Approaches and Models in Special Education and Rehabilitation

Belgrade 2020.

Approaches and Models in Special Education and Rehabilitation

THEMATIC COLLECTION OF INTERNATIONAL IMPORTANCE

Belgrade, 2020

Approaches and Models in Special Education and Rehabilitation
Thematic Collection of International Importance

Publisher
University of Belgrade – Faculty of Special Education and Rehabilitation
Publishing Center of the Faculty

For publisher
PhD Snežana Nikolić, Dean

Editors
PhD Goran Nedović, Professor
PhD Fadilj Eminović, Professor

Reviewers
PhD Danijela Ilić-Stošović, Professor, University of Belgrade – Faculty of Special Education and Rehabilitation
PhD Dragan Marinković, Associate Professor, University of Belgrade – Faculty of Special Education and Rehabilitation
PhD Siniša Ristić, Professor, University of East Sarajevo, Faculty of Medicine Foča, Bosnia and Herzegovina
PhD Bryan McCormick, Professor, Temple University, College of Public Health, United States of America

Cover design
Boris Petrović, MA

Technical Editor
Biljana Krasić

Proceedings will be published in electronic format CD.

Circulation 150

ISBN 978-86-6203-139-6

By decision no. 3/9 from March, 8th 2008. The Teaching and Research Council of the University of Belgrade – Faculty of Special Education and Rehabilitation initiated Edition: Monographs and papers.

By decision no. 3/63 from June, 30th 2020. The Teaching and Research Council of the University of Belgrade – Faculty of Special Education and Rehabilitation has given approval for the printing of Thematic Collection “Approaches and Models in Special Education and Rehabilitation“.

THE EFFECT OF FALLS AND OLDER AGE ON BALANCE PERFORMANCE AMONG ELDERLY POPULATION[a]

Milosav Adamović[1], Nenad Nedović[2], Vojislav Todorović[3], Miodrag Stošljević[1], & Dragan Nikodijević[3]

[1]*University of Belgrade, Faculty of Special Education and Rehabilitation, Belgrade, Serbia*
[2]*Medical College of Professional Studies, Belgrade, Serbia*
[3]*Faculty of Culture and Media, Megatrend University, Belgrade, Serbia*

SUMMARY

Falls and old age have negative effect on balance. Aim of research is to examine the effect of falls and older age on balance performance among elderly population. The sample comprised 142 individuals (52.8% men and 47.2% women) and the mean age for the participants was 73 years and 11 months (SD = 6 years and two months). To assess static and dynamic balance we use the total of twelve different balance test. Results show a statistically significant main effect of the variable related to fall when standing with feet partly put together, One Leg Stance ($p < 0.001$), 360 Degree Turn Test ($p < 0.05$) in mediolateral and anteroposterior direction. Significant main effect of age category on standing with the feet together eyes closed ($p < 0.05$) in anteroposterior direction and standing with feet partly put together, One Leg Stance ($p < 0.001$), Four Step Square Test, Time Up and Go Test – Motor/Cognitive ($p < 0.05$) in mediolateral and anteroposterior direction. Significant effect of the interaction of the factor of fall and the category of age when standing with the feet apart and eyes open ($p < 0.05$) in mediolateral direction, feet apart and eyes closed ($p < 0.05$) in anteroposterior direction, feet together and eyes closed in both directions. Conclusion of our study show that elderly people with a positive history of falling manifest significantly poorer balance on some balance tests compared to younger adults who did not experience a fall.

Key words: falls, old age, balance

INTRODUCTION

Today, 8.5% of the population is over 65 years old. By 2050, this number will increase to 17% (Wan, Goodkind, & Kowal, 2015), while in Europe the number of people over 65 will increase from 16% as measured in 2010 to 29.3% by 2060 (Creighton, 2014). Serbia is a country that follows that negative trend of demographic ageing, as well. According to the analysis of the Statistical Office of the Republic of Serbia on population trends of Serbia published in the Survey of the „Population Projection of the Republic of Serbia 2011–2041“, the number of people aged over 65 years will increase from 17.3% to 25.2%. Besides, the number of people aged over 80 years will increase from 3.5% to 7.8%, while the average age of the population will be 46.5 years (Statistical Office of the Republic of Serbia, Republic of Serbia, 2011).

a This research was done as part of the doctoral dissertation: Adamović, M. (2018). *Balance Assessment and Risk from Falling in the Elderly.* University of Belgrade, Faculty of Special Education and Rehabilitation.

