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The Risk for Fall and Functional Dependence in Polish Adults 60–87 Years Old

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ABSTRACT

The constantly rising percentage of the elderly (60+), who are particularly at risk of the dangerous consequence of falls, results not only in the loss of independence in daily life, but also in a serious threat to health and life. Therefore, many authors emphasize the necessity of conducting prophylaxis and prevention among senior citizens. The most important aspect of fall prophylaxis is care about the optimum level of agility. Exercise should focus on increasing muscular strength, balance and dexterity. The aim of the present study is to determine the relationship between functional fitness and the risk for falls of older people in the light of maintaining physical independence. The research group consisted of 522 persons: 142 males and 380 females aged 60-84 years from Wroclaw (a city in the south-west of Poland). All subjects provided written consent, and were measured and tested in 2009 through 2015, excluding the winter months. Body height and weight were measured. Body mass index was calculated. The Senior Fitness Test was used to assess functional capacity and efficiency. The results of the Senior Fitness Test were used to estimate Maintaining Physical Independence in Older Adults. The differences in the means of the results of all the tests between the age and sex-specific groups were assessed by means of a two-way analysis of variance, where sex and age were factors and results of appropriate test dependent variables. Logistic regression was used to estimate the risk for fall, based on the incidence of fall in the last year, for each test comparing the individuals met referenced criteria to maintain functionally dependence and independent, controlled for age and BMI. The risk for falls was more than twice greater in the case of the studied females, whose muscular strength of the upper part of the body was lower. The females in whose cases no fewer than two tests failed to ascertain functional independence, had a greater risk for falls. In the case of the males, no statistically-significant connections between functional independence and the risk for falls was found.

Key words: *elderly, risk for fall, physical independence, functional fitness, biological condition*

Introduction

Movement is a basic and important factor of positive health in every period of ontogenesis, and the profile of that factor varies depending upon age, sex, the varied conditions of the environment in which one lives, and also upon the organism's biological and health-related parameters. Care about the high biological value of a young generation, instilling positive pro-health behaviour and an active approach to one's own health are reflected in adults' and the elderly's sense of health and the quality of life[1-3]. For that very reason, the educational systems developed in numerous countries of the world treat the acquisition of knowledge and appropriate pro-health behaviours, taking into consideration, in particular, consolidating the habits of methodical physical and sport-recreational activity, as equally important. Simultaneously, restorative medicine (treatment) is as important as preventive medicine. In accordance with Przewęda's opinion (2009), in our country there arises the problem of young generation's deteriorating health caused by an ever greater difference between young Poles' increasing somatic development and decreas-

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ing motor development, which the author refers to as to developmental asymmetry[3]. The existing correlation between children's and young people's physical activity, agility and health and adult's activity and agility, and also health indicates the essence of shaping a human being's biological condition throughout their life[1,4].

Currently, we are observing the substantial extension of lifespan in the numerous regions of the world, and that indicates it is necessary to develop the optimum programs of pro-health education for adults and the elderly. In accordance with this trend, the Universities of the Third Age or Senior Citizen Clubs, making it possible for the elderly, who are subjectively healthy, to gain access to further education, and, additionally, providing an opportunity to meet social, family and health-related needs, have been organized for many years. Simultaneously, the elderly have to cope with numerous health-related problems and with their daily lives[5-10]. One of very significant health-related problems in the case of the elderly are falls, and their frequently serious consequences, not only those related to health. Many researchers express the view that this problem is one of the basic and very important aspects of senior citizens' health[11-17]. The literature relevant to the risk for falls, and to health complications resulting from them, is very extensive. The authors agree that the threat of falls is, to a significant degree, determined by involutionary processes, which intensify as one age, and concern, mainly, the nervous system and the motor system. Therefore, among the most significant factors of the threat of falls, the following are included: the disorders of balance, the increasing instability of postural reflexes, decreasing muscular strength, mainly of the lower limbs and of the pelvic girdle, and also vision disorders[11,15,18-21]. Simultaneously, they indicate that falls are more frequently experienced by females than by males and that a fall itself is determined by the co-occurrence several other risk factors.

