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The assessment of functional fitness and risk of falls in people aged 70 and older

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Abstract

Introduction. One of the key elements of successful aging is to maintain autonomy and independence in daily activities and performance.
Aim. The aim of this dissertation is to evaluate the functional capacity of elders. Due to the growing proportion of elderly people in the society, the next objective of the research was to assess the risk of falls in people over 70 years of age.
Material and methods. The study included 72 people with an average age of 78.74 years +/- 6.50 years, including 44 women and 28 men. The inclusion criteria for the study group was completing 70 years of age and the result above 23 points obtained in the MMSE test (The Mini Mental State Examination). To evaluate balance, a few tests such as Berg Balance Scale, "get up and go" test, Tinetti Test, and Senior Fitness Test were used. In addition, I used Barthel scale to assess functional capacity. The assessment of the balance was based on the Tinetti test and Berg scale. These tests also assess the seniors' exposure on downs.
Results. The results reflect the occurrence of deficits during gait and in the process to maintain balance. For 72 subjects in the test Tinetti only 17 participants showed minor threat of falling, and in 24, risk was five times higher than in others. Test 'get up and go', showed that the increased risk of falls in the study group concerns 28 people, while a high risk of 20 respondents.
Conclusions. The dependence between the risk of falls and reduced functional efficiency points to the need of implementing exercises in geriatric care that could improve the efficiency and the body balance.

Keywords: risk assessment, geriatric assessment, falls, older people

Introduction

Due to demographic changes that take place in society, more and more interest in literature is devoted to issues of ageing and old age. The Central Statistical Office's data clearly indicates an increase in the share of older people in society in relation to the number of people in the pre-working age. This is related to the extended average life expectancy and the decline in the birth rate [1].

The average life expectancy in Poland is 73.8 years (for women 81.6 years and for men 73.8 years). It is predicted that in 2020 the percentage of the elderly in Polish society will amount to 18.2%, and in 2050 to 29.4%. The CSO's forecasts indicate that from 2008 to 2030 the number of people aged 60-74 will increase by 40%, 75-84 years by 66%, and 85 years and more by as much as 90%. At the same time, the number of centenarians will increase [2].

The ageing process leads to a deterioration of regenerative possibilities and to a limitation of the body's efficiency in a natural way. External changes, particularly visible in the body's posture, directly affect the functional state of man [3]. The co-existence of various types of diseases or dysfunctions often prevents a return to previous physical fitness by reducing the quality of life of a given person. Disorders resulting from changes in the neuromuscular and osteoarticular systems adversely affect the sense of balance, thus increasing the risk of falls [4].

Various ailments and life restrictions that worsen with age impair full physical fitness. In advanced age, a correct assessment of functional efficiency plays an extremely important role and belongs to the so-called comprehensive geriatric assessment [5].

The consequences of an ageing population are a challenge for the healthcare system. Disability, social isolation, depression, deterioration of material conditions among seniors - all these factors cause an increase in the need for medical and nursing assistance. Due to the complexity of health and psychological problems of the elderly, cooperation of an interdisciplinary team specializing in the care of geriatric patients is required. The goal of this thesis was to evaluate the functional fitness of elder people and evaluate the risk of fall for people over 70 years old [6].

Material and methods

The research covered 72 people (including 44 women and 28 men), aged 70 – 92 years. The average age was 78.74 years. People with primary education (n = 36) were the largest group of respondents and with higher education - the smallest one (n = 7). In addition, the respondents were divided into four age groups: 70-74 years, 75-79 years, 80-84 years, and over 85 years.

The largest group was composed of people aged 70-79, whereas the smallest group was between 80 and 84 years of age. The research was made from August 2015 to January 2016.

The study group included the following respondents:

- aged 70 years or older,

- with at least 23 points in the MMSE test (which indicated that the patients would understand the physiotherapist's instructions),
- willing to participate and give intentional consent to participate in the study.

All the respondents were informed about the purpose of the research, its duration, methods, and any possible risks. They expressed their written consent to participate in the research. All the research was made by on physiotherapist to preserve the repeatability of collected data.

The examination consisted of the following stages:
- taking a medical history. On this stage patients were asked about age, whether falls occurred within last year, and taken medications,
- checking patient's cognitive abilities and mental capacity using the MMSE test,
- functional fitness assessment.