Aging is defined as a persistent decline in the age-specific fitness components of an organism due to internal physiological degeneration (Rose et al., 2012). The aging leads to an increase in the number of chronic diseases (heart disease, arthritis, diabetes, obesity, and stroke), the severity of the disability and limited functionality (Bjorn, 2016). Almost 80% of people over 65 have at least one chronic illness, while 50% suffer from two or more diseases (Centers for Disease Control and Prevention, United States and worldwide, 2003). Increasing risk factors in the elderly lead to an increased incidence of falls. The causes of the falls can be divided into internal and external factors (Lord et al., 2007).

The category of external risk factors for falls in the elderly includes physical environment (insufficient light in the room, slippery floor, uneven surface, irregular stairs, lack of handrails), inappropriate walking aids or assistive devices (cane, stroller, walker), inappropriate (large) footwear, slippery surfaces of the footwear insoles, high heels (Lord et al., 2007). Falls are the leading cause of fatal and non-fatal injuries in people over 65 years of age (Bergen et al., 2016). On the other hand, injuries caused by falls are the fifth leading cause of mortality (Kannus et al., 2005), which is the high position if other health conditions that often affect the elderly population are taken into account, such as heart disease, cancer, stroke, lung disease.

Available scientific studies indicate that older age and falls affect the ability to maintain balance. Difficulties in maintaining balance occur with age, and it has been found that "older" elderly are more prone to falls than "younger" elderly (Demura, Yamaji, & Kitabayashi, 2005; Steffen, Hacker, & Mollingesr, 2002) have examined age-related differences in dynamic balance in the elderly using four tests. A decreasing number of steps and the increasing average ground connecting time during stepping were noted in older subjects, in contrast to the younger ones. Another study found that the elderly had increased body sway. This study consisted of two stances (self-selected, narrow) and two visual conditions (eyes open, eyes closed). Based on the research results, age is a significant predictor of increased body sway velocity and that with age, body sway velocity increases (Riemann et al., 2018). Similar study results were reported by Butler et al., (2009). Using seven different tests, with balance as the main parameter, they found that older subjects had worse performance than younger ones (Butler et al., 2009).

Research aim is to examine the effect of falls and older age on balance performance among elderly population.

METHOD

The survey was conducted during July and August 2017 within the Home for Adult and Elderly Persons "Bežanijska kosa" (Belgrade), as well as within the day clubs for the elderly, sponsored by the Gerontology Center, Belgrade. Consent to conduct the research was approved by the Board of Directors and the Director of the Home for Adult and Elderly Persons "Bežanijska kosa".

Procedure and data collection

Potential candidates, with the help of a social worker, were introduced with the research, the activities that are expected of them, the manner of realization of the activities, the exclusion criteria, and the research aim. Those candidates who met the criteria and who wanted to participate have confirmed their consent in writing. Data on the health status were obtained through an interview with the participants themselves, used solely for scientific research purposes. and could not be connected with the person's identity.

Criteria for exclusion from the study in both groups were less than 65 years of age, inability to stand and walk independently, use of mobility aids or devices, presence of ophthalmic (cataract, glaucoma) and neurological diseases (stroke, Parkinson's and Alzheimer's disease), illness and injuries of the musculoskeletal system (arthritis, lumbar syndrome, hip fracture in the last two years), surgical cardio-vascular interventions in the last year, and vestibulopathy.

A special two-part protocol was created for data collection. The first part of the protocol included demographic data such as gender, age, education level, marital status, as well as the History of Falls Questionnaire (Mayers, Young, & Langlois, 1996).

The second part of the protocol included basic anthropometric measures, such as body weight and height, based on which each subject's body mass index was calculated, as well as balance tests. Two tests were used to evaluate the static balance, One Leg Stance Test – Eyes Open (Springer et al., 2007), and a modified Romberg test (Agrawal et al., 2011; Briggs et al., 1989; Guralnik et al., 1995; Rossiter-Fornoff et al., 1995), which were performed on Wii Balance Board (Kyoto, Japan, 2007). The tests used to evaluate the dynamic balance were the following: Four Step Square Test (Dite & Temple, 2002), Time Up and Go Test – Motor/Cognitive Task (Shumway-Cook & Brauer, 2000), 360 Degree Turn Test (Gill et al., 1995), and Timed 10-Meter Walk Test (Bohannon, 1997). Before performing the tests, the examiner gave verbal instructions first, then visually demonstrated the position or action required of the subject to perform, and finally, the subject performed one trial. The break between each repetition lasted at least one minute, that is, two minutes between performing the tests themselves. During the break, the subject was allowed to sit if needed. The subjects repeated each test three times and the best result was scored. Subjects performed static balance assessment tests without shoes, while dynamic balance assessment tests were performed in footwear that they normally used. The testing process itself was carried out continuously throughout the day in a pre-arranged term and schedule.