The constantly rising percentage of the elderly (60+), who are particularly at risk of the dangerous consequence of falls, results not only in the loss of independence in daily life, but also in a serious threat to health and life. Therefore, many authors emphasize the necessity of conducting prophylaxis and prevention among senior citizens[12,22-26]. In accordance with an earlier-quoted researchers' opinion, the most important aspect of fall prevention and prophylaxis is care about the optimum level of agility. Exercise should focus on increasing muscular strength, balance and dexterity, and also on increasing the scope of movement in the large joints of the limbs and the torso.

An extremely important problem is providing an elderly individual with basic information within the scope of the organism's build and functions, which will make it possible for them to adopt an active approach to their own health, and increase motivation to ensure the optimum quality of life. Then, curative medicine would be balanced by prophylactic medicine, which is much more beneficial in personal, social and economic dimensions.

The aim of the present study is to determine the relationship between functional fitness and the risk for falls of older people in the light of maintaining physical independence. The study aim was guided by the following research question: does the loss of functional independence increase the risk for falls?

Material and Methods

Setting

The research group consisted of 522 persons: 142 males and 380 females aged 60-84 years. The selected subjects came from Wroclaw and its precincts. The invitations for participations were directed to health clinics, senior citizens centers and the University of the Third Age, as well as others suggested by municipal personnel. All subjects provided written consent, and were measured and tested in 2012 through 2015, excluding the winter months (November through March). All subjects were required to present certification from their respective physicians that there were no medical restrictions or contraindications to their participation in the study.

Surveys

The project had been approved by the University School of Physical Education's Senate Commision of Ethics & Scientific Research dated 18 February 2009. The research was conducted in the Biokinetics Laboratory of the University School of Physical Education in Wrocław between 2009-2015.

The medical history was taken from each participant in order to collect information about the participants. The research was large scale and holistic in its scope[8]. Among others, height was measured with a stadiometer to the nearest mm. Weight was measured with a Seca scale (model 764) to the nearest 0.1 kg. Body mass index (BMI, kg/m^2) was calculated.

The Senior Fitness Test was used to assess functional capacity and efficiency[27]:

1. 30-sec chair stand [n] – to assess lower body strength, number of stands that can be completed in 30 seconds with arms folded across chest,
2. Arm curl [n] – to assess upper body strength, number of biceps curls that can be completed in 30 seconds holding a hand weight of 5 lbs for women and 8 lbs for men,
3. 8-foot up-and-go [s] – to assess agility/dynamic balance, number of seconds required to get up from a seated position, walk 8 feet, turn, and return to a seated position,
4. 6-min walk [m] – to assess aerobic endurance, number of meters that can be walked in 6 minutes around a 50-yard course.

Subjects were asked to complete a general questionnaire which included an item on incidence of falls in last year. Among subjects, significantly more often females declared at least one fall in the last year then males (18.13% vs. 9.59%, chi-square = 5.82; $p<0.05$). However, there were no significant differences with age.

The results of the Senior Fitness Test were used to estimate Maintaining Physical Independence in Older Adults. Individual performances on aerobic endurance, agility/dynamic balance, and upper and lower body strength tests were compared to age group- and sex-specific criteria for „maintaining physical independence". The criterion-referenced standards were based on a subsample of 2,140 physically independent, moderately functioning older American adults, 60-94 years of age[27]. The two flexibility tests were excluded. The criterion values were empirically developed relative to a composite physical function scale, and subsequently validated on an independent sample. The number of functional test scores which equaled or exceeded the criterion-referenced values for each individual was tallied. Each person was defined as functionally independent or dependent according to the results of each functional test. Additionally, four functional groups were formed: 1 – individuals meeting the criteria for maintaining functional independence on all tests (4), 2 – individuals meeting the criteria for three tests (3), 3 – individuals meeting the criteria for two tests (2), and 4 – individuals meeting the criteria for one on none tests (1 or 0). The first group may be viewed as likely to maintain functional independence, in the next groups, the risk of loss of functional independence increases, and the forth group may be viewed as at highest risk of loss of functional independence.