The following research tools were used to assess functional fitness:

1. the Barthel scale - used for evaluation of the following activities: ability to autonomously consume meals, moving from a bed to a chair and vice versa, sitting, maintaining personal hygiene, autonomy in the scope of using toilet, washing and bathing, as well as the activity of moving on flat surfaces and stairs, ability to dress and undress, and autonomous bladder and bowel control.[7] Acquiring a result between 86 and 100 points confirms the patient's independence, result between 85 and 21 points indicates a medium-heavy state, and result between 20 and 0 points points to patient's dependence in performing daily activities. [8]
2. Berg balance scale - used for static and dynamic evaluation of body's balance. It consists from 14 tasks evaluated in a scale from 0 to 4 points each. The maximum number of points in the test is 56. A total sum of points below 20 indicates patient's dependence, acquiring a result between 21 and 40 points indicates a small dependence of a patient, and above 41 points patient is completely autonomous and independent from the environment [9] One of Berg Balance Scale elements assessing the risk of fall is the test of standing on one leg. During this test, the respondent can acquire 4 points if he is able to stand on one leg for more than 10 seconds, 3 points if s-/he is able to maintain balance for 5-10 seconds, 2 points if s-/he is able to maintain balance for 3-5 seconds, 1 point if s-/he is able to maintain balance for less than 3 seconds, and 0 points if s-/he is not able to stand on one leg [10].
3. "get up and go" test - allows to evaluate the execution degree of respondent changing the position from sitting to standing, walking 3 metres, and maintaining a stable posture during a 180 degree turn and sitting back on chair. The universality of this test is the gauge of working capacity and also allows to evaluate the functional condition of elder people. Lack of functional fitness disorders and small risk of fall is indicated by acquiring a time below 10 seconds in the test. The average risk of fall is indicated by a result between 10 and 19 seconds and completing the test in a time exceeding 19 seconds significantly increases the risk of fall [11].
4. Tinetti Balance Assessment Tool (Tinetti Test) - contains 9 tests concerning maintaining balance and 7 tests, which analyse walking. The respondent can

receive 0, 1, or 2 points for each activity. The maximum number of points from balance tests is 16 and from walking tests – 12 (the total amount of points that can be acquired in the test is 28). Acquiring a result below 19 points indicate a high risk of fall, result between 19 and 24 points indicates a tendency for falls, and result above 24 points to exceptionally low risk of fall [12].

5. Senior Fitness Test - this test consists of 6 tasks, however, only 4 of them were used for the needs of this thesis. In the Senior Fitness Test examination were used the following test position in subsequent four tests: 30-second Chair Stand Test, 30-second Arm Curl Test, Chair Sit-and-Reach Test, and Back Scratch Test [13].

A permission of the Bioethics Committee at the Silesian Piasts University of Medicine in Wrocław to carry out examinations was acquired. All respondents were informed about the rules and goal of examination and expressed a written permission to participate in the examination.

The statistical analysis was carried out in STATISTICA 10 program.
- Acquired variables were presented in the form of average value, median, and Standard Deviations (SD).
- Compliances of variables distribution with normal distribution were checked using the Shapiro-Wilk test.
- Differences between groups of examined people in fixed variable values were checked using the t-Student or U Mann-Whitney test at a statistical significance a=0.05 and Bonferroni correction due to the amount of tested hypotheses was applied where it was necessary.
- Differences between groups of examined people characterised by quality variable were analysed using a precise Fisher test for contingency matrix with size of 2x2 or chi-squared conformity test in case of bigger matrixes. In case of small number of observations (n<5) in the contingency matrix cells, the Yates correction to continuity was applied in chi-squared test. A precise Fisher test was used as a post-hoc test, which was carried out separately for each sub-group and after that the Bonferroni correction due to the amount of tested hypotheses was applied.
- Analysis of Variance (ANOVA) was used in case of simultaneous comparing more than 2 groups of examined people in fixed variable values.
- A linear regression model used for Analysis of Variance was diagnosed in terms of normality of rest using the Shapiro-Wilk test and in terms of variance homogeneity using the Bratlett test.
- The fall occurrence probability depending on a group of factors was modelled using logistic regression in the General Linear Model diagram. The model adaptation degree was determined on the basis of Akaike Information Criterion (AIC).

The Variance Inflation Factor (VIF) was used as a measure for collinearity of explanatory variables. Explanatory variables were considered as collinear when VIF>10.

