



# Interplay among physical balance ability, physical activities realization, anthropometric parameters and psychosocial indices in relation to gender and age of seniors 65+

Milada Krejci<sup>1ABDE</sup> , Martin Hill<sup>2ABCD</sup>, Elena Bendikova<sup>3ADE</sup> , Dobroslava Jandova<sup>1AB</sup>, Jiri Kajzar<sup>1BCE</sup>

<sup>1</sup>College of Physical Education and Sport Palestra, Prague, Czech Republic

<sup>2</sup>Institute of Endocrinology, Prague, Czech Republic

<sup>3</sup>Matej Bel University, Faculty of Arts, Department of Physical Education and Sports, Banska Bystrica, Slovakia

Authors' Contribution: A – Study Design, B – Data Collection, C – Statistical Analysis, D – Manuscript Preparation, E – Funds Collection

## Abstract

**Introduction:** The study is aimed to analyze the interplay among the physical balance level, physical activities realization, anthropometric determinants and psychosocial indices in relation to gender and age of seniors 65+. **Methods:** The participants comprised 500 seniors in age 65+ (234 males and 266 females) participated voluntarily in the research. For data collection we used methods of the “Medical anamnesis”, “Tinetti Balance Assessment Tool”, “Health Survey SF-36”. For statistics analyses the multivariate regression with reduction of dimensionality and orthogonal projection to latent structure was used. **Results:** Analyzed disabilities “Depression”, “Type 2 diabetes mellitus”, “Hypertension” and “Vertigo” significantly negatively interplay with the Tinetti summary balance score in both genders. Results of the anthropometric parameters of female seniors, in a contrast to the male seniors parameters, proved that body high and muscle mass correlate significantly positively with the performance of the Tinetti summary balance test ( $p < 0.01$ ) in female seniors. **Conclusion:** Performing of physical activities positively correlates with the performance in the Tinetti summary balance test in both genders of seniors. There are differences between male and female seniors according the psychosocial factors interplay with performance in the Tinetti summary balance test, when more interplaying psychosocial factors were analyzed in females.

**Keywords:** seniors, physical activity, balance performance, body structure, gender specifics

**Address for correspondence:** Elena Bendiková - Matej Bel University, Faculty of Arts, Department of Physical Education and Sports, Banská Bystrica, Slovakia, e-mail: bendikova.elena@gmail.com

Received: 13.12.2019; Accepted: 19.03.2020; Published online: 24.06.2020

**Cite this article as:** Krejci M, Hill M, Bendikova E, Jandova D, Kajzar J. Interplay among physical balance ability, physical activities realization, anthropometric parameters and psychosocial indices in relation to gender and age of seniors 65+. Phys Activ Rev 2020; 8(1): 121-132. doi: 10.16926/par.2020.08.14

## INTRODUCTION

The European Union defines the term “senior” as a person aged 65+, with determined rights on a pension, social security and healthcare [1-3]. There are differences in quality and amount of daily physical activity in seniors. One of main causes adversely affecting the level of physical activity is a low level of balance [4, 5]. Balance ability and balance skills represent an important component and a predisposition of adequate movement regime in senior age [6]. Fall represents the dominant cause of injuries among people over the age of 65 years. Fall injury can lead to long-term physical disability. A risk of falling down is one of the main risks in seniors [7]. Approximately 30% of seniors experience at least one fall per year, when in institutional care the percentage of such seniors is higher. One fall of ten falls ends with a fracture. One fifth of falls requires hospital medical care [8, 9]. The ability to manage static, dynamic and Tinetti summary balance test is therefore considered as a key factor in the prevention of falls and subsequent injuries. However, keeping the body in a balance position represents a dynamic process requiring control mechanisms. Author [10] understands balance posture as a dynamic process of maintaining the position of the body and its parts in a constantly changing environment. It is a complex process resulting from the interaction between motor, sensory and cognitive processes. In general, a body position is more stable, if the centre of gravity is lower. If the body is in a phase of motion, then the body moves from one micro phase to another, i.e. from one dynamic balance micro phase to another dynamic balance micro phase during movement action. Author [11] states that internal balance stabilization takes place at the level of individual segments of the spine. It is ensured mainly by deep intersegmental spine muscles and short deep muscles around the joints. To an involvement of these muscles it occurs even in the state of movement’s imagination. Actual psychosocial state may be also very important for the quality of balance, including attitudes, expectations and feelings. Seniors usually expect automatically a loss or a reduction of balance ability in aging, due to decreasing of sensory elements, limited ability to integrate motor senses associated with a reduction or completely loss of balance [12]. Also fear of certain diseases associated with aging (e.g. Type 2 diabetes mellitus) causes anxiety from loss of balance ability and risk of falls [13, 14].

