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Balance perception as a potential tool for screening postural imbalance in the Timed Up and Go test among cognitively impaired older adults

Percepção de equilíbrio como potencial ferramenta para identificação de desequilíbrio postural no teste Timed Up and Go *em idosos com déficit cognitivo*

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Abstract – Postural Imbalance (PI) is a common complaint in cognitively impaired older adults. It is unknown whether the Cognitive Impairment (CI) affects the validity and interpretability of balance perception in this population when standing up or walking. This study aims to investigate the validity of self-reported PI perception to screen performance limitations related to the task proposed by the Timed Up and Go (TUG) test in older adults with CI. This is a cross-sectional study using the data collected from older people evaluated in 2019-2020 at a specialized geriatric care facility. The sample was composed of 136 older adults with CI identified by the Mini-Mental State Examination (MMSE). The participants were questioned about PI perception (test index) and were submitted to the TUG test (reference standard; cutoff point>20 seconds). The subject's answers were confirmed by the accompanying caregiver. The Sensitivity (SE), Specificity (SP), Positive Predictive Values (PPV) and Negative Predictive Values (NPV) were estimated, measuring the agreement percentage (Cohen's Kappa test). Out of the 136 individuals studied herein, 60.3% (n=82) had self-reported PI and 25.3% (n=35) experienced it during the TUG test. Validity estimates presented high sensitivity and NPV values (SE=85.7%, SP=48.5%, PPV=36.6%, NPV=90.7%). The agreement percentage between the two tools in the overall sample was 58.1%. Despite the low agreement between instruments, the self-reported PI showed low false-negative percentages, indicating that it could be a potential tool for screening limitations in the TUG test, favoring the identification of individuals at risk of imbalance among older adults with CI.

Key words: Self-report; Cognitive dysfunction; Postural balance; Elderly population; Screening tools.

Resumo – *Desequilíbrio Postural (DP) é uma queixa muito comum em idosos com Déficit Cognitivo (DC). Ainda é desconhecido se o DC afeta a validade e a interpretabilidade da autopercepção de equilíbrio nessa população ao se levantar e andar. A presente pesquisa tem como objetivo investigar a validade do autorrelato de DP para rastrear limitação no desempenho da tarefa proposta pelo teste Timed Up and Go (TUG) em idosos com DC. Este é um estudo observacional, transversal e analítico com dados de idosos avaliados em 2019 e 2020 em um serviço de atenção geriátrica especializada. Participaram da pesquisa 136 idosos com déficit cognitivo identificado pelo Mini-Exame de Estado Mental, os quais foram questionados sobre percepção de DP (teste índex) e submetidos ao teste TUG (padrão de referência; ponto de corte>20 segundos). As respostas fornecidas pelo idoso foram confirmadas com o cuidador acompanhante. A Sensibilidade (S), Especificidade (E), Valor Preditivo Positivo (VPP), e Valor Preditivo Negativo (VPN) foram estimadas, calculando em seguida o percentual de concordância (teste Cohen's Kappa). Dos 136 participantes do estudo, 60,3% (n=82) autorrelataram DP e 25,3% (n=35) o apresentaram durante o teste TUG. As estimativas de validade demonstraram altos valores de sensibilidade e valor preditivo negativo (S=85,7%, E=48,5%, VPP=36,6%, VPN=90,7%). O percentual de concordância foi de 58,1% na amostra geral. Apesar da baixa concordância entre os instrumentos, o autorrelato de DP apresentou baixos percentuais de casos falsos negativos, demonstrando ser uma potencial ferramenta útil para a triagem de limitações no teste TUG, favorecendo o rastreio de indivíduos com risco de desequilíbrio postural entre idosos com DC.*

Palavras-chave: *Autorrelato; Disfunção cognitiva; Equilíbrio postural; Idoso; Programas de rastreamento.*