Sample

The study included a total of 142 subjects, 75 (52.8%) male and 67 (47.2%) female. The age of the subjects ranged from 64 years and five months to 89 years and six months, mean age 73 years and 11 months (SD = 6 years and 2 months). The range of years of education of the subjects ranged from 8 to 19, M = 12.82 (SD = 2.25). There were 86 (60.6%) subjects living with their family and 56 (39.4%) subjects living alone in the household.

Instruments

History of Falls Questionnaire (Mayers, Young, & Langlois, 1996) was used to collect data form those subjects who had sustained a fall in the past 24 months. In this study, a fall is defined as a sudden and unintentional change that causes a person "to rest on the ground, floor or other lower level, excluding intentional change in position to rest in furniture, wall or other objects" (WHO, Global Report on Falls Prevention in Older Age, 2007). This definition is supplemented by the definition of Kellogg (according to Zecevic, Salmoni, Speechley, & Vandervoort 2006), who points out that a fall as "unintentionally coming to the ground or some lower level and other than as a consequence of sustaining a violent blow, loss of consciousness, sudden onset of paralysis as in stroke or an epileptic seizure".

The Wii Balance Board (Kyoto, Japan, 2007) is a device (dimension: 45 x 26.5 x 3.5 cm; weight 3.5 kg), which has four sensory transducers installed below the standing surface, located at each corner of the board: top left, top right, bottom left and bottom right. These sensors, whose primary function is to convert one physical size to another, in the case of the Wii Balance Board, involve converting a vertical force into electrical signals that can measure its distribution in a horizontal plane. By measuring the electrical signals coming from all four sensors, especially when the person is standing on the platform, it is possible to accurately determine the pressure centre, i.e. the balance point as projected vertically below, on the surface. The centre of pressure of the body, i.e. its total movement, can be monitored and recorded in the anteroposterior and mediolateral direction of movement.

For proper functioning and measuring of the user's centre of pressure of the body in relation to the surface using the Wii Balance Board, it is necessary to provide certain technical prerequisites. First, the data on the shifting of the user's centre of pressure is transmitted wirelessly via Bluetooth to the laptop from the Wii Balance Board (in our study we used the Lenovo 110-15IBR and Windows 7). Second, to read the parameters, there is a need for specially designed software that graphically displays the imprint of the user's centre of pressure on the laptop screen. For this purpose, we have used the "Posturo Balance" software (Sport Medical Solutions, version 1.3.0, Faculty of Sport and Physical Education, University of Belgrade).

We used various modifications of the Romberg test to assess static balance (Agrawal et al., 2011), some of which were combined with a cognitive task. The motor tasks themselves are designed to activate the vestibular, visual and somatosensory systems to a greater extent. The tests were performed according to their level of difficulty, i.e. from a position of greater stability to a less stable position. The test is considered unsuccessful if a person uses his or her hands to maintain balance, is unable to maintain the required position for a predicted time (time is recorded), opens his or her eyes early in some tasks, or makes more than five errors in a cognitive task. The modified Romberg test is a commonly used test to assess the balance and risk of falls in healthy individuals over the age of 65. If a person is unable to hold the required positions for a period longer than 10 seconds, then he or she is considered to be at increased risk of falling.

The first task requires the subject to stand on the Wii Balance Board with their feet at least 15 cm apart, arms relaxed next to their body and eyes open, head straight, and to maintain this position as steadily as possible for a period of 30 seconds. In the second part of this task, the examiner requires the subject to remain in the same position, except with eyes closed. The third test is combined with the cognitive task, and the subject has to count backwards for the same period, with his / her eyes open starting from 100 by subtracting seven. This task is given just before the start of the test (Pajala et al., 2008).

In the second task, the subject was asked to put the feet together so that heels and toes were touching, to position arms relaxed next to the body and open eyes, and to maintain the required position as steady as possible for 30 seconds. After performing this task, the test is repeated with closed eyes (Bohannon et al., 1984).