Results

The assessment of performing daily activities according to the Barthel scale

The analysis of the functional fitness results assessed on the Barthel scale has demonstrated the patients' independence in performing everyday activities. Compared with men, women showed better functional fitness. The largest group of respondents were people whose condition is described as light. The remaining patients obtained a score between 21-85 points during the test, which indicates little help in performing daily activities (tables 1 and 2).

Table 1. Assessment of functional fitness by gender

Functional fitness assessment - Barthel scale	Women	Men	Total
Light condition	32	23	55 (77%)
Medium to heavy condition	12	5	17 (23%)
Heavy condition	0	0	0
			72 (100%)

Table 2. Assessment of functional fitness by age

Functional fitness assessment - Barthel scale	70-74 years	75-79 years	80-84 years	85 years and more	Total
Light condition	18	17	10	9	55
Medium to heavy condition	0	4	3	10	17
Heavy condition	0	0	0	0	0

The functional fitness degree evaluation between age groups was analysed usingthe chi-squared compliance test. The general chi-squared test has shown that people belonging to various age categories differ between each other with a functional fitness degree measured with a Barthel scale test. Among four performed post-hoc tests, two of them have shown significant differences. They concerned age categories - 2^{nd} and 4^{th}. However in the end, after the application of Bonferroni correction for the amount of tested hypotheses, only 4^{th} age category (85+) turned out to have a significantly different functional fitness degree in comparison to other groups. In this group, people have the medium-heavy functional fitness degree over 16.5 time (OR=0.06) more often than people from the other 3 age categories taken together.

The amount of medication taken

The difference in the amount of medication taken between groups of people with or without falls was tested using the Mann-Whitney U test. The analysis has shown that people in a group with falls take more medications available without prescription than people in group without falls.

A majority of patients in both groups took at least 3 medications on a daily basis. Taking 5 or 6 medications was reported by 15 people from the group with falls and 8 people from the group without falls. Due to the possible manifestation of undesired reactions, taking numerous medications can increase the risk of fall (tables 3 and 4).

Table 3. The amount of medication taken in people with or without falls

Number of people	The amount of medication taken					
	0	1-2	3-4	5-6	7-8	>9
People with falls	0	3	7	15	6	1
People without falls	3	13	13	8	3	0

Table 4. Drug groups used by patients with falls and without falls

Data	People without falls n=40	People with falls n=32
The amount of medicines	4,30 +/- 2,78	5,75 +/- 2,20
Antidepressants	5%	15,6%
Sedatives	17,5%	21,8%
Antihypertensive drugs	42,5%	71,8%
Sleeping pills	7,5%	18,7%
Other medicines	67,5%	90,6%

Fear of falling

During a short interview respondents were asked about the occurrence of medication before subsequent falls (yes/no). The analysis of interview questionnaire has shown that 72% of respondents (23 people) who have experienced a fall in the past fears another such incident.

However, as many as 60% of people (24 people) without a reported fall experience a similar level of anxiety (Fig.1)

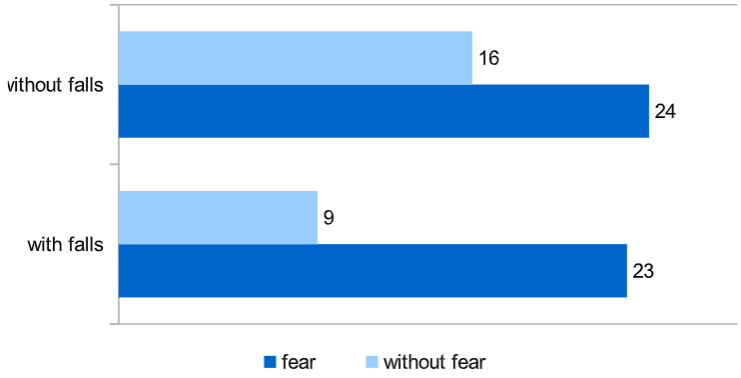

Fig. 1. The assessment of the degree of fear in people with or without falls

Balance assessment and risk of falling

Timed up and go test

A comparison of the TUG (Timed up and go) test values for people with and without falls is shown in tables 5 - 6. The test result does not allow to find a significant difference in the TUG test values
between the mentioned groups (p = 0.679).

Tinetti test

The analysis of the results confirmed a more frequent occurrence of balance and walk disturbances in people who had fallen in the past (tables 5 and 6).