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INTRODUCTION

Cognitive impairment (CI) reduces the intellectual capacity of the older adults and compromises memory, attention, judgment and language, which can lead to movement errors in mobility, balance disorders, inability to walk safely as well as climb stairs, and falls[1]. Cognitively impaired older adults may be twice as likely to fall as those with full cognitive function[2]. In the clinical practice, imbalance is characterized as a recurring complaint reported by the elderly with CI and their caregivers[3]. Balance is defined as the complex interaction between different systems that enables the alignment of body segments, the generation and control of multi-joint movements, as well as the ability to sustain different postures during proactive or reactive dynamic balance situations[4]. One of the challenges related to treating patients who complain of postural imbalance is rapid and accurate identification targeting decision making for intervention. To that end, objective balance assessment tools can be used to reproduce everyday situations in which imbalance might occur, along with the subjective perception self-reported by the patient and/or their caregiver[5].

The balance performance of cognitively impaired older adults can be objectively assessed by the Timed Up and Go (TUG) test[6,7]. Proactive balance and body mobility are then evaluated by timing how long it takes for an individual to rise from a chair, walk 3 meters, turn 180°, return to the chair and sit down again[8]. The test is valid for older adults with CI, being widely used by clinicians and researchers[6,7].

Subjective self-reporting generally provides relevant and reliable information on cognitive, emotional as well as physical status for clinical practice[9]. These simple, low cost[10], accessible instruments allow the individual to actively participate in their own assessment[11]. Previous findings demonstrate that this method provides a good indication of balance ability, since it incorporates the subject's own perception of their skills regarding each task, also providing a similar accuracy to predict recurrent falls with performance-based measures[12]. Controversially, other studies have shown no relationship between instability complaints and different postural stability measurements[5,13,14].

Since balance is crucial to a satisfactory functional performance and fall prevention in the elderly population, it is important to understand whether the self-perceived postural imbalance is suitable for the correct identification of older adults with difficulties in this functional component. Although subjective balance complaints in the geriatric population have been widely investigated by self-report studies, it is still unknown whether CI affects the validity and interpretability of these measurements[15]. Although cognitively impaired older individuals may experience difficulty recalling everyday events in the long term and provide diverging responses[15], the complementary assessment given by a caregiver, usually a family member or trained professional, is an alternative to ensure more accurate and useful information for clinicians[11]. As such, given the controversy in the literature regarding the relationship between objective and subjective self-reported measures, and because none of these studies investigated this relationship in the elderly population with CI[5,13,14,15], the present study aimed to evaluate the validity of self-reported postural imbalance perception to screen for performance limitations in this population's TUG test.

METHOD

This is a cross-sectional study carried out in 2019 and 2020 at the Health Polyclinic in the western Federal District of Brazil, providing a multidimensional assessment of older adults referred from the Basic Health Units. Participants were male and female older adults (≥60 years old) with CI[16], capable of performing the TUG test and communicating perceived imbalance. Cognitive impairment was evaluated via the Mini-Mental State Examination (MMSE). The following cutoff points were adopted: 28 for individuals with more than 7 years of schooling, 24 for 4-7 years, 23 for 1-3 years, and 19 for illiterates[16].

For the sociodemographic characterization of the participants, data was collected on their age, sex and schooling level. Clinical conditions were characterized according to cognitive status, regular physical exercise, nutritional status, functional capacity and continuous use of medications (number).

Engagement in regular physical exercise was established based on at least 150 minutes of moderate-intensity exercise (walking, strength training, multicomponent training) or 75 minutes of vigorous exercise (running, high-intensity interval training), with the purpose of characterizing participants as physically active or inactive[17].

The nutritional status was determined by calculating the Body Mass Index (BMI) and categorized as: underweight (<22Kg/m^2); normal weight (22-27Kg/m^2) or overweight (>27Kg/m^2)[18].