However, according to physical activity realization, the change in body composition is more significant, when lean body mass is decreasing, fat and ligament are increasing. Body weight and body mass index (BMI) with age usually rise to 7<sup>th</sup> – 8<sup>th</sup> decennium. Then it occurs to the decrease. Due to the height reduction, the BMI is problematic to determinate. It seems to be expanding to 27.0 in old age. The ratio of muscle mass to fat is significantly influenced by lifestyle, esp. of food intake, energy expenditure and strength training [15]. From an anthropometric point of view, in both genders male and female, the shape of the chest changes, assessed by the transversal and anteroposterior diameters, and its circumference increases. Comparing the age of 20 and 65 from the view of body height, the difference represents five centimeters in males and nine centimeters in females approximately. Mostly the anteroposterior diameter increases, while the transverse diameter rather decreases. Body proportions vary, especially the ratio of shoulder and hips/waist width as well as the ratio of torso height to lower limb length [6, 16]. In advanced age, body mass often decreases. An extensive European SENECA study, conducted in 1988–1999 in subjects aged 70–75 years, showed that the average body height of seniors decreased by one and half to two centimeters and waist circumference increased by three to four centimeters. In 13% of men and women, the weight increased by more than five kilograms, while in 23% of men and 27% of women the weight decreased by more than five kilograms, which was accompanied by higher mortality in men [17].

There are some typical changes in the psychosocial area of seniors in the age of 65 years old and over. These changes may include decreasing of cognitive function, decreasing of speech function, emotional instability, decreasing of interest in different areas of life, change of needs or their order, decreasing of ability to adapt to changes or new situations. Authors [18, 19] stress that negative emotions may play a role in the level of physical balance in seniors. In the postmodern society seniors are exposed not only to the known and expected changes in the life, but they may live under the stress of unexpected changes (often even fundamental), to which primarily persons in senior age are exposed, and which may leave them in state of misunderstanding, with feelings of insecurity, fear or even a threat. In this context a term “social aging” is referred [18, 20, 21]. Social aging is defined as a period in which social status and social roles of a senior have been lost, which have been an important part of an

individual's life. Social aging is defined as a period in which social status and social roles of a senior have been lost, which have been an important part of an individual's life.

The purpose of the study was to analyze the interplay among the physical balance level, physical activities realization, anthropometric determinants and psychosocial indices in relation to gender and age of seniors 65+. On the basis of the purpose the followed research question was examined: "Which physical activities, anthropometric parameters and psychosocial factors do influent significantly the results of the Tinetti summary balance score in the monitored seniors?" The research question was examined in two hypotheses: H1: "Performing of physical activities positively correlates with the performance in the Tinetti summary balance test in monitored seniors." H2: "There are no differences between monitored male seniors and female seniors according the psychosocial factors interplay the performance in the Tinetti summary balance test."

## MATERIAL AND METHODS

### *Participants*

The monitored group consisted of 500 seniors, selected of all Czech regions from various homes and centers for seniors, participating voluntarily in the research. All seniors were over 65 years old (mean  $75.9 \pm 7.1$  years). 234 males mean:  $74.5 \pm 7.7$  years, median: 71.0 (age: 67.0÷80.0 years) and 266 females mean:  $76.9 \pm 7.2$  years, median: 76.0 (age: 66.0÷84.0 years).

### *Measurement*

The research monitoring was performed by applying of the followed standardized methods.

*Medical Anamnesis:* provided by the authorized physician (member of the research team), when under his guiding each participating senior completed the standardized protocol of the medical anamnesis, specially focused on the current state of the senior's health, medicaments consummation, and past injuries, past surgeries, etc.

*Functional anthropological examination:* consisted of selected classical anthropometry methods, which were non-invasive, using anthropometric instruments as anthropometer, digital personal scale, Harpenden caliper, manual dynamometer type Collin. Following parameters were examined: body height, body weight, BMI, girth of chest across mesosternale, girth of waist, abdominal circumference, gluteal circumference, arm circumference relaxed, calf circumference maximal, biepicondylar width of humerus, biepicondylar width of femur, width of wrist, width of ankle, girth of thigh, girth of knee, girth of ankle; thickness of 7 selected skinfolds - caliper measurement type Harpenden (biceps, triceps, suprailiac, abdominal, subscapular, anterior thigh, calf medial). Body Composition Analysis using In-Body 230 [22].