Table 5. Assessment of balance in people who fell (n = 32)

Tests	*Min*	*Max*	*Median*	*Mean*
TUG	8.87 sec	26.17 sec	14.50 sec	15.15 sec
Tinetti	10.00 points	26.00 points	19.00 points	18.84 points
Berg scale	20.00 points	47.00 points	36.50 points	35.72 points

Table 6. Assessment of balance in people who did not fall (n = 40)

Tests	*Min*	*Max*	*Median*	*Mean*
TUG	8.84 sec	25.47 sec	13.50 sec	14.63 sec
Tinetti	13.00 points	26.00 points	22.00 points	21.82 points
Berg scale	25.00 points	52.00 points	42.00 points	41.73 points

The average point value obtained by the respondents in the Tinetti test was 20.2.

The average of 11.05 points, which is 69% of the maximum value, was obtained by the respondents for the balance assessment, whereas the walk score was 9.2 points,

which gives 76% of the maximum value. The average value of points in men and women in both tasks was statistically insignificant. In 24% of the respondents, the Tinetti test result was within the norm. 43% of people were characterized by a medium fall risk, while in 33% the probability of a fall was high.

In tests assessing the balance, the participants found it difficult to get up, rotate 360 degree, and sit down. When getting up, every third person helped with their hands and when trying to sit down assessed the distance separating the person from the chair poorly.

The walk analysis also showed abnormalities. Most disorders occurred in the length and height of step and in the assessment of the torso during the walk. Over 60% of the respondents inclined the body and were characterized by a no visible phase of propulsion.

Berg scale

The comparison of groups of people with a fall and without a fall in terms of the number of independent people and people in need of care was made with the help of Fisher's exact test.

People from the group who had experienced a fall in the past were characterized by worse

Berg scale results (tables 5 and 6).

The analysis showed differences in the performance of the task: "Standing on one leg" and "reaching out while standing".

The results of the "standing on one leg" test showed that older people who had experienced a fall in the past have much shorter times in the test (Fig.2)

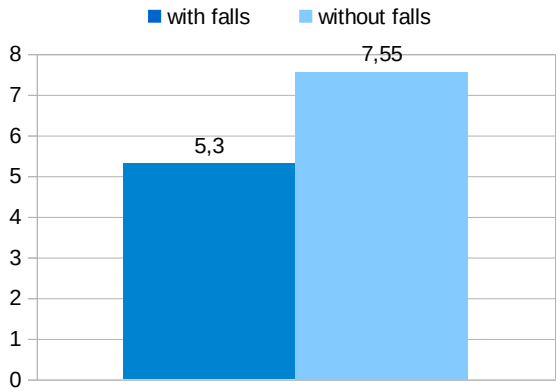

Fig. 1. Time standing on one leg in people with and without a fall

The results of the "reaching out while standing" test in the study group showed differences in people with or without falls. In the group of people without a fall most patients were able to reach safely above 12.5 centimetres. People with falls in the interview were able to reach safely above 5 centimetres (Fig. 3).

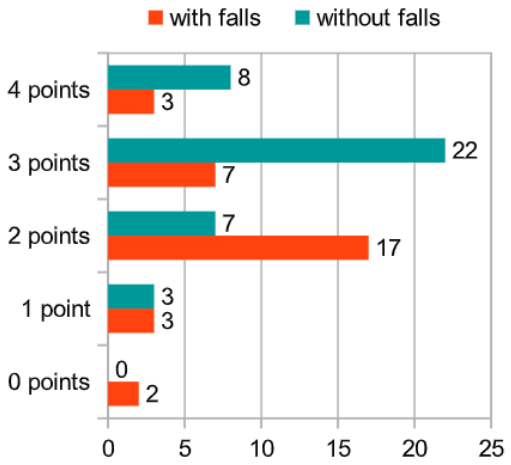

Fig. 2. The number of points gained in the task: reaching out while standing in people with and without a fall

Functional fitness at the senior fitness test

The International Council of Sport Science and Physical Education recommends using the SFT test in evaluation of functional fitness of people older than 60 years. Tables 7 and 8 are present in detail standards, which take into account division by sex.