The functional capacity related to the Instrumental Activities of Daily Living (IADLs) was assessed by the Pfeffer Questionnaire and was applied to the patient's caregivers[19]. It comprises 10 activities scored from 0 to 3: using the telephone, traveling out of the neighborhood, going shopping alone, performing household tasks, preparing meals, taking medications and managing finances. The final score ranged from 0 to 30, where the lower the score, the greater the individual's independence, with 0 to 5 indicating independence[20]. The instrument was adapted for the Brazilian population, presenting good sensitivity and high reliability for functional impairment assessment[21].

In order to identify perceived imbalance, participants were questioned on its occurrence in at least one of five different situations, with dichotomous response options (yes/no): "Can you stand safely?"; "Can you climb stairs normally?"; "Do you feel safe walking or do you need assistance?"; "Are you afraid of falling?"; "Do you avoid any daily activity for fear of falling?"[22] The answers were confirmed with the caregivers and, in the event of divergence, the affirmative responses were considered.

The Timed Up and Go (TUG) test was used as an objective measure of proactive balance performance, and it is a reliable instrument[6,23]. The test measures the time taken to rise from a chair without using the hands for support, walk 3 meters as quickly as possible, turn 180°, return to the chair and sit down again. Participants were given the following verbal instructions before the task: "when I say 'go', I want you to get up, walk to the cone as quickly and safely as possible, turn around, walk back to the chair and sit down again, in the shortest time possible"[6,7]. The participants were allowed to use walking aids if needed. Two attempts were made, with the first targeting familiarization. In the second try, the timing began when the participant`s torso left the backrest of the chair and stopped when they returned to the initial position. The time, measured

in seconds, of the second attempt was used for the analyses described herein. A cutoff point of 20 seconds (>20s) was considered as a postural control deficit[24].

The whole data was collected in a single day by a multiprofessional team trained to gather scientific evidence. All the assessments were conducted in a private room to minimize disturbances. The anamnesis was then carried out to record sociodemographic and clinical data, the self-reported imbalance perception was evaluated, and the TUG test was applied. The same examiner was responsible for both assessment attempts of a given participant.

This study was approved by the Human Research Ethics Committee of the Faculdade de Ceilândia da Universidade de Brasília (protocol No. 3.650.491), and all participants signed the informed consent form before the data collection.

Statistical analysis

The data was descriptively analyzed using mean, median, standard deviation, as well as the 25th and 75th percentiles for numerical data, along with the absolute frequency and percentage for categorical data. The numerical data distribution was assessed using the Kolmogorov-Smirnov test. Then, the numerical data regarding older adults with and without perceived imbalance were compared using the Student's t-test for independent samples (parametric data on age and nutritional status) or the Mann-Whitney U test (nonparametric data), as well as the Chi-square test for the distribution of categorical data. Accuracy was analyzed considering self-reported imbalance as an index test and performance on the TUG task as a reference standard. Sensitivity (SE), Specificity (SP), Positive Predictive Value (PPV), Negative Predictive Value (NPV) and overall accuracy were thus calculated.

Additionally, the agreement between the self-reported postural imbalance and TUG data were assessed by Cohen's Kappa. Both validity and agreement were estimated for the general sample and stratified by age, sex, functional capacity, nutritional status and polypharmacy (≥5 continuous use medications). At last, the significance was set at 5% and the data was analyzed using the Statistical Package for the Social Sciences (SPSS), version 23.0.

RESULTS

A total of 136 older adults were included in the present study (Figure 1), with a mean age of 77.5 ± 8.02 years and median of 3 years of schooling; 74.3% were women, 89% were considered physically inactive and 66.9% dependent in IADLs (Table 1).

