Scale (FES-I) was used to evaluate the subjective perceptions of fear of falling. This scale has shown excellent psychometric properties, correlates well with balance and gait measures, and predicts future falls and functional decline[25]. The FES-I scores range from 16 to 64; score of 64 means extremely concerned and 16, lack of concern. The cut-off score < 22 indicates low concern and > 22, high concern[26].

TUG Performance

For the TUG assessment, a digital stopwatch, and a 43-cm high armless chair, were used. A 3-meter distance was delimited on the ground, and a cone was placed at the end of this path, so that the participants could turn around it. Three attempts without DT and two with cognitive and motor DT were obtained at both usual and maximum speeds and the mean values were recorded for analyses. The test conditions were randomized. For the cognitive DT, the participants were instructed to count backwards from 90, subtracting 6, successively, whereas for the motor DT, they held a tray with both hands, keeping their elbows at 90 degrees and a tennis ball at the tray center, and were instructed not to drop the ball.

The DT cost (DTC) was also used as a measure of the percentage at which the second task interfered on the test performance and was calculated using the following equation: DTC [%] = 100 * (simple task score - dual task score)/simple task score[27].

Analyzed variables

Three variables were analyzed: age, education, and physical activity levels. Two age groups were defined: 69 to 74 and 75 to 79 years. Regarding education, the participants were divided into two subgroups: 3-4 years and ≥ 8 years. They were also grouped as sedentary and active.

Statistical analysis

Descriptive statistics and tests for normality and homogeneity of variance were carried out using the SPSS software for Windows. Independent t-tests were employed to evaluate differences between the groups regarding their TUG performances with and without DT, considering age, education, and physical activity levels. For all analyses, the significance level was set at 5%.

RESULTS

Participants' characteristics

The sociodemographic and clinical data of the 92 participants are shown in Table 1. Most of the participants were sedentary and had more than eight years of education. The groups were similar regarding the other clinical variables, except for number of falls, since the youngest group reported more events ($p = 0.03$).

TUG with and without DT, according to age

Table 2 depicts the descriptive data and the results of the comparisons between the two age groups regarding the time taken to perform the tests. No differences were found for all tests without DT ($1.44 < t < 1.61$; $0.11 < p < 0.16$). However, between-group differences were observed for all TUG-DT ($3.38 < t < 4.23$; $0.0001 < p < 0.001$), except for the motor DT at fast speeds ($t = 1.95$; $p = 0.051$), which almost reached statistical significance. These results indicated that the older group took longer time to perform the DT tests.

Table 3 gives the DTC as the percentage at which the second task interfered on the TUG performance[27]. The DTC of the dual task was higher for the 75-79 age group, especially regarding the cognitive DT.

TUG with and without DT, according to education

Table 4 shows the descriptive data and the results of the comparisons between the two education groups regarding the time to perform the tests. Significant between-group differences were found for all tests with and without DT ($2.01 < t < 4.23$; $0.0001 < p < 0.05$), demonstrating that women with higher education levels performed the tests faster.

TUG with and without DT, according to levels of physical activity

Table 5 displays the descriptive data and the results of the comparisons between the physical activity level groups regarding the time to perform the tests. No significant differences were found between the groups, regarding their TUG

Table 1. Descriptive data (means ± standard deviations (SD)) regarding the participants' sociodemographic and clinical characteristics, according to age and levels of education and physical activity.

Variable	Medication	Comorbidities	Number of falls	Fall efficacy scale
Age				
69-74 years (n = 63)	3.6 ± 2.0	1.9 ± 1.2	0.6 ± 1.1*	23.6 ± 5.9
75-79 years (n = 28)	3.5 ± 2.4	2.2 ± 1.1	0.2 ± 0.6	21.9 ± 4.0
Education				
3-4 years (n = 40)	3.3 ± 2.2	2.0 ± 1.2	0.4 ± 1.0	23.5 ± 4.8
> 8 years (n = 52)	3.8 ± 2.1	1.9 ± 1.2	0.5 ± 1.0	22.8 ± 5.9
Level of physical activity				
Sedentary (n = 54)	3.9 ± 2.1	2.1 ± 1.2	0.6 ± 1.2	24.1 ± 5.9
Active (n = 38)	3.1 ± 2.1	1.7 ± 1.2	0.4 ± 0.6	21.7 ± 4.4

*p = 0.03.

performances with and without DT ($0.02 < t < 0.71$; $0.48 < p < 0.99$), demonstrating that sedentary and active elderly women showed similar performances.