Table 7. SFT - standards for men

	70-74	75-79	80-84	85-89	90+
Chair Stand	12-17	11-17	10-15	8-14	7-12
Arm Curl	14-21	13-19	13-19	11-17	10-14
Chair Sit&Reach	-8,5 to 6	-10 to 5	-13,5 to 3,5	-13,5 to 1,5	-16 to 1,5
Back Scratch	-20 to -2,5	-22,5 to -5	-24 to -5	-25 to 7,5	-26 to -10

Table 8. SFT- standards for women

	70-74	75-79	80-84	85-89	90+
Chair Stand	10-15	10-15	9-14	8-13	4-11
Arm Curl	12-17	11-17	10-16	10-15	8-13
Chair Sit&Reach	-2,5 to 10	-3,5 to 8,5	-5 to 7,5	-6,5 to 6,5	-11 to 2,5
Back Scratch	-10 to 2,5	-12,5 to 0	-14 to 0	-17,5 to -2,5	-20 to -2,5

Chair stand

In the 30-second Chair Stand Test - in the group of 72 people, 25 respondents obtained a result below the norm, of which 19 respondents did not achieve more than 10 repeats. This may be a proof of the weakened muscular strength of the lower body, which consequently predisposes to an increased risk of falls (table 9).

Table 9. Assessment of functional efficiency in the task: Getting up from the chair

	70-74	Chi square	75-79	Chi square	80-84	Chi square	85+	Chi square
below standard	4	0,056	2	0,208	9	0,014	10	0,139
In the norm	13	0,181	15	0,028	1	0,125	4	0,056
Above the standard	6	0,083	4	0,056	4	0,056	0	0

P-value= 0,002 chi-square= 24.039

Arm curl

In the 30-second Arm Curl Test (arm strength assessment) - values below the norm were recorded in 10 respondents. The weakening of the muscular strength of arms creates problems when shopping, and hinders daily activities (table 10).

Table 10. Assessment of functional efficiency in the task: Strength of arms

	70-74	Chi square	75-79	Chi square	80-84	Chi square	85+	Chi square
below standard	4	0,056	1	0,014	0	0	5	0,069
In the norm	16	0,222	17	0,236	13	0,181	8	0,111
Above the standard	3	0,042	3	0,042	1	0,014	1	0,014

P-value= 0,11 chi-square= 10.254

Chair Sit & Reach

In the Chair Sit-and-Reach Test (thigh flexibility assessment) - 19 respondents obtained a result below the lower limit of the norm, including 4 persons with results that were very unfavourable (from - 15cm to - 24 cm). Reduced flexibility of the lower limbs is conducive to problems related to bending, dressing, putting on footwear, entering the bathtub (table 11).

Table 11. Assessment of functional efficiency in the task: Assessment of thigh elasticity

	70-74	Chi square	75-79	Chi square	80-84	Chi square	85+	Chi square
below standard	5	0,069	3	0,042	2	0,028	9	0,125
In the norm	18	0,250	18	0,250	12	0,167	5	0,069
Above the standard	0	0,000	0	0,000	0	0,000	0	0,000

P-value= 0,004 chi-square= 13.246

Back Scratch

In the Back Scratch Test (hand flexibility test) - among 72 respondents, in 14 people the valuesbelow the average were recorded. 9 out of 14 tested persons scored above - 20 cm. Limiting the muscle elasticity of the upper limb rim leads to problems with raising hands, dressing the upper garment or doing the bra (table12).

Table 12. Assessment of functional efficiency in the task: Assessment of the flexibility of the hands

	70-74	Chi square	75-79	Chi square	80-84	Chi square	85+	Chi square
below standard	4	0,056	2	0,228	1	0,014	7	0,097
In the norm	16	0,222	16	0,222	13	0,181	6	0,083
Above the standard	3	0,042	3	0,042	0	0,000	0	0,014

P-value= 0,034 chi-square= 13.688

Discussion

Physiological changes in the ageing process occur throughout the human body. However, the rate of these changes depends on many factors, such as physical activity, comorbidities

or genetic determinants. The effect of ageing is deterioration of functional fitness and physical fitness, which significantly limits seniors' self-dependence.

Research by Kachaniuk et al. shows that the majority of the respondents over 65 have good physical fitness. The author also noted that in the surveyed group, women were characterized by better physical fitness [14]. It can be influenced to a certain degree by the fact that in Kachaniuk et al. examinations women constituted 54% of examined group. Own studies indicate a slightly different results. The analysis of the results of the "standing on one leg" test and the SFT showed that in the examined group men are better.

Borowicz and Wieczorowska-Tobis also decided to evaluate physical fitness of elderpeople. In the examinations of authors, patients have acquired by average 90.8 points in the Barthel Index, where 49 of them have acquired the maximum amount of points [15]. In own studies, the average acquired by patients amounted to 89.1 points in theBarthel scale, where 27 patients have acquired the highest possible amount of points.The functional fitness of examined group was evaluated i.e. using the Senior Fitness Test.