In the third task, the balance is evaluated on a narrow stance. Subjects are required to look straight ahead and position one foot to the other one by putting the thumb of one foot next to the inner side of the heel of the other foot. A subject should maintain this position for a period of 20 seconds (Pajala et al., 2008).

One Leg Stance Test – Eyes Open (Springer et al., 2007) requires the subject to stand on the dominant leg (without shoes) as steady as possible for 30 seconds. The subject should bend one leg at the knee, fold his arms across chest, look straight, while the examiner measures time with a stopwatch. The test is stopped and time recorded (in seconds) if the subject touches the floor with the bent leg, uses his or her hands to maintain balance, moves the standing leg to maintain equilibrium, stand longer than 45 seconds. If the subject is unable to perform the test for more than five seconds, then he or she is considered to be at increased risk of falling. The dominance of lower extremities was determined by using a battery of tests for dominant lateralization assessment within the framework of "General Defectological Diagnostics", such as kicking the ball (the leg with which the person kicked the ball is the dominant one) (Ćordić & Bojanin, 2011).

The Four Step Square Test (Dite & Temple, 2002) is a clinical test that assesses the ability to change direction while stepping, and it includes a cognitive component. To perform the test, a stopwatch and four canes (90 cm long) are required. Four canes should be set-up like a cross on the floor. On the examiner's sign "Step", the subject should, while standing in the square no. 1, step into square no. 2 (located in front), then in the square no. 3 (located on the side) and then take a step back to square no. 4. When in square no. 4, the subject should return in the same direction to square no. 1 and then time stops. Subjects are required to complete the task as quickly as possible, but when stepping, they should make sure not to touch the canes, and that both feet should make contact in each square. If possible, the subject is asked to look straight while performing the task. The test is considered unsuccessful if the subject makes contact with the cane or loses balance. If the subject takes more than 15 seconds to perform the test, that subject is considered to be at increased risk of falling.

Performing the Time Up and Go Test – Motor/Cognitive Task (Shumway-Cook & Brauer, 2000) involves a motor task. Subjects are required to sit on a chair (45 cm high, without handles) and hold a glass filled with water in one hand of their choice. On the examiner's sign "Go", they should get out of the chair and walk three meters to the cone, then turn around and then return to the chair the same way. With a stopwatch, the examiner measures the time it takes the subject to perform this motor action. During the test, the cognitive task implies that the subject is counting backward by seven from 100 while walking. If the subject needs more than 15 seconds to complete these tasks, he or she is considered to be at risk of falling.

The 360 Degree Turn Test (Gill, Williams, & Tinetti, 1995) was used to evaluate the dynamic balance. The subjects were asked to stand on a line of adhesive tape previously glued to the floor, and to make the full circle in place on a verbal sign “Go”, so that they would finally return to their starting position, shoulders facing forward to the examiner. The examiner uses a stopwatch to measure the time, as well as the number of steps it takes a subject to perform this motor action. Research shows that if it takes more than 3.8 seconds for an elderly person to turn around itself in a full circle, then increased risk of falling is indicated.

The Timed 10-Meter Walk Test (Bohannon, 1997) was used in clinical practice to assess functional mobility and gait in individuals. The test measures the gait speed (in seconds) in relation to distance (in meters). The test is very easy to perform, the examiner marks a distance of 10 meters on the floor with adhesive tape before testing, and then, within that distance, further marks the second meter and the eighth meter. Subjects are required to position themselves behind the first line and to start at normal speed to the last line at the tenth meter. The stopwatch measures the time from the moment when the subjects cross a line at the second meter and stops when the subjects cross a line at the eighth meter, so that gait speed is measured over a distance of six meters, while the first two meters and last two meters serve for speeding up or slowing down the speed of walking. A walking speed of less than 0.7 m/s is a predictor of fall.

Statistical data processing

Survey data were processed using descriptive and inference statistics methods. The processing was performed in the Statistical Package for Social Sciences (SPSS) computer program, version 20. We used the following descriptive statistics measures: arithmetic mean, standard deviation, percentage. In the inference statistics, we used multivariate analysis.

RESULTS

The two-way multivariate analysis of variance was used with the following factors: fall (has sustained a fall; no history of fall) and age category (categories: 65–75 years; 76–85 years). Indicators of static and dynamic balance were selected as dependent variables, in order to examine whether there were statistically significant main effects of factors of experienced fall and age category and a significant effect of the interaction of these factors on indicators of static and dynamic balance. Multivariate analysis of variance takes into account the interrelationships of the dependent variables, in this case, the correlations of indicators of static and dynamic balance. The results of the analysis are presented in Table 1.

