The Journal of Physical Therapy Science

S P T S

Original Article

Assessing gait and balance impairment in elderly residents of nursing homes

Adrianna Borowicz, PhD[1)], Ewa Zasadzka, PhD[1)*], Agnieszka Gaczkowska, MPT[1)],
Olga Gawłowska, MPT[1)], Mariola Pawlaczyk[1)]

[1)] Department of Geriatric Medicine and Gerontology, Karol Marcinkowski University of Medical
Sciences: ul. Święcickiego 6, 60-781 Poznań, Poland

Abstract. [Purpose] The risk of falls in the elderly is an important public health problem. Suitable tests may help detect those at risk of falling. This study determined which balance test for older adults generates the most reliable results in terms of fall risk assessment, based on the number of falls over the last 12 months. [Subjects and Methods] A total of 153 individuals (31 males, 122 females, aged 76.67 ± 8.3 years; median 76.5, range 65–94) were investigated. The subjects were subdivided between fallers (a fall over the last 12 months) and non-fallers (no falls over the last 12 months). All participants were assessed with the following: Barthel Scale, Mini-Mental State Examination, Timed Up and Go, Tinetti Performance-Oriented Mobility Assessment), Berg Balance Test, and One-Legged Stance Test. [Results] Statistically significant differences were detected between fallers and non-fallers in TUG, POMA, BBS, and OLST scores. The number of falls correlated positively with the results for TUG, POMA, and OLST. [Conclusion] TUG and POMA were the most useful screening tests for balance and gait impairment in elderly nursing home residents. Two or more tests should be performed for more precise assessment of the risk of falling.
Key words: Elderly, Balance, Falls

INTRODUCTION

Falls among the elderly constitute a significant health problem, as approximately every third person over 65 and every second individual over 85 falls at least once a year[1, 2]. The multi-disease phenomenon may significantly negatively affect functional dexterity in the elderly and result in gait and balance impairment. Various consequences of somatic diseases, combined with reduced dexterity and physical activity, influence the quality of life in older adults, especially those who have already lost independence for activities of daily living (ADL), and are residents of nursing homes. Their independence is usually lower and they belong to the group at high risk of falling. Thus, fall risk assessment should include various tests for static and dynamic balance.

The physical and functional consequences of falls (fractures, soft tissue injury, premature institutionalization, and death) have been well documented. Long-term consequences may include loss of independence, restriction of physical activity, lowered quality of life, increased social isolation, or depression[3, 4]. Fear of falling affects psychological well-being and constitutes an independent risk factor for reduced mobility and lowered quality of life[5].

Numerous methods have been developed to evaluate balance and risk of falling among older adults, including the Timed Up and Go (TUG) test, Tinetti Performance Oriented Mobility Assessment (POMA) test, Berg Balance Test (BBS), and One-Legged Stance Test (OLST). These tests assess various parameters, especially standing balance, stepping ability, general function, reaction time, lower limb strength, dual tasking, gait variability, gait cadence, and vision (visual acuity, contrast,

Table 1. Patient characteristics

Characteristics	Male	Female
Number of patients	31	122
Age (years)		
Mean ± SD	73.0 ± 8.0	77.6 ± 8.1
Median (range)	72 (65–81)	77 (65–94)
Education		
Primary school (completed 7 years)	6	39
Vocational school (completed 3 years)	14	14
High school (completed 4 years)	7	55
University degree (completed 5 years)	4	14
Number of diseases		
Degenerative disease	14	76
Stroke	4	11
Hypertension	16	59
Osteoporosis	2	7
Diabetes mellitus	5	17
Ischemic heart disease	6	46
Visually impaired	3	16
Others	15	86
Number of medications		
Mean ± SD	3.2 ± 3.4	2.7 ± 3.7
Median (range)	1 (0–9)	1 (0–14)
Barthel Scale (points)		
Mean ± SD	96.2 ± 6.4	89.8 ± 13.2
Median (range)	100 (85–100)	95 (45–100)
MMSE Score (points)		
Mean ± SD	25.4 ± 2.8	26.5 ± 3.1
Median (range)	25.5 (19–30)	27 (19–30)
Number of falls over the last 12 months		
Mean ± SD	1.03 ± 1.6	1.01 ± 1.7
Median (range)	0 (0–6)	0 (0–8)

and field)[6]. They may also identify those at risk of falling who require lifestyle interventions, including exercises and home environment safety modifications[7, 8]. A physiotherapist, as a member of the geriatric team, should implement adequate preventive and therapeutic measures.