DISCUSSION

The findings of the present study indicated that younger women with high education levels demonstrated better TUG performances. The sociodemographic and clinical characteristics were similar between the two groups for most of the studied variables, except for the number of falls over the last six months. The younger group reported more falls, but the mean value was still low (< 1) for both groups. The sample had comorbidity and medication indices similar to those obtained for the general population of similar age[1,2]. The participants also showed good FES-I levels, indicating risks of sporadic falls, which were consistent with low risk of falls and comorbidity rates[26].

Younger women were able to perform both the TUG with cognitive and motor DT faster than the older ones. Thus, age appeared to influence the performance of the TUG-DT. It is possible that TUG without DT may be too simple for detecting changes within small age variations. However, the differences appeared with the DT tests. It is important to note that the older group exercised regularly and had a very active social lifestyle. This factor may have contributed for these findings.

Education influenced the TUG performances with and without TD. This was an interesting finding, especially since there were no statistical differences between the age groups regarding the TUG without DT. Significant differences in TUG performance without DT according to educational level were not expected, since the test itself is very simple. As expected, during the TUG-DT, differences in performance related to education also emerged. Therefore, higher education was related to a reduction in time to perform the TUG with and without DT.

Active and sedentary elderly women performed the TUG with and without DT similarly, which was not expected. This fact can be explained by the easiness of the test and its short distance. Elderly women, who are willing to engage into physical activity programs within the community, as it was the case for the participants in this study, are usually independent, very socially active, and sustain satisfactory levels of physical functioning. Therefore, the time they took to perform the TUG with and without DT may be an inadequate measure for assessing people with different physical activity levels.

No differences were found between the two age subgroups in the time to perform the usual TUG. In a meta-analysis, Bohannon found an average time of

Table 2. Descriptive data (means ± standard deviations (SD)) of the time, in seconds, to perform the Timed Up and Go Test with and without dual-tasks, at usual and fast speeds, and results of the comparisons between the age groups: 69-74 years (n = 64) and 75-79 years (n = 28).

Timed Up and Go test	Age group (years)	Mean ± SD	t; p-value
Without dual-task, usual speed	69-74	10.44 ± 1.5	1.47; 0.15
	75-79	10.93 ± 1.5	
Without dual-task, fast speed	69-74	8.30 ± 1.0	1.61; 0.11
	75-79	8.70 ± 1.3	
Cognitive dual-task, usual speed	69-74	10.88 ± 2.4	3.00; 0.003
	75-79	12.51 ± 2.5	
Cognitive dual-task, fast speed	69-74	9.04 ± 1.5	3.98; < 0.0001
	75-79	10.56 ± 2.1	
Motor dual-task, usual speed	69-74	10.67 ± 1.6	3.16; 0.002
	75-79	11.90 ± 2.0	
Motor dual-task, fast speed	69-74	8.77 ± 1.2	1.95; 0.05
	75-79	9.34 ± 1.5	

Table 3. Means ± standard deviations (SD) of the dual-tasks cost and results of the comparisons between the age groups: 69-74 years (n = 64) and 75-79 years (n = 28).

Timed Up and Go	Age group (years)	Dual task cost (%)	t; p-value
Cognitive dual-task, usual speed	69-74	4.04 ± 16.1	2.78; 0.007
	75-79	14.73 ± 19.0	
Cognitive dual-task, fast speed	69-74	9.04 ± 12.6	2.60; 0.001
	75-79	22.61 ± 26.4	
Motor dual-task, usual speed	69-74	2.75 ± 13.0	2.22; 0.03
	75-79	9.01 ± 11.2	
Motor dual-task, fast speed	69-74	6.09 ± 10.9	0.66; 0.51
	75-79	7.72 ± 11.1	

9.2 seconds for 798 elderly aged 70 to 79 years, and these values were lower than those found in the present study[17]. However, he did not report the methodology employed in all of the evaluated studies[17]. Hofheinz and Schusterschitz evaluated 120 community-dwelling elderly aged from 60 to 87 years and reported an average time of 8.39 seconds for the TUG at usual speeds[16]. In the present study, the TUG was carried out with an armless chair and without the possibility of using the upper limbs to stand-up. In addition, the time count started after the participants' backs lost contact with the chair and stopped only after their backs touched the chair again. In contrast, many studies allowed the participants to use their upper limbs and started timing when the participants' buttocks lost contact with the seat, which could considerably influence their performances.

Beauchet et al. pointed out the need for standardizing the TUG regarding the chair type (with or without armrests) and height, usual (comfortable, day to day) and fast (as fast as possible) speeds, and when to start timing (when the buttocks or the back loses contact with the chair)[20]. For the TUG at fast speeds, the mean time was 8.4 seconds. We could not find any data in the literature for comparison.