*Tinetti Balance Assessment Tool:* examines the summary balance score consisted from the two components: static balance score and gait score. During testing procedure seniors may use aids as sticks, crutch, if they use it in daily life. The test requires a hard armless chair, a stopwatch, and a space for the even and uniform walkway. The test has two sections; the first assesses static balance abilities on a chair and also in standing, and the other assesses dynamic balance during the gait on the uniform walkway. The senior is to sit in an armless chair and will be asked to rise up and stay standing, in normal standing, then in standing with closed eyes, and then to keep standing balance while physiotherapist pushes against his sternum. The senior will then turn 360° and then sit back down. Next, the senior walks at a normal speed, followed by turning and walking back at a "safe" speed. The senior will then sit back down. There are evaluated senior's rise up and sitting down on the chair, keeping upright while sitting on the chair and during standing (open/close eyes, push on sternum), length and height of the steps, symmetry and continuity of the steps and straightness of the trunk during the walk [23].

*RAND 36 Short Form Health Survey (SF-36):* The questionnaire SF-36 is sensitive to all problems in areas of physical, mental and social health in aging. It allows objectification of physical functioning (common physical activities in daily life), psychic functioning and social functioning. It consists of 36 questions grouped into categories: "Overall perception of health"; "Physical activity"; "Restrictions of physical activity"; "Restriction caused by emotional problems"; "Pain"; "Vitality, neurosis, depression"; "Social activity"; "Health change" [24], (Table 1).

### Procedure

The study was supported by the Czech Science Foundation under the grant GACR ID 17-25710S “Basic research of balance changes in seniors”. Ethical committee of the research institution expressed full agreement with research aim, concept and procedure and judged the research study as appropriate from ethic view of point. All investigations were provided by research team members in constant conditions, always in the morning time in a spacious bright room equipped with measuring devices. Every laboratory session started with “Medical Anamnesis” of a senior using a standardized protocol provided by a physician cooperation, followed with “Functional anthropological examination” provided by an anthropologist with two assistants (helped in measuring and data recording), followed by the test of balance according the “Tinetti Balance Assessment Tool” provided by a physiotherapist. After that the senior had 15 minutes break with free movement or relax in sitting position with drinking a glass of water. After the break the senior completed the RAND 36 Short Form Health Survey (SF-36) by calm sitting around a table with the possible assistance of a research team member.

### Data analysis

While For the statistics analyses the multivariate regression with reduction of dimensionality such as the method of orthogonal projection to latent structure (OPLS) which are capable to cope with the problem of multicollinearity, which is expectable namely in the anthropometric data [25, 26]. Statgraphic Centurion software, version XVI from Statpoint Inc., Warrenton, Virginia, was used for the statistical evaluation.

### Ethics

Each senior has been informed about the research procedure and signed the “Informed consent” for the voluntary participation. The protocol was approved by the Ethics Committee of the College of Physical Education and Sport PALESTRA in Prague (approval No. EK02/2016).

## RESULTS

The results are presented gradually from the view of correlation analyses focused on the interplay of significant correlations between the Tinetti summary balance score, and the physical balance ability, physical activities realization, anthropometric parameters and psychosocial indices in relation to gender and age of monitored seniors. First the results of male seniors are presented.

From the provided correlation analyses focused on the interplay between the Tinetti summary balance score, and the physical and psychosocial indices it is evident, that increasing age is in the negative correlation ( $p < 0.01$  multidimensional regression, Table 2). Thus, we can confirm that the increasing age is an important negative predictor in males seniors aged 65+ with a negative significant effect on balance performance. From the correlation analysis of the “Medical Anamnesis” with the results of the Tinetti summary balance score in male monitored seniors it is evident, that clinically diagnosed disabilities significantly negatively correlate with the results of the summary balance score. The significant results are based on the correlation coefficients with predictive component  $p < 0.05$  in diagnosis of the “Depression” and at  $p < 0.01$  in the case of diagnosis “Hypertension”, “Type 2 diabetes mellitus” and “Vertigo” (Table 1).

Convincing conclusive results of the statistical analyses were analyzed in the area of the tool “RAND 36 Short Form Health Survey (SF-36)”. The analyzed results of correlations of the monitored group of male seniors examined by the SF-36 resulted in a total of 20 SF-36 questions at  $p < 0.01$ ,  $p < 0.05$ . In the monitored seniors there were analyzed as the significant positive predictors for balance ability the questions Q7 – Q12 ( $p < 0.01$ ) which document importance of a good physical functioning for the balance results. Physical activities as for example “Walking up one floor stairs”, “Bending, kneeling, or stooping”, ability to “Walking more than a mile”, “Walking several blocks” or even “Walking one block” and ability for the self-service activities as the “Bathing or dressing yourself” (Table 1, Table 2, Figure 1).