The aim of the study was to determine which gait and balance tests generated the most reliable results for assessment of risk of falling, based on the number of falls over the last 12 months.

SUBJECTS AND METHODS

All subjects gave informed consent. The study was conducted in accordance with the Declaration of Helsinki and the local ethics committee approved the study protocol (No. 838/13). This study was conducted in 5 nursing homes in Poznan, Poland. Out of 400 individuals (aged >65), a group of 153 residents who were able to walk a distance of 3 m unaided or using orthopedic equipment (i.e., performed the TUG test) and scored >18 points on the Mini-Mental Sate Examination (MMSE) were identified. Patient characteristics are presented in Table 1. Comprehensive geriatric assessment was performed in 153 subjects to determine the program of rehabilitation. Various scales were used, including the Barthel scale to measure ADL performance, (0–20 points: very dependent, 21–85: moderately dependent, 86–100: independent)[9]. The MMSE was used to evaluate cognitive function[10], which in older adults aids in design of the physiotherapy treatment. The scale assesses 5 areas of cognitive function: orientation, registration, attention and calculation, recall, and language.

Tests to predict the risk of falling have been used to evaluate balance in the elderly; for example, TUG assesses proactive balance. The patient is instructed to rise from the chair (approximate seat height of 46 cm), walk at a comfortable and safe pace to a line on the floor 3 m away, then turn and walk back to the chair and sit down again. The time required for the

Table 2. Gait and balance assessment

Parameters		Results	Fallers	Non- fallers
Age (years)	Mean	76.67 ± 8.3	78.7 ± 7.9	75.2 ± 8.3 *
	median	76.5	79	74
	range	65–94	65–94	65–91
TUG (sec)	Mean	18.6 ± 9.3	20.75 ± 9.2	16.5 ± 9.1 *
	median	16	16	14
	range	5–52	5–48	0–52
POMA (pts)	Mean	20.4 ± 5.7	19.1 ± 5.7	21.4 ± 5.4 *
	median	22	20	23
	range	4–28	4–28	8–28
BBS (pts)	Mean	41.3 ± 12.7	38.9 ± 13.4	43.1 ± 11.9 **
	median	45	44	46
	range	0–56	0–56	4–56
OLST (sec)[a]	Mean	5.3 ± 7.8	3.5 ± 6.0	6.6 ± 8.6 **
	median	2	0	4
	range	0–30	0–27s	0–30s

[a]n=71, *p<0.01, **p<0.05

patient to perform all commands is recorded. Patients should wear their usual footwear and may use their customary walking aid (cane or walker), if necessary[11]. A score of <10 s is normal, 11–20 s signifies subjects with frailty syndrome or slight disability, and a score of >20 s indicates that the individual requires a significant amount of help from others while walking, and usually heralds the need to implement an intervention. A TUG score of ≥13.5 s has been used to identify individuals at risk of falling[11]. POMA consists of 2 parts for assessment of balance and gait, and is frequently used to evaluate balance in elderly populations. A score of <19 corresponds to very high risk of falling. Scores of 26–19 reveal the presence of a problem, which might lead to a fall, whereas a score of 26–28 is normal[12]. BBS is another tool used to evaluate balance. It consists of 14 items, with a maximum total score of 56 points. Item-level scores range from 0–4 points. Item scores are summed. A score of 0–20 signals balance impairment, 21–40 signifies acceptable balance, and 41–56 represents good balance[13]. BBS scores have been identified for the ability to walk without an aid (49/56 points) and the ability to walk without a 4-wheeled walker (43/56 points)[14]. Steady-state balance may also be evaluated with the use of OLST, which is used as a screening method to determine balance impairment in elderly populations. The person is instructed to stand on one leg without support of the upper extremities. The length of time the subject can remain in this position is measured. The maximum test time is 30 s. In this study, the participants were instructed to keep their eyes open. Normal ranges with the eyes open are: 60–69 years: 22.5 ± 8.6 s, and 70–79 years: 14.2 ± 9.3 s[15]. Gehlsen and Whaley demonstrated that people who fall usually score lower on this test, whether with the eyes open or closed (10.9 s vs. 18.7 s, p<0.001, and 3.6 s vs. 5.2 s, p<0.05)[16]. In this study, the results were analyzed according to the number of falls during the last 12 months. The participants were subdivided into fallers and non-fallers.