Table 1. *Results of two-way multivariate analysis of variance, dependent variables – static and dynamic balance indicators; factors –fall and age category*

Balance Tests	Factor	F	df	*p*
Wide stance with eyes open (ml.)	Fall	0.34	11	0.563
	Age category	2.97	11	0.088
	Fall x Age category	6.28	11	**0.014**
Wide stance with eyes open (ap.)	Fall	2.57	11	0.112
	Age category	1.42	11	0.236
	Fall x Age category	1.59	11	0.211
Wide stance with eyes closed (ml.)	Fall	0.01	11	0.945
	Age category	0.34	11	0.582
	Fall x Age category	2.85	11	0.089
Wide stance with eyes closed (ap.)	Fall	0.02	11	0.882
	Age category	7.81	11	**0.006**
	Fall x Age category	11.22	11	**0.001**
Wide stance with a cognitive task (ml.)	Fall	1.41	11	0.239
	Age category	3.07	11	0.083
	Fall x Age category	0.32	11	0.562
Wide stance with a cognitive task (ap.)	Fall	2.84	11	0.095
	Age category	1.27	11	0.262
	Fall x Age category	0.34	11	0.562
Closed stance with eyes open (ml.)	Fall	2.13	11	0.147
	Age category	3.70	11	0.058
	Fall x Age category	1.08	11	0.302
Closed stance with eyes open (ap.)	Fall	0.97	11	0.328
	Age category	0.17	11	0.677
	Fall x Age category	0.95	11	0.332
Closed stance with eyes closed (ml.)	Fall	0.44	11	0.509
	Age category	2.57	11	0.112
	Fall x Age category	6.62	11	**0.012**
Closed stance with eyes closed (ap.)	Fall	0.307	11	0.581
	Age category	4.40	11	**0.039**
	Fall x Age category	11.58	11	**0.001**
Semi-tandem stance (ml.)	Fall	444.39	11	**0.000**
	Age category	129.97	11	**0.000**
	Fall x Age category	0.18	11	0.671

Balance Tests	Factor	F	df	*p*
Semi-tandem stance (ap.)	Fall	730.79	11	**0.000**
	Age category	103.64	11	**0.000**
	Fall x Age category	0.00	11	0.957
One Leg Stance (ml.)	Fall	77.67	11	**0.000**
	Age category	21.12	11	**0.000**
	Fall x Age category	1.30	11	0.257
One Leg Stance (ap.)	Fall	102.13	11	**0.000**
	Age category	25.65	11	**0.000**
	Fall x Age category	0.65	11	0.799
Four Square Step Test	Fall	0.50	11	0.481
	Age category	6.86	11	**0.010**
	Fall x Age category	0.92	11	0.339
Timed Up and Go (motor)	Fall	2.81	11	0.097
	Age category	4.40	11	**0.039**
	Fall x Age category	0.61	11	0.436
Timed Up and Go (cognitive)	Fall	3.13	11	0.080
	Age category	12.44	11	**0.001**
	Fall x Age category	2.11	11	0.150
10m Walk Test	Fall	1.29	11	0.259
	Age category	1.09	11	0.299
	Fall x Age category	0.30	11	0.587
360 Degree Turn Test – left (number of steps)	Fall	0.65	11	0.424
	Age category	1.72	11	0.193
	Fall x Age category	0.01	11	0.903
360 Degree Turn Test - left (time)	Fall	4.42	11	**0.038**
	Age category	1.18	11	0.280
	Fall x Age category	0.04	11	0.849
360 Degree Turn Test – right (number of steps)	Fall	0.83	11	0.363
	Age category	2.03	11	0.158
	Fall x Age category	0.05	11	0.821
360 Degree Turn Test - right (time)	Fall	4.18	11	**0.044**
	Age category	0.91	11	0.342
	Fall x Age category	0.03	11	0.871

Note: ml – mediolateral direction; ap – anteroposterior direction; F – Fisher statistics; df – degrees of freedom; *p* – probability.

Table 1 shows a statistically significant main effect of the variable related to fall on the following measures of balance: shifting of the user's centre of pressure in the mediolateral and anteroposterior direction on the task of standing with feet partly put together and on the test of standing on one leg ($p < 0.001$) and time recorded for the 360-degree turn on left and right ($p < 0.05$).