Other significant correlations at  $p < 0.01$ ,  $p < 0.05$  in terms of positive significant predictors of the male seniors performance in the Tinetti summary balance test include SF-36 in the category “Health problems in the past month”, see Tab. 1, Table 2, Figure 1. The positive significant correlation with the

overall balance ability may be expect in case of an absence of actual deterioration of health, i.e. that the senior has not had any health problems in the last four weeks. Furthermore, negative significant correlations with the overall balance level were analyzed in male seniors in relation to subjective feelings “Lack of energy”, “Exhaustion”, “Missing feelings of happiness” (Table 1, Table 2, and Figure 1). According to the results it can be discussed that social contacts with friends, relatives play a significant role in the overall balance level. Restrictions of social life due to health or emotional problems have a negative impact on the overall balance of the male seniors at  $p < 0.01$ . The identical significant negative predictors for monitored male seniors were analyzed in the categories as “Pain”, “Vitality, neurosis, depression” which correlates already with the above mentioned results of the “Medical Anamneses”. Results of the statistical analyses of the male monitored seniors proved that from the all measured anthropometric parameters only the “Width of humerus” correlates significantly positively with the performance of the Tinetti summary balance test in the investigated male seniors ( $p < 0.01$ ), see Table 1.

Table 1. Interplay results of significant predictors to the performance in the Tinetti summary balance test evaluated by OPLS model and multiple regression (n=234 males)

	Variable	Predictive component, OPLS			Multiple regression	
		Component loading	t-statistics	<sup>a</sup> R	Regression coefficient	t-statistics
Relevant predictors (matrix X)	Age	-0.222	-8.32	-0.613**	-0.071	-3.30**
	Depression	-0.089	-2.48	-0.252*	-0.060	-1.88
	Hypertension	-0.197	-9.12	-0.556**	-0.057	-3.54**
	Diabetes	-0.227	-10,35	0,641**	-0.055	-3.15**
	Vertigo	-0.277	-14.09	0.773**	-0.081	-4.49**
	Q7	0.303	21.34	0.862**	0.085	5.76**
	Q8	0.252	20.99	0.711**	0.073	2.91*
	Q9	0.289	27.16	0.819**	0.094	5.06**
	Q10	0.290	14.06	0.820**	0.089	2.37*
	Q11	0.261	6.64	0.736**	0.091	3.08**
	Q12	0.224	6.85	0.634**	0.077	3.04**
	Q14	0.078	2.00	0.224*	-0.040	-2.49*
	Q15	0.093	2.00	0.265*	-0.043	-1.78
	Q16	0.126	3.90	0.358**	-0.008	-0.37
	Q18	0.096	2.81	0.272*	-0,024	-1.05
	Q19	0.100	2.47	0.285*	-0.020	-1.40
	Q20	-0.102	-4.27	-0.291**	0,015	0.38
	Q22	-0.131	-6.25	-0.374**	0.026	0.97
	Q27	-0.138	-6.08	-0.386**	-0.022	-0.88
	Q29	0.110	3.70	0.308**	-0.035	-0.89
Q30	-0.089	-2.21	-0.250*	0.011	0.33	
Q31	0.104	2.28	0.285*	-0.002	-0.07	
Q32	0.099	3.35	0.279**	-0.030	-1.69	
Q34	-0.121	-5.49	-0.340**	-0.047	-2.81*	
Q36	-0.147	-8.74	-0.413**	0.009	0.44	
	Width of Humerus	-0.053	-1.47	-0.135**	-0.084	-3.82**
matrix Y	Tinetti summary test	1.000	32.07	0.728**		
Explained variability		53.1% (46.9% after cross-validation)				

<sup>a</sup>R Component loadings expressed as a correlation coefficients with predictive component; \* $p < 0.05$ , \*\* $p < 0.01$

Table 2. The survey "SF-36" overview of questions (Q) and categories (in bold) [24]