Quantitative variables are presented as mean and standard deviation. Due to the non-parametric distribution of some variables, median and range of parameters were taken into account. The Mann-Whitney test, Spearman's rank correlation coefficient, and the Deming Linear Regression (because parameters were in different units: points and seconds) were used in the analysis. Statistical analysis was performed using GraphPad Software Prism 6. A p-value of <0.05 was considered statistically significant.

RESULTS

The results of the tests are presented in Table 2. Out of 153 subjects, only 46% were deemed eligible for the OLST test. Deming Linear Regression (n=153) revealed statistically significant correlations between the number of falls, longer results for TUG r=0.27 (p<0.001), and lower scores for POMA r=−0.24 (p<0.001) and OLST r=−0.17 (p<0.01). The correlation between the number of falls and BBS scores was statistically insignificant. Table 3 presents results after the study group was subdivided according to gender. A statistically significant correlation between age and the number of falls in males (p<0.01) and females (p<0.05) was detected with Spearman's Correlation. A high correlation was also found between the number of falls and both longer TUG results (males p<0.001, females p<0.01) and lower POMA scores (males p<0.05, females p<0.05). No correlation was found between gender and the BBS score, whereas results of the OLST test correlated with gender only in the case of males (p<0.05).

Table 3. Correlation between number of falls in males and females, age and tests results

Gender	Age (years)	TUG (sec)	POMA (pts)	BBS (pts)	OLST (sec)
Male (n=31)	r=0.5046*	r=0.5627**	r=−0.3739***	r=−0.3450	r=−0.4027***
Female (n=122)	r=0.1811***	r=0.2393*	r=−0.2294***	r=−0.1380	r=−0.1314

*$p < 0.01$, **$p < 0.001$, ***$p < 0.05$

DISCUSSION

Based on the results, the evaluation of balance in fallers and non-fallers among elderly residents of nursing homes showed that all tests, i.e., TUG, POMA, BBS, and OLST, enabled adequate assessment of balance and identification of patients in need of interventions to prevent falls. In nursing homes, it is essential to apply tests that will identify people who need services to prevent falls. The OLST was least useful, as it could only be conducted in 46% of the subjects. The difference between fallers and non-fallers was statistically significant in a comparison of TUG ($p < 0.01$) and POMA ($p < 0.01$) results. For BBS and OLST, a difference was present at a level of significance of $p < 0.05$. Compared with non-fallers, TUG, POMA, BBS, and OLST scores in fallers were 4.25 s longer, 2.3 points lower, 4.2 points lower, and 3.1 s shorter, respectively. Müjdeci et al. also evaluated balance in fallers vs. non-fallers, but used BBS and Computerized Dynamic Posturography (CDP). The BBS and CDP results in fallers were significantly lower compared to non-fallers[17].