Our data show that there is a statistically significant main effect of age category on the following measures of balance: shifting of the user's centre of pressure in the anteroposterior direction on the task of standing with the feet together and eyes closed ($p < 0.05$), on the change of the centre of pressure in both the anteroposterior and mediolateral direction on the task of standing with feet partly put together and the One Leg Stance Test ($p < 0.001$), the Four Step Square Test and the Time Up and Go Test – Motor/Cognitive Task ($p < 0.05$).

A statistically significant effect of the interaction of the factor of fall and the category of age on the following indicators of balance was confirmed: shifting of the centre of pressure in the mediolateral direction when standing with the feet apart and eyes open ($p < 0.05$), shifting of the centre of pressure in the anteroposterior direction with the feet apart and eyes closed ($p < 0.05$), shifting in the centre of pressure in both directions with the feet together and eyes closed. All these effects of interaction were statistically significant at the 0.05 level ($p < 0.05$).

DISCUSSION

The results of our study show that elderly people with a positive history of falling manifest significantly poorer dynamic (longer test time) and static balance on some balance tests. More precisely, a greater shifting of the body's centre of pressure was found in the mediolateral and anteroposterior direction of movement during standing on the Wii Balance Board, compared to younger adults who did not experience a fall.

Available research suggests that aging also leads to difficulties in maintaining balance (Steffen, Hacker, & Mollingesr, 2002). Demura et al., (Demura, Yamaji, & Kitabayashi, 2005) examined gender and age-related differences in dynamic balance in the elderly based on four stepping tests. They used a device that measured different parameters during stepping, such as foot contact time, number of steps during a certain time period, etc. The results obtained by the authors indicated significant differences by age in all test situations. Older subjects, in contrast to younger ones, performed fewer steps over a given period, while having an increased average ground connecting time during stepping.

As confirmation of previous research that over the years the ability to maintain body balance becomes more unstable and the risk of experiencing falls higher, we can cite the results of a study that found that the elderly have increased sway velocity. The subjects stood on a force platform on a wide and narrow stance with two visual conditions (eyes opened, eyes closed). Based on the research results, it was found that the age of a significant predictor of body sways velocity and that with age, the body sway increases (Riemann et al., 2018).

Similar results were obtained by Butler et al., (Butler et al., 2009). They examined age-related differences in functional mobility in the elderly using seven different tests. The balance was the main parameter for the success of the activity. The sample was divided into younger and older groups. The results indicated that older participants performed significantly worse than the younger ones.

Furthermore, based on the previous scientific and empirical material, it was found that older participants who reported having fallen had a poorer balance than those who did not experience a fall (citation). Using a force platform, Melzer et al., (Melzer, Benjuya & Kaplanski, 2004) have examined postural balance as a risk factor in the elderly who reported having fallen and those who did not. The authors have found a statistically significant difference between the groups in balance tests performed on a narrow base stance. The elderly participants who experienced recurrent falls had a significantly increased overall displacement of the body's centre of pressure during standing on the force platform, increased sway of the centre of pressure, as well as increased mediolateral body sway on open-eyed tasks during narrow base stance compared with participants who did not experience the fall.

The results of a study by Lin et al., (Lin et al., 2004) indicate that the elderly who experienced a fall in the Standing and Walking Test, which measures the time it takes a person to get out of a chair, walk three meters, and return, have increased average task completion time (16.8 seconds) compared to participants who did not experience the fall (12.9 seconds). In the Grasping Test, in which participants were asked to stretch their arms as far forward as possible without stepping, distances achieved were significantly longer in participants who did not experience the fall (15.1 centimeters) compared to elderly participants who experienced a fall (11.5 centimeters).

Toulotte et al., (Toulotte et al., 2006) compared different gait parameters in healthy elderly fallers and non-fallers. The results indicate that the elderly persons who experienced the fall had different gait and balance control parameters compared with the healthy elderly who did not experience a fall. On the single-leg balance test, subjects who experienced a fall touched the floor three times more often than subjects who did not experience a fall under eyes open conditions, and twice as often with their eyes closed. Statistically significant differences were found between groups in the gait parameters (cadence, speed, stride and step time, single-support time), which were worse for the group of fallers.

CONCLUSION

The results of our study indicate that the elderly who experienced a fall had a significantly poorer dynamic and static balance compared to young adults who did not fall.