Statistical analyses

Logistic regression was used to estimate the risk for falls, based on the incidence of falls in last year, for each tests, by comparing the individuals met criteria referenced to maintain functionally dependent or independent, controlled for age and BMI. Next, the risk for falls was estimated for each defined group based on achieved scores of tests, also controlling for age and BMI. Additional analysis was applied to compare the risk of falls between the functionally independent reference group to three dependent groups with gradually increased limitation of functional independence. The odds ratio (OR) derived from logistic regression is interpreted differently from linear regression models. OR significantly less than 1.0 indicates that the independent variables lessen the probability of the event occurring (in this case the onset of risk of falls). Additionally, the differences in means of results of all test between age and sex-specific groups were assessed by the means of a two-way analysis of variance where sex and age were factors and results of appropriate test dependent variable. All calculations were done by the use of Statitica 12.0[28].

Results

Descriptive statistics of the scores of the four functional tests by age and sex and results of the two-way analysis of variance assessing the difference between age and sex-specific groups, are presented in Table 1. Both sex and age significantly differentiated scores of tests, however a post hoc comparison (Tukey HSD test) showed only significant sex differences for the arm curl in the age group 65-69 ($p<0.01$), for the 6-min walk in the 70-74 year age group ($p<0.01$), and for the 8-foot up-and-go in the 60 to 74 year age groups ($p<0,001$, $p<0,05$, $p<0,05$, respectively). (Table 1 and Table 2)

Percentages of individuals not meeting the standards for maintaining physical independence in each of the tests did not show a clear trend with age and varied from 8.6%,

TABLE 1
MEANS AND SDS FOR RESULTS OF FOUR FUNCTIONAL TESTS BY SEX AND AGE

		30-sec chair stand [n]		Arm curl [n]		6-min walk [m]		8-foot up-and-go [s]	
Age [yrs]	N	mean	SD	mean	SD	mean	SD	mean	SD
	Males								
60-64	35	18.80	4.34	23.11	4.36	563.1	83.99	5.21	0.59
65-69	50	18.52	5.66	22.98	6.56	540.6	90.92	5.66	0.99
70-74	34	17.74	6.02	21.91	6.46	512.9	94.51	5.93	1.24
75-79	18	17.06	5.97	18.28	5.91	469.2	114.90	6.47	1.25
80-84	5	14.40	5.13	19.00	5.79	492.0	30.12	6.76	0.58
	Females								
60-64	151	17.18	4.45	20.76	4.52	606.2	100.04	6.08	1.07
65-69	129	16.50	3.96	19.80	4.34	561.5	99.85	6.25	1.08
70-74	71	15.46	3.75	18.76	4.51	587.4	97.45	6.70	1.13
75-79	24	14.46	5.00	17.83	4.00	506.2	109.22	7.18	1.57
80-84	5	13.20	4.09	15.80	5.07	553.6	50.87	7.47	0.99
Factors	Sex	F=7.45; p<0.01		F=10.54; p<0.01		F=9.97; p<0.01		F=18.60; p<0.001	
	Age	F=3.80; p<0.01		F=6.71; p<0.001		F=8.58; p<0.001		F=13.14; p<0.001	
Interaction		F=0.13; p>0.05		F=0.73; p>0.05		F=1.20; p>0.05		F=0.28; p>0.05	

TABLE 2
PERCENTAGES AND NUMBERS OF PEOPLE WHO DID NOT MEET CRITERION-REFERENCED TO MAINTAINED FUNCTIONALLY INDEPENDENT FOR EACH TEST

Age	30-sec chair stand [n]	Arm curl [n]	6-min walk [m]	8-foot up-and-go [s]
	Males			
60-64	25.7% (9)	8.6% (3)	58.8% (20)	34.3% (12)
65-69	36.0% (18)	26.0% (13)	64.0% (32)	30.0% (15)
70-74	32.4% (11)	14,7% (5)	41,2% (14)	44,1% (15)
75-79	33,3% (6)	22.2% (4)	61.1% (11)	38.9% (7)
80-84	40.0% (2)	0.0% (0)	0.0% (0)	40.0% (2)
	Females			
60-64	29.8% (45)	15.9% (24)	53.3% (80)	12.6% (19)
65-69	32.6% (42)	22.5% (29)	53.1% (68)	16.3% (21)
70-74	36.6% (26)	25.4% (18)	59.2% (42)	12.7% (9)
75-79	33.3% (8)	16.7% (4)	47.6% (10)	33.3% (8)
80-84	20.0% (1)	20.0% (1)	20.0% (1)	20.0% (1)