This study confirmed that the risk of falling increases with age in both males and females over 65. Nakano et al. demonstrated that female patients in their 70s show a significant decline in functionality, i.e., physical performance and balance, as compared to their male peers. Older females display greater loss of muscle mass and muscle strength, which predisposes to frailty syndrome[18]. Duckham et al. showed that males over 65 had significantly greater rates of outdoor falls while engaging in recreational or vigorous activities. In turn, older females tended to have significantly higher rates of indoor falls, which more often proved to be injurious[19]. This study found a correlation between the number of falls in the 12 months before the study and the score for the TUG test ($p < 0.001$), followed by POMA ($p < 0.001$) and OLST ($p < 0.01$). King et al. investigated patients with Parkinson's disease, who might have difficulty turning over, and also found TUG to be superior to POMA and BBS[20]. On the other hand, Chiu et al. compared 4 functional tests, i.e., BBS, POMA, the Elderly Mobility Scale (EMS), and TUG, in fallers and non-fallers and concluded that BBS proved to be the most reliable in discriminating between fallers and non-fallers[21]. Some authors are of the opinion that standing balance is only one of the myriad competencies that contribute to an individual's ambulatory ability. BBS evaluates the dynamic aspects of balance, and thus it could be used to influence decisions about an individual's ambulation status or serve as targets for intervention strategies[13, 14]. Regardless, BBS should be combined with other balance tests in patients after stroke[13]. Sibley et al. showed that in Canada 70% of physiotherapists use OLST and BBS to evaluate balance, whereas TUG is used by only 56.9% of physical therapy practitioners, mainly due to lack of time during their work and lack of sufficient knowledge[22]. The use of balance tests in their work also depends on the goal of such an assessment. TUG evaluates the basic level of activity, whereas BBS supplies information about more complex balance-related problems. All tests allow for immediate comparison of the results before and after rehabilitation. Barry et al., in a systematic review and meta-analysis, showed that TUG has limited ability to predict falls among community-dwelling older adults, and should not be used alone to identify individuals at high risk of falling[23]. On the other hand, Zasadzka et al. confirmed that TUG effectively assessed balance in elderly patients with osteoarthritis[24]. The abovementioned tests will enable physiotherapists working with elderly residents of nursing homes to identify individuals who require prophylactic measures to prevent falls, including introduction of exercises that improve gait, balance, muscle strength, and coordination. According to Schoene et al., sensorimotor training with pneumatic compressors, balance platforms, and diversified exercises, including balance and aerobic exercises, should be included[25]. Based on the findings of the present study, it seems advisable to use 2 or more tests to assess the risk of falling in elderly residents of nursing homes. As indicated by the results, TUG and POMA are the most useful tools to screen for balance and gait impairment in this population.

REFERENCES

1) Hubbard RE, Eeles EM, Rockwood MR, et al.: Assessing balance and mobility to track illness and recovery in older inpatients. J Gen Intern Med, 2011, 26: 1471–1478. [Medline] [CrossRef]

2) Campbell AJ, Borrie MJ, Spears GF, et al.: Circumstances and consequences of falls experienced by a community population 70 years and over during a prospective study. Age Ageing, 1990, 19: 136–141. [Medline] [CrossRef]

3) Eckert KG, Lange MA: Comparison of physical activity questionnaires for the elderly with the International Classification of Functioning, Disability and Health (ICF)—an analysis of content. BMC Public Health, 2015, 15: 249–259. [Medline] [CrossRef]

4) Chang JT, Morton SC, Rubenstein LZ, et al.: Interventions for the prevention of falls in older adults: systematic review and meta-analysis of randomised clini-

cal trials. BMJ, 2004, 328: 680–683. [Medline] [CrossRef]

5) Padubidri A, Al Snih S, Samper-Ternent R, et al.: Falls and cognitive decline in Mexican Americans 75 years and older. Clin Interv Aging, 2014, 9: 719–726. [Medline]

6) Brouwer B, Musselman K, Culham E: Physical function and health status among seniors with and without a fear of falling. Gerontology, 2004, 50: 135–141. [Medline] [CrossRef]

7) Laessoe U, Hoeck HC, Simonsen O, et al.: Fall risk in an active elderly population—can it be assessed? J Negat Results Biomed, 2007, 6: 2. [Medline] [CrossRef]