Participants with and without self-perceived imbalance did not differ significantly in terms of age, schooling level or engagement in physical activity (Table 1), and 60.3% (n=82) self-reported imbalance. The median time for the TUG test was 14.65 seconds [P25=11.80; P75=20.32], with 25.7% (n=35) taking longer than 20 seconds to complete the task. The older adults who perceived no imbalance executed the TUG test significantly faster than those who presented postural imbalance complaints (12.57 [10.70; 15.39] *versus* 17.75 [12.63; 24.61]; p<0.001). Among those with self-reported imbalance, 36.6% (n=30) exhibited this characteristic during the TUG test, while 90.7% (n=49) of those who perceived no imbalance showed no difficulties during the task (p<0.001) (Figure 2).

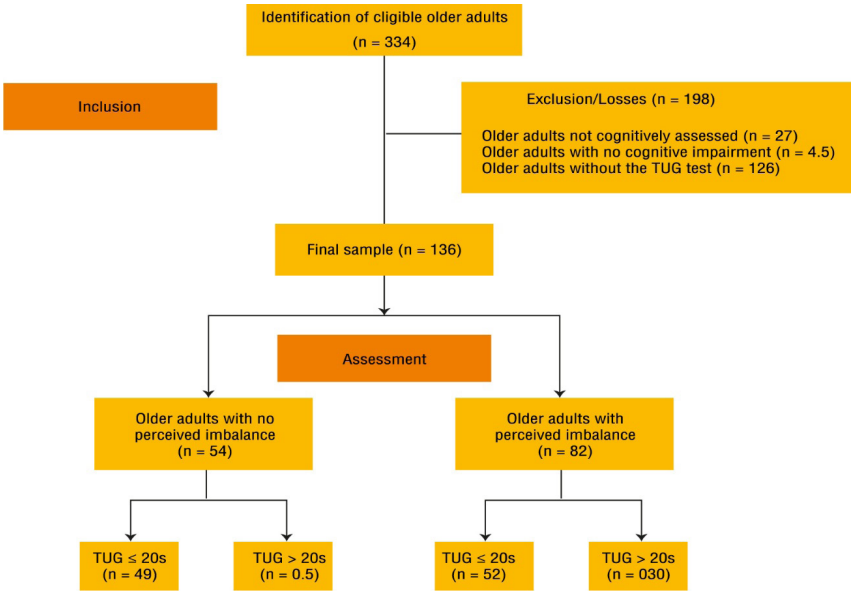

Figure 1. Sample flowchart.

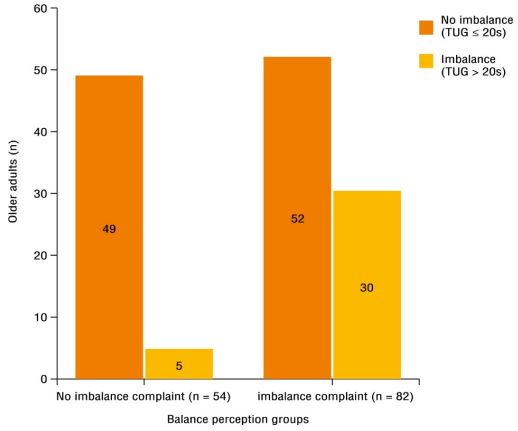

Figure 2. Comparison between the frequency distribution of older adults with TUG≤20s and TUG>20s among individuals with and without self-reported postural imbalance perception.

Table 1. Comparison of the sociodemographic and clinical data collected from older adults with and without self-reported perceived imbalance.