The falls experienced every year worldwide by an increasing number of the growing population of third-age persons are a very serious social and medical problem. The falls, directly or indirectly, can cause temporary or permanent physical, psychological, social and economic problems that significantly limit the independence and quality lifestyle. The consequences of the fall have a negative impact, both on the persons who had fallen, their families, and the health care system that deals with the treatment and rehabilitation of the injured.

We can conclude that falls in the elderly represent a global social phenomenon, which knows no boundaries. Raising awareness of this problem is not only health but also a general national task that needs to be further worked on.

More specifically, we tested the elderly only during one encounter, instead of being longitudinally monitored and examined on several occasions over a longer period, for example, one year. Recommendations for future research could be to examine the balance in, for example, the populations of elderly people in nursing homes. This population has also been recognized in the literature for its unstable balance and at high risk of experiencing falls. Moreover, the balance could also be examined in elderly patients on hospitalization or those who have some third-age specific chronic illnesses (arthritis, diabetes, neuropathies).

REFERENCES

1. Agrawal, Y., Carey, J. P., Hoffman, H. J., Sklare, D. A., & Schubert, M. C. (2011). The modified Romberg Balance Test: normative data in U.S. adults, *Otology & Erotology, 32*(8), 1309–1311. https://doi.org/10.1097/MAO.0b013e31822e5bee.
2. Bergen, G., Stevens, M. R., & Burns, E. R. (2016). Falls and Fall Injuries Among Adults Aged ≥65 Years - United States, 2014. *Morbidity and Mortality Weekly Report, 65*(37), 993-998. https://doi.org/10.15585/mmwr.mm6537a2.
3. Bjorn, L. (2016). *The Rise in Life Expectancy, Health Trends among the Elderly, and the Demand for Health and Social Care*. Working Papers 142, National Institute of Economic Research. Retrieved from March 1, 2017. https://www.konj.se/download/18.45f4dff21532e40aa884dc49/1456823350974/Working-paper-142-The-rise-in-Life+Expectancy-health-trends-among-theelderly-and-the-demand-for-health-and-social-care.pdf.
4. Bohannon, R. W. (1997). Comfortable and maximum walking speed of adults aged 20–79 years: reference values and determinants. *Age and Ageing, 26*(1), 15–19.
5. Bohannon, R. W. (1997). Comfortable and maximum walking speed of adults aged 20–79 years: reference values and determinants. *Age and Ageing, 26*(1), 15–19.
6. Bohannon, R. W., Larkin, P. A, Cook, A. C., Gear, J., & Singer, J. (1984). Decrease in timed balance test scores with aging. *Physical Therapy, 64*(7), 1067–1070.
7. Butler, A., Menant, J., Tiedemann, A., & Lord, A. (2009). Age and gender differences in seven tests of functional mobility. *Journal of Neuroengineering Rehabilitation, 6*(31). https://doi.org/10.1186/1743-0003-6-31.
8. Centers for Disease Control and Prevention (CDC) (2003). Trends in aging United States and worldwide. *Morbidity and Mortality Weekly Report, 52*(6), 101–104. Retrieved from 10 March, 2020. https://www.cdc.gov/mmwr/preview/mmwrhtml/mm5206a2.htm.
9. Ćordić, A., & Bojanin, S. (2011). *Opšta defektološka dijagnostika*, Beograd: Zavod za udžbenike i nastavna sredstva, ISBN 978-86-17-17526-7.
10. Creighton, H. (2014). *Europe's Ageing Demography*. EU Factpack. Retrieved from 10 March, 2020. https://ilcuk.org.uk/wp-content/uploads/2019/11/Europes-Ageing-Demography.pdf
11. Creighton, H. (2014). *Europe's Ageing Demography*. EU Factpack. Retrieved from 10 March, 2020. https://ilcuk.org.uk/wp-content/uploads/2019/11/Europes-Ageing-Demography.pdf

