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RELATIONSHIP BETWEEN PERFORMANCE IN THE TIMED UP AND GO TEST AND PARTICIPATION OF BODY BALANCE MAINTENANCE SYSTEMS IN OLDER ADULT

RELAÇÃO ENTRE DESEMPENHO NO TESTE TIMED UP AND GO E PARTICIPAÇÃO DE SISTEMAS DE MANUTENÇÃO DO EQUILÍBRIO CORPORAL EM IDOSOS

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ABSTRACT - Objective: Evaluate the relationship between performance in Timed Up and Go (TUG) and the participation of body balance maintenance systems in older adults. **Methods:** This paper present an observational cross-sectional analytical study of mobility and balance involving 62 participants (60 years and older), 40 female and 22 male, minimum 60 and maximum 96 years old, mean age 76,83 years (±13,20 years). Each participant answered a questionnaire (sociodemographic and clinical characteristics) and performed two tests to assess mobility (TUG) and body balance (Sensory Organization Tests-SOT) using Dynamic Posturography *Foam Laser* (PFL). Tests with type I error below 5% were considered statistically significant and those between 5 and 10% were considered as statistical trend. We performed the data analysis using the Epi Info ™ 7.2 program. **Results:** The vast majority of the elderly had average and high performance in TUG test (87%). Those with high performance were

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younger (60-79 years old) than those with average and low TUG performance (p<0.001). Less education participants performed worse performance in than participants with higher education (p=0.003). Participants with abnormal Mini Mental State Examination (MMSE) had average and low TUG performance than those with normal MMSE score (p<0.001). In the SOT, it was possible observed that Visual Preference had a statistical trend (p=0.057), not significant on Somatosensory, but significant on Visual and Vestibular tests (p<0.001).The Age group (p<0.001), Schooling (p=0.018), MMSE (p<0.001), Visual preference (p=0.026), Visual (p<0.001) and Vestibular(p<0.001) were significantly correlated with total TUG time. Physical activity model reach a statistical trend level (p=0.082). **Conclusion:** The balance maintenance systems is strongly correlated with TUG, where TOS performance explained 68% of TUG variability. The results indicate that TUG's correlation with balance is independent of participant's cognitive status, sex, age group, educational level and physical activity.

Keywords: Aged; Aged 80 and over; Aging; Postural Balance; Public Health.

RESUMO - Objetivo: Avaliar a relação entre o desempenho em Timed Up and Go (TUG) e a participação de sistemas de manutenção do equilíbrio corporal em idosos. **Métodos:** Este trabalho apresenta um estudo observacional transversal analítico de mobilidade e equilíbrio envolvendo 62 participantes (60 anos ou mais), 40 mulheres e 22 homens, com idade mínima de 60 e máxima de 96 anos, idade média de 76,83 anos (± 13,20 anos). Cada participante respondeu a um questionário (características sociodemográficas e clínicas) e realizou dois testes de avaliação da mobilidade (TUG) e do equilíbrio corporal (Teste de Organização Sensorial – TOS) utilizando a Posturografia Dinâmica *Foam Laser* (PFL). Os testes com erro tipo I menor que 5% foram considerados estatisticamente significantes e aqueles entre 5 e 10% foram considerados como tendência estatística. A análise dos dados foi realizada por meio do programa Epi InfoTM 7.2. **Resultados:** A grande maioria dos idosos apresentou desempenho médio e alto no teste TUG (87%). Aqueles com alto desempenho eram mais jovens (60-79 anos) do que aqueles com desempenho médio e baixo no TUG (p<0,001). Participantes com menor escolaridade tiveram pior desempenho do que participantes com ensino superior (p = 0,003). Os participantes com Mini Exame do