<i>Overall perception of health</i>	
Q1	In general, would you say your health is: Excellent; Very good; Good; Fair; Poor?
Q2	Compared to one year ago, how would you rate your general health now? Much better than one year ago; Somewhat better than one year ago; About the same; Somewhat worse than one year ago; Much worse than one year ago.
<i>Physical activity</i>	
Q3	Vigorous activities, such running, lifting heavy objects, participating in strenuous sports.
Q4	Moderate activities, such a moving a table, pushing a cleaner, bowling, or playing golf.
Q5	Lifting or carrying groceries.
Q6	Climbing several flights of stairs.
Q7	Climbing one flight of stairs.
Q8	Bending, kneeling, or stooping.
Q9	Walking more than a mile.
Q10	Walking several blocks.
Q11	Walking one block.
Q12	Bathing or dressing yourself.
<i>Restriction of physical activity</i>	
Q13	Cut down the amount of time you spent on work or other activities.
Q14	Accomplished less than you would like.
Q15	Were limited in the kind of work or other activities.
Q16	Had difficulty performing the work or other activities (for example, it took extra effort).
<i>Restriction caused by emotional problems</i>	
Q17	Cut down the amount of time you spent on work or other activities.
Q18	Accomplished less than you would like.
Q19	Did not do work or other activities as carefully as usual.
<i>Social activity</i>	
Q20	During the past 4 weeks, to what extent have your physical health or emotional problems interfered with your normal social activities with family, friends, neighbors, or groups?
<i>Pain</i>	
Q21	How much bodily pain have you had during the past 4 weeks?
Q22	During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?
<i>Vitality, neurosis, depression</i>	
Q23	Did you feel full of pep?
Q24	Have you felt like a very nervous person?
Q25	Have you felt so down in the dumps that nothing could cheer you up?
Q26	Have you felt calm and peaceful?
Q27	Did you have a lot of energy?
Q28	Have you felt downhearted and blue?
Q29	Did you feel worn out?
Q30	Have you been a happy person?
Q31	Did you feel tired?
<i>Social activity</i>	
Q32	During the past 4 weeks, how much of the time have your physical health or emotional problems interfered with your social activities (like visiting friends, relatives, etc.)?
<i>Health change</i>	
Q33	I seem to get sick a little easier than other people.
Q34	I am as healthy as anybody I know.
Q35	I expect my health to get worse.
Q36	My health is excellent.

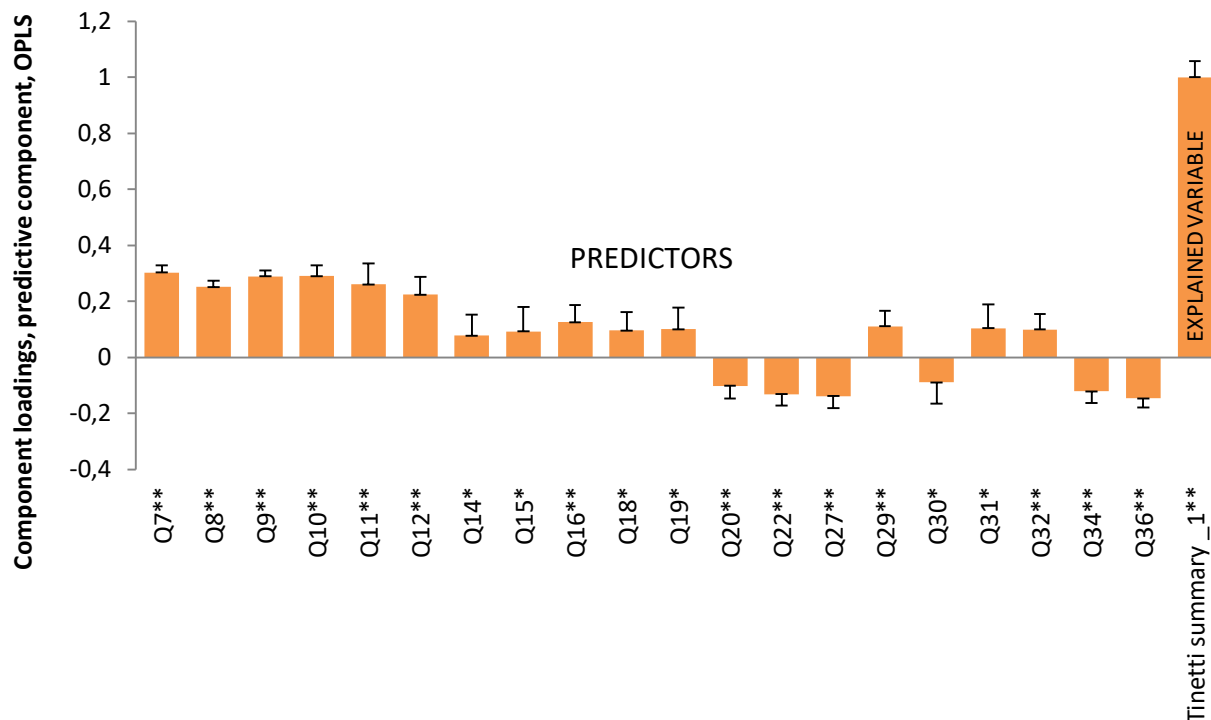


Figure 1. Significant positive and negative predictors for the performance in the Tinetti summary balance test, in the interplay with SF-36 questions (n=234 males)