For the purposes of making comparisons with the existing literature, the mean time at usual speed for the participants included in the present study was 11.3 seconds for the motor and 11.7 seconds for the cognitive DT. Hofheinz and Schusterschitz reported an average time of 11.5 seconds to perform the manual DT, which consisted of carrying a glass filled with water up to 1 cm from the edge, removing it from a 70-centimeter high table, walking, returning, putting the glass back on the table, and sitting back[16]. An average time of 9.8 seconds was obtained for the cognitive DT test consisting of successively subtracting 3 from the numbers 100, 90, 80, or 70[16]. Shumway-Cook et al. found an average time of 8.4 seconds to perform the cognitive countdown DT and 9.7 seconds to perform the manual TUG of carrying a glass with water[15]. The values found in the present study were higher than those previously reported, and this could probably be due to methodological differences.

The cognitive DTC concerning age group differences at usual speed (a successive countdown starting at 90-6) was 4% for the younger women and 14.7% for the older ones. On the other hand, the motor DTC (carrying a tray with a ball) was 2.7% for the younger and 9.0% for the older women. At maximum speeds, the cognitive DTC was 9.0% for the younger and 22.6% for the older women, and the motor DTC was 6.1% for the younger and 7.7% for the older women. These results suggest that the type of task strongly influenced the results.

In the study conducted by Shumway-Cook et al., the cost of the motor and cognitive DT was 13.4%, and this task consisted of carrying a glass of water and counting down by 3 numbers from 20 and 100, respectively. Values obtained for the TUG-DT indicated that when performing a secondary

Table 4. Time, in seconds, (means ± standard deviations (SD)) to perform the Timed Up and Go Test with and without dual-task, at usual and fast speeds, and results of the comparisons between the groups regarding their education levels: 3-4 years (n = 40) and ≥ 8 years (n = 52).

Timed Up and GO	Education (years)	Mean ± SD	t; p-value
Without dual-task, usual speed	3-4	11.15 ± 1.4	3.39; 0.001
	≥ 8	10.15 ± 1.5	
Without dual-task, fast speed	3-4	8.84 ± 1.0	3.38; 0.001
	≥ 8	8.10 ± 1.1	
Cognitive dual-task, usual speed	3-4	12.41 ± 2.6	3.69; < 0.0001
	≥ 8	10.58 ± 2.2	
Cognitive dual-task, fast speed	3-4	10.34 ± 1.8	4.23; < 0.0001
	≥ 8	8.86 ± 1.5	
Motor dual-task, usual speed	3-4	11.75 ± 1.86	3.46; < 0.001
	≥ 8	10.50 ± 1.58	
Motor dual-task, fast speed	3-4	9.24 ± 1.20	2.01; 0.048
	≥ 8	8.72 ± 1.31	

Table 5. Time, in seconds, (Means ± Standard deviations (SD)) to perform the Timed Up and Go Test with and without dual-tasks, at usual and fast speeds, and results of the comparisons between the physical activity level groups: sedentary (n = 54) and active (n = 38).

Timed Up and Go	Physical activity	Mean ± SD	t; p-value
Without dual-task, usual speed	Sedentary	10.63 ± 1.2	0.33; 0.75
	Active	10.53 ± 1.8	
Without dual-task, fast speed	Sedentary	8.47 ± 0.9	0.47; 0.64
	Active	8.36 ± 1.3	
Cognitive dual-task, usual speed	Sedentary	11.49 ± 2.5	0.38; 0.70
	Active	11.26 ± 2.5	
Cognitive dual-task, fast speed	Sedentary	9.50 ± 1.7	0.02; 0.99
	Active	9.51 ± 2.0	
Motor dual-task, usual speed	Sedentary	10.98 ± 1.6	0.42; 0.68
	Active	11.14 ± 2.1	
Motor dual-task, fast speed	Sedentary	8.87 ± 1.1	0.71; 0.48
	Active	9.06 ± 1.5	

motor or cognitive task during gait, community elderly women took more time to complete the tasks[15]. In our study, the time spent to perform the TUG was more affected by the cognitive, than by the motor DT.

Chen et al. reported worse performance when conducting a triple task (giving verbal responses and overcoming obstacles during gait). Other studies also reported decreases in mobility performance of the elderly, when combining motor tasks and gait[15,28,29]. These findings could be explained by the interference of cognitive functions, which require dividing attention between the two tasks[15,28,29].

A possible limitation of the present study was that the sub-groups comprised elderly women with a limited age range, which may have affected the results. Therefore, the variations between the two groups were subtle. In addition, no studies assessing the influences of the variables analyzed in this study were found, which hinders comparisons.

In summary, increases in time to perform the TUG associated with a second task were observed in older women with lower education levels. However, physical activity levels did not influence their TUG performances with or without DT. Elderly women with higher education levels completed the TUG with and without DT faster than did their less educated counterparts, regardless of the speed they were required to complete the tests.

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