TABLE 3
RESULTS OF LOGISTIC REGRESSION ESTIMATED THE RISKS OF FALL DEPENDING ON FUNCTIONAL INDEPENDENCE BASED ON RESULTS OF FUNCTIONAL TESTS IN POLISH ADULTS 60-84 YEARS OLD

	Wald's	p	ORs	+/- 95% CI
	30-sec chair stand [n]			
Males	2.67	n.s.	2.95	0.80-10.96
Females	1.97	n.s.	1.52	0.84-2.74
	Arm curl [n]			
Males	0.00	n.s.	1.00	0.26-3.81
Females	7.42	<0.01	2.38	1.27-4.46
	6-min walk [m]			
Males	2.28	n.s.	0.34	0.09-1.39
Females	3.22	n.s.	1.75	0.95-3.22
	8-foot up-and-go [s]			
Males	0.27	n.s.	0.69	0.16-2.88
Females	0.58	n.s.	0.72	0.30-1.70

in 60-64 year old males for the arm curl test, to 64% in 65-69 year old males for the 6-minute walk test.

Table 3 presents the results of analysis of logistic regression separately for males and females, allowing for age and BMI. Only the women, whose results of the arm curl test did not meet the criterion-referenced value for functional independence, were 2.3 times at a higher risk for falls. No significant relationship was found in the males.

The results of clustering risk for males and females are presented in Table 4. In males no significant relationship was found. Females, whose results in at least two tests, did not meet the criterion-referenced value for functional independence, were 4.3 times at a higher risk for falls, in comparison with women who met the criterion-referenced value for functional independence for all tests. However, this risk for falls dropped to 3 times higher where the women's results of functional tests in 3 or all of them, did not meet the criterion-referenced value for functional independence.

Discussion and Conclusion

Becoming a person qualifying for geriatric care commences a natural stage of human ontogenesis of which the features usually include a reduction in general efficiency, and the progressive degradation of physical and mental functions. The pace of the ageing processes is characterized by a multi-factor polarization. The changes accompanying old age mainly increase the risk of the occurrence

TABLE 4
RESULTS OF THE LOGISTIC REGRESSION ESTIMATED THE CLUSTERING RISK FOR FALLS DEPENDING ON RESULTS OF FUNCTIONAL TESTS ASSESSING CRITERION-REFERENCED FOR FUNCTIONAL INDEPENDENCE IN POLISH ADULTS 60-84 YEARS OLD. REFERENCES GROUP CONSISTED OF SUBJECT MET CRITERION-REFERENCED FOR FUNCTIONAL INDEPENDENCE FOR ALL TESTS.

Groups	Wald's	p	OR	+/- 95% CI
	Males			
dependent – 1 test	1.14	n.s.	0.42	0.08-2.12
dependent – 2 tests	1.95	n.s.	0.19	0.02-2.08
dependent – 3 i 4 tests	0.09	n.s.	1.31	0.22-7.78
	Females			
dependent – 1 test	3.00	n.s.	2.32	0.89-6.07
dependent – 2 tests	9.37	<0.01	4.26	1.71-12.15
dependent – 3 i 4 tests	3.68	<0.06	3.04	0.96-9.60

of functional disability, which significantly increases the risk for falls and injuries. Involutionary processes exert influence upon handicapping the numerous functions of the motor and postural systems, which will significantly reduce the stability of body posture.

The comprehensive assessment of the environment in which a senior citizen lives, including the introduction of numerous modifications aimed at eliminating the external and internal causes of falls, is becoming an element of successful ageing, free of the diseases of affluence and physical disability[14].