Szewieczek et al. used SFT elements to assess the activity of older people, comparing the results before and after the rehabilitation period [16].

Studies by Takata et al. show that older women are characterized by weak muscle strength and show greater balance disorders than men [17]. This research confirms this dependence. In the Chair Stand test, the analysis showed differences between the group of men and women with a division into people with and without falls. Women with a fall are characterized by weakened muscle strength and made fewer repetitions in the test.

Checking the differences in the Chair Sit & Reach test between women and men, with a division into persons with and without a fall, showed no relationship between groups of women and men with a fall ($p = 0.357$), while there was a correlation between men and women in general ($p = 0.007$). Better flexibility was reported among men.

In their studies using the SFT, Toraman et al. showed that the weakening of muscle strength and deterioration of the ability to maintain balance predisposes to falls [18].

Węgrzynowska - Teodorczyk et al. used the SFT test in the study of patients with a diagnosed heart failure. The patients showed good test tolerability, no adverse effects on the cardiovascular and respiratory systems were observed. Thus, during the diagnostics of people with existing heart failures and other geriatric diseases, a supplementation of this diagnosis may be the use of the SFT test [19].
In their studies, Kamińska et al. have shown that the risk of fall increases along with age and that women are more exposed to falls. Own studies do not confirm the dependency of influence between sex and increased risk of fall [20].

The analysis of risk of fall using the Tinetti Test shows that the low risk of fall occurs among 24% of examined patients, medium – among 43%, and high – among 33% of patients. Kujawa et al. also analysed the risk of fall using the Tinetti Test [21]. The acquired results indicate that a slight risk of fall occurs among 73.4% of respondents, medium risk – among 15.2%, and high – among 11.4% of respondents.

The application of "get up and go" test in the evaluation of risk of fall has shown that among 1/3 of examined people the risk is minimal. The average risk was noted among 39% of people, and high risk was noted among 28% of respondents. The studies performed by Wdowiak and Budzyńska-Kapczuk confirm the acquired results [22].

The "standing on one leg" test was another element of the balance assessment. During the test, loose hands along the torso were recommended. The test was made with the eyes open, the respondents looked straight ahead.

The test performance time differs among the respondents. Rubenstein et al. [22] assess during 15 s, Berg et al. - 10 s, Netz and Argov have the set time of 60s [23]. In this work the scoring was based on the Berg scale.

According to numerous studies, the time of standing on one leg decreases with age. This research fully confirms this relationship, in addition, the effect of a previous fall on a worse test result was observed.

Studies by Świątek and Urodow [24] and this research confirm the relationship between the amount of medications taken and the increased risk of falling. The results of Hammond and Wilson point to a correlation between the type of taken medication, and not their amount [25].

People, who experienced falls, were characterised by worse functional fitness and worse results in balance tests. It is pursuant with data from the literature.

A result of experienced fall can be the so-called post-fall syndrome. Elder people experience fear of another incident and, as a result, they limit their physical activity [26]. Own studies have shown a similar feel or fear among people with and without fall.

In their own studies, Skalska and Gałaś have discovered a correlation between the occurrence of falls and physical fitness. The risk of fall increases among people characterised by the reduction of physical fitness and at the same time the consequence of experienced fall was the worsening of physical fitness [27].

The analysis of the research of numerous authors and own results showed the need to perform fall risk assessment and functional fitness tests in elderly patients. These tests were part of the broadly understood preventive actions, allowing for the selection of individual exercises improving the walk and balance. Counteracting falls is important as it results in a change in the pattern of walk and posture, gradual reduction of physical activity or deterioration of physical fitness. What is more, the occurrence of fear of another fall causes the elderly to adopt a defensive strategy in the form of a more cautious and slower movement. This leads to a vicious cycle mechanism where the limitation of activity affects the decrease in body efficiency, changes in the pattern of walk and this further limits functional fitness, which increase the risk of subsequent falls.

Conclusions

1. In the analysed group, women showed poor functional fitness compared to men.
2. Older people with previous falls were at greater risk of falling again.
3. Factors determining the risk of falls include: the number of medications taken and Berg scale value.

4. The biggest problem in the studied group was maintaining balance while standing on one leg and in the reaching out while standing task.
5. Upper limb flexibility in the examined group does not meet the standards determined in the SFT test.
6. Lower limb flexibility in the examined group does not meet the standards determined in the SFT test.

Conflict of interest: The authors state no conflict of interest.

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