Estado Mental (MEEM) anormal tiveram desempenho médio e baixo no TUG do que aqueles com pontuação normal no MEEM (p <0,001). No TOS, foi possível observar que a Preferência Visual apresentou tendência estatística (p=0,057), não significativa nos testes Somatossensorial, mas significativa nos Testes Visuais e Vestibulares (p<0,001). Faixa Etária (p<0,001), Escolaridade (p=0,018), MMSE (p<0,001), preferência visual (p=0,026), visual (p<0,001) e vestibular (p<0,001) foram significativamente correlacionados com o tempo total de TUG. O modelo de atividade física atingiu um nível de tendência estatística (p=0,082). **Conclusão:** Os sistemas de manutenção do equilíbrio estão fortemente correlacionados com o TUG, onde o desempenho do TOS explicou 68% da variabilidade do TUG. Os resultados indicam que a correlação do TUG com o equilíbrio é independente do estado cognitivo do participante, sexo, faixa etária, nível educacional e atividade física.

Palavras-chave: Idoso; Idoso com 80 anos ou mais; Envelhecimento; Equilíbrio Postural; Saúde pública.

INTRODUCTION

Aging population is a worldwide phenomenon. In developing countries, like Brazil, this transition process occurred by a reduction in the prevalence of infectious diseases and an increase in the prevalence of chronic degenerative diseases (WHO, 2015). In this scenario, the increase in chronic diseases associated with the presence of changes in the aging process makes the Brazilian older-adults more vulnerable to intrinsic and extrinsic aggressions, favoring several complications, including balance deficit (NEUMANN; ALBERT, 2018).

Balance is a complex process. Maintaining body balance requires integration of sensory information from three systems: vestibular, somatosensory(proprioceptive) and visual. The vestibular is responsible for the perception of angular and linear accelerations; the proprioceptive is responsible for the perception of the body and body members in space; and the visual is responsible not only for the good perception of the environment, but also for the reference of verticality that is fundamental to guide the posture, movement and direction to follow (IVANENKO; GURFINKE, 2018). Thus, proper balance maintenance depends on the integrity and correct functioning of all these

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body Balance Maintenance Systems, but also on muscular and joint flexibility (HONAKER et al., 2016). The Central Nervous System (CNS) receives and analyzes the stimuli from these systems and sends a motor response through muscle contractions in order to maintain certain posture during an action (SOLDERA; OLIVEIRA; BÓS, 2015). Aging significantly interferes with these communications, while compromising sensory system components by decreasing their compensatory capacity. Simultaneously, the presence of musculoskeletal changes, also observed with advancing age, implies factors that contribute to postural instability (FRITH et al., 2019).

In older-adults, postural instability is an important clinical problem, since it is a risk factor to the occurrence of falls. Fall is a serious event for this population, as it can generates significant functional impairment, increasing morbidity and mortality levels. Thus, fall is a public health problem due to its high prevalence and the high costs it generates for health services (FLORENCE et al. 2018). In Brazil, the prevalence of falls in the older-adult ranges from 27.1% to 34.8% and may reach 50% in those aged 80 or older (SAMPAIO et al. 2013). Thus, its prevention becomes one of the main challenges for the health system. Today, proper fall risk screening has been instrumental in directing more accurate and satisfying treatments seeking to decrease the incidence of the event (FRITH et al., 2019).

There are several studies seeking to identify the risk of falling and determining their predisposing factors in older-adults (CARDON-VERBECQ et al., 2017; CHEN et al., 2018; ROONGBENJAWAN; SIRIPHORN, 2019). Among the fall assessment instruments is the performance on the Timed Up and Go Test (TUG). Although TUG is widely used, there is no consensus in the literature about its use of the test as a predictor of falls in the clinical practice (CARDON-VERBECQ et al., 2017). Morever, there are few scientific studies that observe the possible participation of sensory information (vestibular, visual and proprioceptive) in the performance of TUG (SOLDERA; OLIVEIRA; BÓS, 2015). In this context, the objective of this study is to evaluate the relationship between performance in TUG and the participation of body Balance Maintenance Systems in older-adults.