Variable	Valid data	Overall sample	No perceived imbalance	Perceived imbalance	p-value
Age (years), mean (SD)	135	77.50 (8.02)	76.41 (7.76)	78.21 (8.15)	0.206
Female, % (n)	136	74.3 (101)	64.8 (35)	80.5 (66)	0.047*
Schooling (years), median [P25; P75]	130	3 [0; 4]	3 [0; 4]	3 [0; 4]	0.334
Cognitive status (MMSE), median [P25; P75]	136	16 [11.25; 19.75]	18 [13; 20]	15 [10; 19]	0.029*
Regular physical activity (physically inactive), % (n)	136	89.0 (121)	83.3 (45)	92.7 (76)	0.101
BMI (Kg/m2), mean (SD)	132	27.25 (5.92)	25.63 (4.83)	28.34 (6.35)	0.006*
Nutritional status	131				
Underweight		27.5 (36)	32.7 (17)	24.1 (19)	0.008*
Normal weight		37.4 (49)	48.1 (25)	30.4 (24)	
Overweight		35.1 (46)	19.2 (10)	45.6 (36)	
Functional capacity (Pfeffer), median [P25; P75]	129	11 [3.5; 22]	7.5 [2.75; 16.50]	16 [4; 24]	0.021*
Dependent, % (n)	129	66.9 (87)	58.8 (30)	72.2 (57)	0.130
Medications (number), median [P25; P75]	136	5 [3; 7]	3 [2; 5.25]	5 [3; 7]	0.001*

*p<0.05. SD: standard deviation.

Table 2 presents the validity, and agreement estimates for self-reported imbalance to identify older adults with difficulty performing the TUG test in the overall sample, as well as in groups of older individuals stratified by sex, functional capacity, nutritional status and polypharmacy. The validity estimates demonstrated high sensitivity and NPV values, and the Kappa test indicated a low agreement between both tools in the overall sample as well as in most of the stratified analyses, with 58.1% agreement for the overall sample.

Table 2. Validity estimates for self-reported postural imbalance to identify balance problems in the Timed Up and Go test (cutoff point > 20 seconds).

Group	SE (%)	SP (%)	PPV (%)	NPV (%)	Overall accuracy (%)	Kappa	% agreement
Overall sample (n=136)	85.7	48.5	36.6	90.7	58.0	0.238**	58.1
Sex							
Female (n=101)	88.0	42.0	33.0	91.0	53.0	0.194*	53.5
Male (n=35)	80.0	68.0	50.0	89.0	71.0	0.407*	71.5
Functional capacity							
Independent (n=43)	80.0	52.0	18.0	95.0	55.0	0.132	55.8
Dependent (n=87)	87.0	45.0	45.0	87.0	60.0	0.266*	59.8
Nutritional status							
Underweight (n=36)	80.0	57.0	42.0	88.0	63.8	0.295*	63.9
Normal weight (n=49)	83.0	62.0	41.0	92.0	67.3	0.340*	67.3
Overweight (n=46)	91.0	26.0	38.0	90.0	41.3	0.093	41.3
Continuous use of medications							
<5 medications (n=63)	78.0	61.0	37.0	91.0	65.0	0.283*	65.1
Polipharmacy (n=73)	90.0	36.0	36.0	90.0	52.0	0.188*	52.0

*p<0.05. **p<0.01.

DISCUSSION

The aim of the present study was to investigate the validity of self-reported postural imbalance perception to identify limitations in the TUG task of getting up and walking among older adults with CI. Considering the sample of cognitively impaired elderly treated at a specialized geriatric facility, those with perceived imbalance performed worse in the TUG test. Approximately 60% reported imbalance and only 25% demonstrated it in the TUG. Despite the low agreement observed in the results, the self-reported imbalance perception was a valid tool in identifying TUG limitations in this specific population, which is evident in the high sensitivity and low NPV values obtained herein. Furthermore, most individuals with perceived imbalance in the sample were women with poor cognitive status, high BMI, larger number of continuous use medications and worse functional capacity. Given the possibility that these characteristics might be confounding factors, stratified analyses were conducted and demonstrated similar magnitudes for the validity estimates as well as agreement percentages to those obtained for the overall sample.