Results of female monitored seniors show the interplay of significant correlations between the Tinetti summary balance score and the physical and psychosocial indices it is evident, that increasing age of female seniors represents the negative predictor of the overall balance ability ( $p < 0.01$  multidimensional regression, Table 3). The statistical analysis showed that the same clinically diagnosed disabilities significantly negatively correlate with the results of the Tinetti summary balance score in the female seniors as well as in the male monitored seniors: "Depression" ( $p < 0.05$  in males,  $p < 0.01$  in females), "Type 2 diabetes mellitus" ( $p < 0.01$  in both genders - males, females), "Hypertension" ( $p < 0.01$  in both genders - males, females), "Vertigo" ( $p < 0.01$  in both genders - males, females).

In the female seniors the statistical analyses of the survey "SF-36" in the correlation with the performance in the Tinetti summary balance test proved significant differences comparing to the male seniors in psychosocial area. In the female seniors, in opposite to the male seniors, there were found 13 more significant items of SF-36 (compare Fig. 1, Fig. 2, Table 2) in categories "Overall perception of health", "Restriction caused by emotional problems", "Pain", Social activity, and "Vitality, neurosis, depression". The significant predictors of "Overall perception of health", in female seniors declare significant pessimistic attitudes comparing to male seniors. Further moderate activities, lifting or carrying groceries, walking up the stairs in several floors were analyzed as positive predisposition for the performance in the Tinetti summary balance test in female seniors only. It seems, that the male seniors subjectively suffer less of restriction of physical activity than female seniors ( $p < 0.01$ , Table 3, Figure 2), when for female seniors were negative significant predictors to balance ability if the emotional problems cut time spent on work and other activities. The health problems were the reason of balance ability decreasing if in female seniors were feelings that they must use excessive effort during work or other activities. It may be interpreted that female seniors are significantly more sensitive in emotions and in social attitudes. In addition, significant correlations with the level of Tinetti summary balance test were found, contrary to male seniors due to the subjectively experienced pain. The perceived pain influences negatively balance performance in female seniors comparing to male seniors.

Table 3. Interplay results of significant predictors to the performance in the Tinetti summary balance test evaluated by OPLS model and multiple regression (n=266 females)

	Variable	Predictive component, OPLS			Multiple regression	
		Component loading	t-statistics	<sup>a</sup> R	Regression coefficient	t-statistics
Relevant predictors (matrix X)	Age	-0.187	-12.38	-0.618**	0.004	0.22
	Depression	-0.115	-3.39	-0.378**	-0.029	-1.15
	Hypertension	-0.053	-3.21	-0.175**	-0.003	-0.10
	Diabetes	-0.072	-3.41	-0.235**	-0.056	-2.20*
	Vertigo	-0.103	-4.67	-0.342**	-0.070	-2.91*
	Q1	-0.164	-10.48	-0.540**	-0.023	-1.44
	Q2	-0.091	-4.63	-0.305**	0.096	4.20**
	Q3	0.161	15.05	0.534**	0.075	3.47**
	Q4	0.247	17.04	0.818**	0.043	6.64**
	Q5	0.228	17.98	0.750**	0.059	4.80**
	Q6	0.218	20.30	0.718**	0.085	4.27**
	Q7	0.238	24.04	0.783**	0.096	5.01**
	Q8	0.225	16.74	0.743**	0.078	3.59**
	Q9	0.255	27.01	0.835**	0.024	1.61
	Q10	0.245	24.17	0.811**	0.087	3.63**
	Q11	0.226	18.94	0.747**	-0.021	-3.16**
	Q12	0.218	11.26	0.725**	-0.062	-4.56**
	Q13	0.080	2.97	0.269*	0.004	0.25
	Q14	0.057	2.30	0.194*	0.004	0.17
	Q15	0.139	6.59	0.464**	-0.021	-1.02
	Q16	0.110	5.53	0.370**	-0.052	-2.80*
	Q17	0.089	3.63	0.292**	0.025	1.71
	Q20	-0.134	-7.33	-0.449**	0.048	5.66**
	Q21	-0.072	-5.31	-0.244**	0.048	4.08**
	Q22	-0.120	-8.48	-0.404**	-0.020	-1.48
	Q23	-0.176	-13.23	-0.578**	-0.014	-0.59
	Q25	0.078	2.71	0.260*	-0.007	-0.39
	Q26	-0.120	-8.17	-0.399**	-0.025	-1.92*
	Q27	-0.169	-8.37	-0.556**	-0.004	-0.16
	Q28	0.098	3.09	0.322**	0.010	0.55
	Q29	0.103	4.48	0.339**	-0.010	-0.65
	Q30	-0.125	-6.06	-0.410**	-0.028	-2.45*
	Q31	0.115	6.56	0.387**	0.017	0.99
	Q32	0.133	4.20	0.444**	0.036	1.85
	Q33	0.114	8.49	0.372**	-0.015	-0.63
	Q34	-0.125	-6.31	-0.412**	0.044	3.28**
Q35	0.112	11.65	0.367**	-0.008	-0.65	
Q36	-0.154	-13.97	-0.503**	-0.068	-6.34**	
	Body height	0.093	4.00	0.307**	0.037	1.26
	Body mass	0.019	1.30	0.064*	0.110	7.82**
	Width of ankle	0.099	6.41	0.284**	0.028	2.67*
	Width of femur	0.165	8.26	0.471**	0.043	2.10*
	Girth of chest	0.082	3.62	0.263**	0.045	1.60
matrix Y	Tinetti summary test	1.000	33.50	0.717**		
Explained variability		48.8% (42.1% after cross-validation)				