METHODS

This is a secondary analysis of the data of participants from a non-probabilistic convenience sample research involving older adults (60 years and older). This is an observational cross-sectional analytical study. The sample consisted of 78 older-adult patients from the Geriatrics outpatient clinic of Hospital São Lucas da PUCRS (HSL) of the Pontifical Catholic University of Rio Grande do Sul (PUCRS), older-adults participants of a physical activity program at School of Physical Education at PUCRS, and older-adults filiated to a workers association, also from Porto Alegre, Brazil (SOLDERA; OLIVEIRA; BÓS, 2015). The Research Ethics Committee of PUCRS approved the study under the registration #11/05647. All participants authorized their participation by signing the Informed Consent Form, which informed the research purposes, with easy and accessible language. The researchers answered all doubts and questions before the participants' signature. The anonymity of the participants was maintained.

The study included participants who walked without the use of walking devices (cane, crutch or walker). The exclusion criteria was: not being able to stand for five minutes or more, to respond adequately to verbal commands, reported the occurrence of at least one fall episode in the last six months, had clinical history of stroke with motor or cognitive sequelae, had visual impairment without proper correction (glasses or lenses).Other exclusion criteria were: using anti-vertigo, anxiolytic or antidepressant medications, drunk alcohol in the 24 hours previous to the assessment, had tremors or muscle stiffness (Parkinsonism),used prostheses on lower limbs, had a diagnosis of labyrinthopathy established by a doctor, and had a history of alcoholism.

Initially, the participant answered a questionnaire about sociodemographic (gender, age, education, monthly income) and clinical (self-perceived general health and regular physical activity) characteristics which included the Mini Mental State Examination (MMSE), for cognitive performance assessment (FOLSTEIN; FOLSTEIN; MCHUGH, 1975). The classification of the cognitive status used the cut-off points, adjusted for educational level in the Brazilian population, proposed by Bertolucci et al. (1994). Finally, the participant performed two tests to assess the body balance: TUG and Sensory Organization Tests (SOT).

TUG assesses the functional mobility in small motor tasks essential for independent living such as postural self-control and balance (PODSIADLO;

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RICHARDSON, 1991). The test consists of getting up from a chair with a back and without arms, walking a distance of three meters, going around and returning. We instructed the participant to start and finish the test with his/her back resting in the back of the chair. The participant had to wait for the "go" to stard the test. The tester recorded the total time taken to perform the test, from the command voice until the moment the participant rests his/her back on the chair, in seconds using a standard chronometer. The longer the time to execute the test the lower was the performance of the participant. In the present study we used the cutoff points proposed by Wall et al. (2000) to classify the participants in high (<10 seconds), average (10-20 seconds) and low performance >20 seconds.

We used the Dynamic Posturography Foam-Laser (PFL) to measure SOT using the methodology described by Soldera et al. (2015). The test allows isolating and quantifying the participation of vestibular, visual and proprioceptive information, as well as its sensory integration in maintaining body balance, through six SOT (SOLDERA; OLIVEIRA; BÓS, 2015).

For analysis purposes, we divided the variables in independent (demographic and clinical variables) and dependent (TUG and SOT components). The distribution of the sociodemographic and clinical characteristics of the participants as to the risk of fall according to the TUG classification was tested by Chi-square. The possible differences in the mean age and SOT performance at each level of the TUG classification were tested by ANOVA, when the variances were homogeneous by the Bartlett test. When the variances were different, the Mann-Whitney non-parametric test was used to observe the possible difference in the distribution of variables between the levels of TUG. Linear regression tested the correlation between TUG and SOT components. We tested each component of the SOT separately in simple models and then adjusted with all components in the same model. Tests with type I erro below 5% were considered statistically significant and those between 5 and 10% as statistical trend. We performed the data analysis using the Epi Info ™ 7.2 program.