Among the participants who showed limitations in the TUG test, 85.7% were correctly identified via self-reported perceived postural imbalance, whereas 90.7% of those who reported no imbalance exhibited no limitations in the task. It is important to emphasize that the high sensitivity and NPV values observed ensure fewer false negatives. However, despite the low percentage, 10% of older adults who perceived no balance deficits in the self-reported questionnaire presented imbalance in the TUG task, likely characterizing

them as patients with a high risk of falls. This may be explained by the fact that they were unaware of their poor balance and unable to sufficiently focus to control their balance when moving and walking[5]. The caregivers of this small group of participants could have likewise failed to properly recognize postural imbalance signs, highlighting the need to include this issue in the caregivers' orientation and training.

By contrast, out of the participants with no limitations in the TUG task, only 48.5% were correctly identified via self-reported perceived imbalance, and only 36.6% of those who presented postural imbalance complaints were in fact limited in the TUG test. It should be noted that the TUG is used to assess proactive balance, therefore, individuals that presented no limitations in the test may have exhibited other dynamic, reactive or static balance deficits that could be identified with further investigation[4]. As such, in the context of detecting a high percentage of false positives in older adults with imbalance complaints, further research is recommended with complementary information from other objective measures (balance tests)[5]. It is important to reiterate that, despite the low agreement between the tools, even if a risk assessment instrument with a high sensitivity presents a low specificity, it still meets the first objective of application, which is to identify people at high risk of balance disorders in order to prevent falls and other functional consequences[25]. Moreover, Chiarovano et al.[5] further stated that some of the patients' complaints may be false positive cases, which presents a problem for clinicians, since they are likely to keep complaining regardless of the physical treatment implemented or rehabilitation received.

To conclude, the present study has strengths and limitations. To the best of our knowledge, this is the first study to investigate the validity of postural imbalance perception in identifying balance deficits among cognitively impaired older adults. The results herein are robust because most remained unchanged in stratified analysis. Given that the population studied had a medical condition that may affect their ability to self-report[15], it was relevant to confirm the information with their respective caregivers, generally a family member or trained professional. This provides an alternative to ensure more accurate and useful information for clinical practice assessments as well as for research, since caregivers monitor the daily routines of this population and are not cognitively impaired[11]. On the other hand, while acknowledging that the present sample was relatively small, only the older adults who required specialized geriatric evaluation were included, which made it difficult to increase the sample size. Finally, the clinical data and information on self-reported postural imbalance (index test) were available to the professional applying the TUG test (reference standard), and selecting the TUG as the reference to identify older adults with balance deficits could be questioned. Although the TUG test is not the gold standard, it is widely used in clinical practice as a fast, accessible, easily applied and straightforward instrument, in addition to being one of the most reliable tools[6,7,23].

CONCLUSION

Ultimately, despite these limitations, the results obtained herein indicate that self-reported postural imbalance perception is a valid assessment tool and can be used in clinical practice to screen for problems in the TUG task among

cognitively impaired older adults. Once these individuals with high-risk of falls have been identified, additional investigations should be carried out with application of the TUG test and other supervised performance tests valid for this population, with the purpose of identifying real balance deficits and ensuring more assertive interventions. However, the results of the present research should be considered preliminary, requiring further studies with larger samples and the application of more robust balance assessment methods. The confirmed validity of self-reported imbalance perception to screen for balance deficits in people with CI could help caregivers to identify elderly individuals at risk, regardless of difficulties related to limited time or space and insufficient equipment or expertise to assess balance-specific supervised performances.

Compliance with ethical standards

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Ethical approval

Ethical approval was obtained from the local Human Research Ethics Committee – Faculdade de Ceilândia/Universidade de Brasília and the protocol (no. 3.650.491) was written in accordance with the standards set by the Declaration of Helsinki.

Conflict of interest statement

The authors have no conflict of interests to declare.

Author Contributions

Conceived and designed the experiments: PAG; Performed the experiments: IFR, AMSA, LSG, RSB; Analyzed the data: PAG, IFR, AMSA, LSG; Contributed reagents/materials/analysis tools: IFR, AMSA, LSG, RSB, SGRN, FASM; Wrote the paper: PAG, IFR, AMSA, LSG, SGRN, FASM.

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