<sup>a</sup>R Component loadings expressed as a correlation coefficients with predictive component, \*p<0.05, \*\*p<0.01



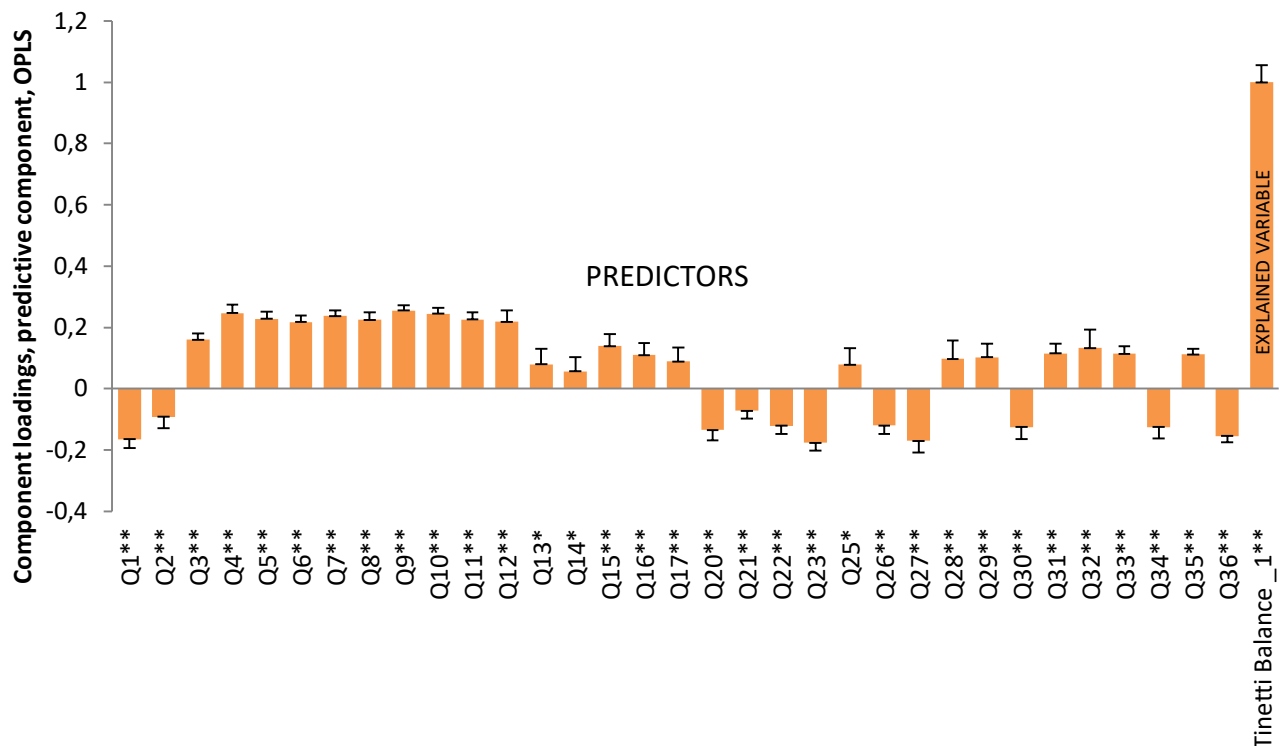


Figure 2. Significant positive and negative predictors of the Tinetti summary balance test in the interplay of SF-36 results (n=266 males)