RESULTS

Among the 78 older adults invited to participate, 11 were using anti-vertigo or anxiolytic medication and five for having a fall six months previous the evaluation,

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consequently excluded. The final sample was 62 participants, 40 female and 22 male, minimum 60 and maximum 96 years old, mean age 76,83 years (±13,20 years).

Table I shows the distribution of the participants' sociodemographic and clinical characteristics regarding the TUG classification. Twenty-seven (43.5%) had high performance on the TUG, same number of those who had average performance and 13% had low performance. Women presented higher frequency of average and low performance in the TUG (60%) than men (50%). However, this association was no significant (p=0.682). Those participants with high performance in the TUG were on average younger (66.4±7.25 years), than both average (83.2±11.94 years) and low TUG performance (90.4±3.11 years), being statistically significant (p<0.001). Most participants at younger age groups (aged between 60 and 79 years) had high and none had low performance on TUG. Only 7% of those participants with 80 years and older had high performance (p<0.001). Participants with lower education level (7 years or less of school) had more often average (55%) and lower performance (21%) in TUG when compared to those with higher education (31% and 3% respectively, p=0.003). Physical activity has a statistical trend association with TUG performance (p=0.096). Participants not active participants had more often average (50%) and low (19%) TUG performance. No individual reported bad self-perceived health. Only 18 (23%) participants considered they self-perceived health regular. Besides not significant (p=0,375), there was a higher proportion of participants who reported regular self-perceived health performing TUG at average (39%) and low (22%) level. Regarding the MMSE, a higher proportion of abnormal cognitive participants had average (58%) and low (21%) performance in TUG, being statistically significant (p<0.001).

Table II shows the mean differences in TOS scores according to the performance in TUG. It is possible observed that Visual Preference had a statistical trend on ANOVA test (p=0.057), not significant on Mann-Whitney test on Somatosensory, but significant on Visual and Vestibular tests (p<0.001). The better the TUG performance the higher was mean values on all TOS, except in the Somatosensory test.

The results of simple and adjusted linear regression models of the components of TOS for the prediction of TUG performance time are in Table III. At simple models Age group (p<0.001), Schooling (p=0.018), MMSE (p<0.001), Visual preference (p=0.026), Visual (p<0.001) and Vestibular (p<0.001) were significant correlated to TUG performance time. Physical activity model reaches a statistical trend level (p=0.082). Participants who were 80 years or older needed, on average, 6.5 seconds

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more time to perform the TUG, those with 8 or more of study needed 3.2 seconds less time and those physically active took on average 2.4 seconds less than those not active. Each point on MMSE correlated to almost a second lower time on TUG. Better performance on each SOT was associated to less time to perform TUG. At adjusted model with all variables in the same model, only MMSE remained significant among the sociodemographic and clinical variables. The analysis of the visual preference, which was significant in the simple model, ceased to be significant in the adjusted model. In other hand, somatosensory test that was not significant in the simple and became significant in the adjusted model. The correlation coefficient of the final model (r^2) was 0.74.

DISCUSSION

The present work aimed to evaluate the possible association between the TUG performance and the participation of the systems for maintaining body balance in older adults. Besides its controversy TUG is widely used as a functional mobility, gait speed and balance test (CARDON-VERBECQ et al., 2017). More than half of the participants had average and low TUG performance. The participants were asked to come to the location of the test voluntarily and did not seek medical assistance. This might be a reason for having more participants with higher performance.

In the analysis of demographic variables, a higher proportion of women presented average and low performance in the TUG, same as observed by Pondal & Del Ser (2008). The authors analyzed the TUG times stratified by gender and confirmed that women have significantly higher scores, this is, present worse performances in TUG when compared with men. There is not a definite explanation for this gender difference, considered a common demographic effect, but the authors believed that muscle strength, which is required to get out of a chair, is lower in women (PONDAL; DEL SER, 2008). Rolita et al. (2013) observed higher risk of falls related to analgesic use. In the present study, CNS acting drugs was an exclusion criterion, reducing the difference between males and females on this factor. As a result, we did not find significant differences on TUG performance in sex. Even so, women had worst performance in TUG, leading to believe that other factors may also interfere in this difference between genders.