8) Goodwin VA, Abbott RA, Whear R, et al.: Multiple component interventions for preventing falls and fall-related injuries among older people: systematic review and meta-analysis. BMC Geriatr, 2014, 14: 15. [Medline] [CrossRef]

9) Kamińska MS, Brodowski J, Karakiewicz B: Fall risk factors in community-dwelling elderly depending on their physical function, cognitive status and symptoms of depression. Int J Environ Res Public Health, 2015, 12: 3406–3416. [Medline] [CrossRef]

10) Folstein MF, Folstein SE, McHugh PR: "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res, 1975, 12: 189–198. [Medline] [CrossRef]

11) Podsiadlo D, Richardson S: The timed "Up & Go": a test of basic functional mobility for frail elderly persons. J Am Geriatr Soc, 1991, 39: 142–148. [Medline] [CrossRef]

12) Tinetti ME, Baker DI, McAvay G, et al.: A multifactorial intervention to reduce the risk of falling among elderly people living in the community. N Engl J Med, 1994, 331: 821–827. [Medline] [CrossRef]

13) Blum L, Korner-Bitensky N: Usefulness of the Berg Balance Scale in stroke rehabilitation: a systematic review. Phys Ther, 2008, 88: 559–566. [Medline] [CrossRef]

14) Stevenson TJ, Connelly DM, Murray JM, et al.: Threshold Berg balance scale scores for gait-aid use in elderly subjects: a secondary analysis. Physiother Can, 2010, 62: 133–140. [Medline] [CrossRef]

15) Bohannon RW, Larkin PA, Cook AC, et al.: Decrease in timed balance test scores with aging. Phys Ther, 1984, 64: 1067–1070. [Medline]

16) Gehlsen GM, Whaley MH: Falls in the elderly: Part II, Balance, strength, and flexibility. Arch Phys Med Rehabil, 1990, 71: 739–741. [Medline]

17) Müjdeci B, Aksoy S, Atas A: Evaluation of balance in fallers and non-fallers elderly. Braz J Otorhinolaryngol, 2012, 78: 104–109. [Medline] [CrossRef]

18) Nakano MM, Otonari TS, Takara KS, et al.: Physical performance, balance, mobility, and muscle strength decline at different rates in elderly people. J Phys Ther Sci, 2014, 26: 583–586. [Medline] [CrossRef]

19) Duckham RL, Procter-Gray E, Hannan MT, et al.: Sex differences in circumstances and consequences of outdoor and indoor falls in older adults in the MOBILIZE Boston cohort study. BMC Geriatr, 2013, 13: 133. [Medline] [CrossRef]

20) King LA, Mancini M, Priest K, et al.: Do clinical scales of balance reflect turning abnormalities in people with Parkinson's disease? J Neurol Phys Ther, 2012, 36: 25–31. [Medline] [CrossRef]

21) Chiu AY, Au-Yeung SS, Lo SK: A comparison of four functional tests in discriminating fallers from non-fallers in older people. Disabil Rehabil, 2003, 25: 45–50. [Medline] [CrossRef]

22) Sibley KM, Straus SE, Inness EL, et al.: Clinical balance assessment: perceptions of commonly-used standardized measures and current practices among physiotherapists in Ontario, Canada. Implement Sci, 2013, 8: 33. [Medline] [CrossRef]

23) Barry E, Galvin R, Keogh C, et al.: Is the Timed Up and Go test a useful predictor of risk of falls in community dwelling older adults: a systematic review and meta-analysis. BMC Geriatr, 2014, 14: 14. [Medline] [CrossRef]

24) Zasadzka E, Borowicz AM, Roszak M, et al.: Assessment of the risk of falling with the use of timed up and go test in the elderly with lower extremity osteoarthritis. Clin Interv Aging, 2015, 10: 1289–1298. [Medline] [CrossRef]

25) Schoene D, Valenzuela T, Lord SR, et al.: The effect of interactive cognitive-motor training in reducing fall risk in older people: a systematic review. BMC Geriatr, 2014, 14: 107–128. [Medline] [CrossRef]