12. Demura, S., Yamaji, S., & Kitabayashi, T. (2005). Gender and age-related differences of dynamic balancing ability based on various stepping motions in the healthy elderly. *Journal of Human Ergology (Tokyo), 34*(1–2), 1–11.
13. Dite, W., & Temple, V. A. (2002). A clinical test of stepping and change of direction to identify multiple falling older adults. *Archives of Physical Medicine and Rehabilitation, 83*(11), 1566–1571.
14. Gill, T. M., Williams, C. S., & Tinetti, M. E. (1995). Assessing risk for the onset of functional dependence among older adults: the role of physical performance. *Journal of the American Geriatrics Society, 43*(6), 603–609.
15. Gill, T. M., Williams, C. S., & Tinetti, M. E. (1995). Assessing risk for the onset of functional dependence among older adults: the role of physical performance. *Journal of the American Geriatrics Society, 43*(6), 603–609.
16. Kannus, P, Parkkari, J., Niemi, S., & Palvanen, M. (2005). Fall-induced deaths among elderly people. *American Journal of Public Health, 95*(3), 422-424. 1 https://doi.org/0.2105/AJPH.2004.047779.
17. Lin, M., Hwang, H., Hu, M., Wu, H., Wang, Y., & Huang, F. (2004). Psychometric comparisons of the 'Timed Up and Go', 'One-leg Stand', 'Functional Reach', and 'Tinetti Balance Measures' in community-dwelling older people. *Journal of American Geriatrics Society, 52*(8), 1343–1348. https://doi.org/10.1111/j.1532-5415.2004.52366.
18. Lord, S., Sherrington, C., & Menz, H. B. (2007). *Falls in Older People: Risk Factors and Strategies For Prevention*. Cambridge: Cambridge University Press. ISBN 0-521-58964-9, Retrieved from February 12, 2017, https://www.stayonyourfeet.com.au/wp-content/uploads/2015/03/Falls-inOlder-People-Risk-Factors-and-Strategies.pdf.
19. Melzer, I., Benjuya, N., & Kaplanski, J. (2004). Postural stability in the elderly: a comparison between fallers and non-fallers. *Age and Ageing, 33*(6), 602–607. https://doi.org/10.1093/ageing/afh218.
20. Myers, A. H., Young, Y., & Langlois, J. A. (1996). Prevention of falls in the elderly. *Bone, 18*(1), 87–101.
21. Pajala, S., Era, P., Koskenvuo, M., Kaprio, J., Tormakangas, T., & Rantanen, T. (2008). Force Platform Balance Measures as Predictors of Indoor and Outdoor Falls in Community-Dwelling Women Aged 63–76 Years. *Journal of Gerontology, 63*(2), 171–178.
22. Riemann, B. L., Lininger, M., Kirkland, M. K., & Petrizzo, J. (2018). Age related changes in balance performance during self-selected and narrow stance testing. 202 *Archives of Gerontology and Geriatrics, 75*, 65–69. https://doi.org/10.1016/j.archger.2017.11.012.
23. Rose, J., Wolf, D. R., Jones, V. K., Bloch, D. A., Oehlert, J. W., & Gambie, J. G. (2002). Postural balance in children with cerebral palsy. *Developmental Medicine & Child Neurology, 44*(1), 58–63.
24. Rose, M. R., Flatt, T., Graves, J. L., Greer, L. F., Martínez, D. E., Matos, M., ... & Shahrestani, P. (2012). What is aging? *Frontieres in Genetics.* 3:134.
25. Statistical Office of the Republic of Serbia (2011). *Projection of population in Republic of Serbia 2011–2041*, Retrieved from March 3, 2017, http://pod2.stat.gov.rs/ObjavljenePublikacije/Popis2011/Projekcije%20stanovnistva%202011-2041.pdf.
26. Steffen, T. M., Hacker, T. A., & Mollinger, L. (2002). Age- and gender-related test performance in community-dwelling elderly people: Six-Minute Walk Test, Berg Balance Scale, Timed Up & Go Test, and gait speeds. *Physical Therapy, 82*(2), 128–137. doi.org/10.1093/ptj/82.2.128.
27. Wan, He., Goodkind, D., & Kowal, P. (2015). *An Aging World: 2015*. U.S. Government Publishing Office Washington, DC, 2016.
28. Wan, He., Goodkind, D., & Kowal, P. (2016). *An Aging World: 2015*. U.S. Government Publishing Office Washington, DC.

29. World Health Organization. (2007). *WHO global report on falls prevention in older age*, Geneva, Switzerland. ISBN 978 92 4 156353 6, Retrieved from 22, September 2017, http://www.who.int/ageing/publications/Falls_prevention7March.pdf.
30. Zecevic, A. A., Salmoni, A. W., Speechley, M., & Vandervoort, A. A. (2006). Defining a fall and reasons for falling: comparison among the views of seniors, health care providers, and the research literature. *The Gerontologist, 46*(3), 367–376.