When comparing the different age groups, oldest-old participants (80 years and older) had worse performance in TUG. This finding corroborates with Rolita et al. (2013) who state that the level of frailty in the older-adult increases over the years, while the level of functionality decreases, favoring a greater proportion of falls. This can be justified by the primary sarcopenia associated with aging, in addition to the possible reduction of motor neurons, which lead to greater impairment in speed gait with the evolution of age (ALEXANDRE, 2014; PATEL, 2013). In the present study, participants with less education had worse performance in TUG when compared to those with higher education. Educational level influences the spatial perception of older-adults, so that when performing visual search tasks individuals with a low educational level need more time, make more mistakes and reach fewer targets when compared to individuals with higher education (BRUCKI; NITRINI, 2008).

Regarding cognitive performance, participants with abnormal MMSE had average and low performance in the TUG more often than those with normal level of exam. For Gleason et al. (2009), older-adult people with cognitive deficits are more likely to suffer falls, while they have compromised protective responses and an impoverished judgment of the severity of their condition and their losses, with little or no awareness of their problem. This can lead them to an erroneous assessment of their abilities and to engage in risky activities, causing accidents, especially falls.

Regarding the analysis of SOT, it was observed that the lower the performance in the TUG, the lower the scores in visual preference, in the visual and vestibular system. For the visual and vestibular systems, we observed an even more significant decrease in scores, when we take into account the older adult classified as underperforming in the TUG. The somatosensory analysis was the only sensory variable that was not significant. Owsley (2008) state that one of the first systems to suffer the impact of the physiological aging process is the visual system. Presbyopia, which begins around the age of 40 to 50, with a gradual and irreversible reduction in the ability to accommodate or focus on nearby objects, is one of the first symptoms that we are aging. Functional visual changes are also frequent, such as a decrease in visual acuity that, after the sixth decade of life, undergoes a gradual decline, reaching up to 80% loss when the ninth decade is approaching. Associated with the decrease in visual acuity, there is a decrease in the peripheral visual field, sensitivity to contrast, color discrimination, the ability to recover exposure to blinding light, adaptation to the dark and the notion of (OWSLEY, 2008).

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Tiedemann et al. (2005) investigated the contributions of a variety of sensorimotor, balance and psychological factors to the gait speed performance of 668 older-adult people in the community. Corroborating with our findings, the results of Tiedmann et al. (2005) indicated that walking speed is influenced not only by the strength of the lower limbs, but also by balance, reaction time, vision, pain and emotional well-being. The results of this study showed that good vision, in particular good contrast sensitivity; contribute to better walking performance over the years. This suggests that walking speed is sustained not only by adequate strength, but also by the ability to move in a safe and controlled manner. For the authors, this finding is due to the fact that vision plays an important role in judging distances and maintaining stability when standing and walking, justifying why we have identified the visual system as an important factor in predicting the performance in TUG, along with the vestibular system.

Comparing simple and adjusted models, age lost its significance to predict TUG total time, the same happened with schooling and Visual Preference. Trying to understand which factors influenced age in the model, we run models with only two or three independent variables. In two independent variables models age decrease its significance when MMSE, Vestibular and Visual variables were in the model. Age lost its significance when MMSE and vestibular or visual were in the same model (three independent variables). Vestibular and visual in the same model, age maintained its significance. As a result, the age related performance of TUG is dependent of cognition status and one of two components of SOT: visual or vestibular. Meaning that, young older-adults and oldest old participants might perform TUG total time similarly if they have the same level of cognition and visual or vestibular function. In the same approach, schooling lost its significance in two-variable models with MMSE, age, visual, and vestibular. Similarly with schooling, Visual preference lost its significance in two-variable models with MMSE, age, visual, and vestibular. Somatosensory performance that was not significant in the simple model became significant in any model with Vestibular. Meaning that, with the same vestibular performance, participants will have better TUG total time if they have a better somatosensory function. These results are unique, we could not find in the literature similar approach that could support our results.