Falls in old age are a serious public health problem. Reconstructing a situation in which falls occur more frequently, and also recognizing a cause, is a way of assessing risk for falls and monitoring disorders of motor ability. In accordance with epidemiological data, a fall is experienced no fewer than once a year by 30% of people older than 65 and living on their own, by 20% of hospitalized patients and 50% of the inhabitants of care centres[29-33]. The frequency of falls increases with age[34], so more than a half of females and one-third of males older than 85, fall more than once a year[35]. The results of the survey research conducted as part of this study confirmed this tendency as it was found that females experienced falls more frequently (18.1%) than males for the last year. The reason could be the lack of relationship between number of falls and functional performance in the male groups in comparison to the female groups. Studies into the frequency of falls take into consideration the place of residence (living on one's own or in certain elderly-care centres) are conducted ever more frequently[15], but their results are ambiguous. Perhaps, individuals living on their own are in greater danger of losing balance and falling while performing their daily activities. On the other hand, the elderly provided with the permanent care of others are not obliged to perform a number of self-care activities; because of that, their motor ability is significantly reduced, which increases the frequency of falls[13]. This is a very serious problem because falls are a significant cause of injuries and increased mortality[29]. A fall of an elderly individual frequently results in fractures and other injuries, the loss of independence, functional limitations, and even death[36]. It seems to be necessary to identify individuals whose risk for falls and fractures is increased in order to implement prophylactic procedures[37,38].

The causes of falls may be divided into internal (resulting from disorders within the organism) and external (originating in the environment around a human being). The external factors result from: involutionary changes, the presence of chronic diseases, medications in use and currently experienced medical problems. Tinetti (2003) analysed many risk factors of falls: arthritis, symptoms of depression, orthostatic disorders, handicapping cognitive functions, vision, balance, gait or muscular strength, and also taking four or more drugs. It was revealed that risk for falls increases together with the number of those factors[29]. The multi-factor assessment, taking into consideration the circumstances of previous falls, makes it possible to minimize that risk. It was Toraman and Yıldırım (2010) and Vu *et al.,* (2011) as well that confirmed that there are many factors responsible for falls, but many of them can be avoided[25,39].

The recent review of the literature on risk for fall factors in the case of the elderly has demonstrated that the disorders of balance and deteriorated gait are of the main risk for fall factors[22,40]. The disorders of balances to a significant degree limit daily, routine activities of an elderly individual, increasing the risk of the occurrence of a fall, and, quite frequently connected with it, soft tissue injuries or bone fractures. It ought to be added that if the disorders of balance are accompanied by osteoporosis the risk of bone fractures increases very significantly[17,20,23,24,41,42]. Therefore, it can be concluded that decreasing, as one grows older, the strength of postural muscles (muscles of the back, hip and knee region) most frequently results in lateral destabilization, which clearly reduces the sense of balance and ability to move safely in the case of an elderly individual[17,20,43]. The recent research has demonstrated that diagnosing and understanding changes in the nervous-muscular system has a crucial role in the regulation of gait and balance in the case of the elderly.

Our results show crucial meaning of the strength of the upper body in lowering the risk for falls. The risk for falls in the female group increased when their upper body strength decreased. Daily home activities more often require efficient work of the upper limbs and trunk than lower limbs. Stronger upper limbs support body balance and prevent falls.

Functional independence is the possibility of performing, without additional help, typical activities of daily life such as: simple housework, lifting and carrying items, or walking an appropriate distance. In other words, this is the physiological ability to perform daily activities normally, safely and unaided, without excessive tiredness. The battery of tests proposed by Rikli and Jones (2013) with the standards accompanying it, seems to have sufficiently sound empirical backing so as to justify their use by researchers and practitioners working on issues in the field of geriatrics[27]. Those tests make it possible to estimate the level of functional ability for maintaining the independence of the elderly.

Jeon's study (2013) confirms that limited functional ability, increased BMI, and also pain, are factors influencing increase in risk for falls[44]. Current research indicates that the elderly should live a healthy life, with a particular emphasis on increased physical activity.

Wildinga *et al.,* (2013) conducted the review of the literature[37] on connections of the high level of physical fitness and lower risk for falls, caused by increased endurance, balance and coordination[45-48]. In a few studies, functional mobility was assessed as an ability to perform ADLSs[48,49]. These studies suggest that in the case of the elderly whose level of physical activity is high a lower risk for falls is observed. Many researchers indicate a positive connection between increased and appropriately selected physical activity of the elderly and the sense of balance and lowered risk for falls[25,50].