We used in this research the PFL, more sophisticated and computerized system are available in the market that can corroborate or reject our findings. Only total time to perform TUG was used, in future approach we are planning to use systems that also collect information on TUG subtasks like time to stand, time to sit and trunk angle.

CONCLUSIONS

Lastly, we concluded that balance maintenance systems have a strong correlation with TUG, where TOS performance explained 68% of TUG variability. As a widely used test, TUG seems to be a good screening test for balance changes in clinical practice. The results allow us also to conclude that TUG's correlation with balance is independent of participant's cognitive status, sex, age group, educational level and physical activity.

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Table 1. Distribution of the sociodemographic and clinical characteristics of the participants regarding performance in the TUG.

Variable	High Performance n=27	Average Performance n=27	Low Performance n=8	p
Gender				
Female	16 (40.00%)	18 (45.00%)	6 (15.00%)	0.682
Male	11 (50.00%)	9 (40.91%)	2 (9.09%)	
Age Range				
60-79 years-old	25 (78.13%)	7 (21.88%)	0 (0.00%)	<0.001
80 years and older	2 (6.67%)	20 (66.67%)	8 (26.67%)	
Schooling				
0 to 7 years	8 (24.24%)	18 (54.55%)	7 (21.21%)	0.003
8 years or more	19 (65.52%)	9 (31.03%)	1 (3.45%)	
Regular Physical Activity				
Yes	17 (56.67%)	11 (36.67%)	2 (6.67%)	0.096
No	10 (31.25%)	16 (50%)	6 (18.75%)	
Self-Perceived Health				
Good	20 (45.45%)	20 (45.45%)	4 (09.10%)	0.375
Regular	7 (38.89%)	7 (38.89%)	4 (22.22%)	
MMSE				
Normal	22 (57.89%)	13 (34.22%)	3 (7.89%)	<0.001
Changed	5 (20.83%)	14 (58.33%)	5 (20.83%)	

Mini Mental State Examination (MMSE); n=number

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Table 2. Differences in Sensory Organization Test mean scores according to TUG performance.

Variable	High Performance mean±SD	Average Performance mean±SD	Low Performance mean±SD	p
Visual Preference	77.22±17.15	70.95±21.43	56.51±30.98	0.057*
Somatosensory	86.81±7.99	83.64±18.10	86.27±7.65	0.696**
Visual	91.14±6.15	75.49±34.04	8.98±25.42	<0.001**
Vestibular	76.76±9.68	54.01±28.91	8.12±22.98	<0.001**

SD=Standard Deviation; *ANOVA; **Mann-Whitney

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Table 3. Results of the simple and adjusted linear regression models of the components of Sensory Organization Tests for the prediction of TUG performance time.

Variable	Simple Model	p	Ajusted Model	p
Sociodemographic and clinical				
Gender (reference females)				
Males	-1.658	0.254	-0.225	0.794
Age Group (reference <80 years-old)				
80 years and older	6.485	<0.001	0.728	0.578
Schooling (reference <8 years)				
8 years or more	-3.227	0.018	0.940	0.315
MMSE	-0.809	<0.001	-0.383	0.007
Physical Activity	-2.401	0.082	0.550	0.557
Sensory Organization Test				
Visual Preference	-0.071	0.026	0.006	0.791
Somatossensory	-0.067	0.207	0.077	0.038
Visual	-0.117	<0.001	-0.059	0.014
Vestibular	-0.136	<0.001	-0.069	0.040

MMSE=Mini Mental State Examination