However, the analysis of connections of physical activity and the risk of fracture is frequently ambiguous[51,52]. Sometimes, excessively increased physical activity may increase the risk of fractures among adults at every age[53].

Yamada *et al.,* (2011) describe factors making it possible to perform ADLs without aid in the case of the elderly. For maintaining independence and the quality of life in old age, the mass and strength of the skeletal muscles are important[54]. The degenerative loss of skeletal muscle (sarcopenia) is common in the case of the elderly, increases risk for falls and of fractures, and handicaps ability to perform basic daily activities[55]. Fear of falls is common in the case of the elderly, rises as one grows older (from 21 to 85%) and is higher in the case of females than in that of males[54,56].

In recapitulation, statistical analyses of the results of research performed as part of this study aimed at determining the connections between functional ability, as well as risk for falls in the case of the elderly in the light of maintaining physical independence. It was found that risk for falls was more than two times higher in the case of the studied females, when in the »Arm Curl« test they did not meet the criterion of functional independence. Also, the loss of functional independence in the case of females, in no fewer than two tests, increased the risk for falls several times. In the case of males, in turn, no statistically-significant connections between functional independence and risk for falls were found.

Falls are a significant problem of old age, which greatly influences limited ability and the quality of life, and also increases health dysfunctions and mortality of the elderly. Although counteracting them is a difficult task, it is possible to reduce risk for falls. The greatest benefits are provided by multi-directional activities directed simultaneously at identifying a few risk factors. Estimating individual risk factors seems to be unjustified if one takes under consideration that fall results from many, frequently different, causes. The problem is still not solved, and remains important due to health-related, social, and also economic, considerations.

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RIZIK ZA PAD I FUNKCIONALNU OVISNOST KOD ODRASLIH POLJAKA

S A Ž E T A K

Stalno rastući postotak starijih (60 i više godina), koji su posebno u opasnosti od opasne posljedice padova, rezultira ne samo do gubitka samostalnosti u svakodnevnom životu, ali iu ozbiljnu prijetnju zdravlju i životu. Zbog toga, mnogi autori naglašavaju nužnost provođenja profilakse i prevencije među starijim građanima. Najvažniji aspekt pada profilaksi je briga o optimalnoj razini agilnosti. Vježba se treba usredotočiti na povećanje mišićne snage, ravnoteže i vještinu. Cilj ovog istraživanja je utvrditi odnos između funkcionalne tjelesne spreme i rizik za padove starijih osoba u svjetlu održavanje tjelesne neovisnosti. Istraživana skupina sastojala se od 522 osoba: 142 muškaraca i 380 žena u dobi od 60-84 godina iz Wroclawa (grad u jugo-zapadno od Poljske). Svi ispitanici su potpisali pismeni pristanak, a mjereni su i testirani u 2009 do 2015, osim u zimskim mjesecima, mjereni su visina i težina tijela i izračunat je indeks tjelesne mase. Viši test za tjelesnu spremu se koristi za procjenu funkcionalne sposobnosti i učinkovitost. Rezultati Senior Testa spremnosti su korišteni za procjenu održavanja fizička neovisnosti u starijih odraslih osoba. Razlike u sredstvima rezultata svih testova između dobi i spola specifična skupina ispitana pomoću dvosmjerne analize varijance, pri čemu su spol i dob faktori i rezultati odgovarajućih zavisnih varijabli ispitivanja. Logistička regresija korištena je za procjenu rizika za pad, na temelju učestalosti pada u posljednjih godinu dana, za svaki test su se uspoređivali pojedinci koji su zadovoljili kriterije za održavanje funkcionalne ovisnosti i neovisnosti, kontrolirano za dob i BMI. Rizik pada bio je više nego dvostruko veći u slučaju istraživanih žena, čiji je mišićna snaga gornjeg dijela tijela bila je niža. Ženke u čije slučajevi ne manje od dva ispitivanja uspjeli utvrditi funkcionalnu neovisnost, imao veći rizik za padova. U slučaju muškaraca, pronađena je statistički značajna-veze između funkcionalne samostalnosti i rizika za pad.