## DISCUSSION

On the base of the statistical analysis has been proven that the increasing age is an important negative predictor of balance performance in males and females in the age 65+ with significant negative effect. This finding is consistent with the research results of Balogun et al. [27] that balance performance for both genders increased with chronological age, peaked in the age 30-40 years old and after a progressive decline was found. So, it would be fruitful to start with balance development preventively since the fourth decade of human life. Of course, it is good to start with balance exercises in any age, but it seems that a crucial period is in the fourth decade. With increasing age, decreasing muscle mass and muscle strength tend to diminish, which, as shown above, may play a key role in the level of performance in the Tinetti summary balance test in female seniors. According to the findings of the studies o [4, 15, 28, 29], it is very important to discuss the individual possibility of female motivating to manage the ability to provide daily adequate physical activity sequences according to the individual capacity and specifics. Bukova et al [30-32] similarly confirm that adults with chronic diseases should be physically active regularly. All the guidelines also indicate that patients should consult a healthcare professional or a physical education specialist.

The important anthropometric aspects of the study to discussion represent the confirmations that the body height and muscle mass correlates significantly positively with the performance of the Tinetti summary balance test in the females in a contrast to the male seniors. Also width of ankle, width of femur and the girth of chest correlate significantly positively with the Tinetti summary balance test in monitored female seniors. It can be discussed in accordance with Benzo et al. [13] and Oatis [10] that an optimal robustness of female body can be presented as predictor with significant positive influence for balance ability in females aged 65+. In the male seniors only the width of humerus correlated significantly as positive predictor of the Tinetti summary balance test. Frost [11] states, that the biepicondylar width of the femur itself already provides significant and valid information about the robustness of the skeleton, what is valid for both genders males and females, what may play a positive role in preventing injuries and falls in senior age 65+. Further, it seems to be very important to discuss the individual possibility of motivating a senior to manage the adequate

movement regime according to the individual capacity. In the context it is recommended to keep and develop the body flexibility [33] in male and female seniors aged 65+. We may discuss in accordance with study results [6, 27, 29] that daily physical activities, esp. walking represent an effective prevention of problems with balance in senior age and an effective prevention of psychosocial problems associated with hypokinetic lifestyle of seniors.

We can discuss to the fact, that clinically diagnosed “Depression”, “Type 2 diabetes mellitus”, “Hypertension” and “Vertigo” represent significant predictors for physical imbalance in both genders of the monitored seniors 65+. These results are very alarming. It may be recommended to regulate perceived imbalance through slow provided and controlled exercise techniques, based on two-phase process, where the first phase presents an undisturbed self-perception (body, breathing, etc.), follow-up by active changing of muscle tension and release, in synchrony with breathing and mindfulness [17, 33-35]. In such type of physical exercises, a senior is educated to learn step by step the process of relaxation, balance and strength exercises [33, 35].

In the psychosocial idiocies to balance we can discuss fact that there were found significant differences between male seniors. In female seniors psychosocial factors play a more important role. The social activities of daily life, including physical activities and health aspects, interfere very sensitively in female seniors to the balance abilities. Negative emotions, pain and nervousness were analyzed as significant negative predictors for balance performance of the female seniors. These findings are consistent with the research findings of Charles and Carstensen [18], Freund and Isaacowitz [20] and Montepare [21], who state that reduction of social activities is related to the disbelief in one’s own good health of seniors. These facts are in conformity with results which implies that balance performance may be significantly reduced in women due to emotional difficulties (e.g. anxiety) [16, 22, 34]. The pain is associated with a health negative predictor for balance, it affects the mobility of female seniors and limits their normal activities including social area [19, 28, 34].

## **CONCLUSION**

The purpose of the study was fulfilled. There were analyzed the predictors interplaying significantly with the performance of Tinneti summary balance test. Age, Depression, Type 2 diabetes mellitus, Hypertension, Vertigo, Health decreasing expectation and Social isolation influent significantly negatively the level of the Tinneti summary balance test in male and female seniors.

On the contrary the Physical activities provided regularly, Feelings of happiness and Social self-confidence were analyzed as significant positive predictors interplaying with the performance of Tinneti summary balance test in both genders of monitored probands, i.e. male and female seniors in the age 65+. In addition in female monitored seniors the positive predictors interplaying with the performance of Tinneti summary balance test are Optimal robustness of the skeleton, Muscle mass, Muscle power and Social balance feelings.

The hypothesis H1: “Performing of physical activities positively correlates with the performance in the Tinneti summary balance test in monitored seniors” was verified based on the statistical analysis and the interplaying of the obtain data in seniors 65+. The study results proved the positive correlations of physical activities realization in daily life of seniors with their performance in the summary balance test.

The hypothesis H2: “There are no differences between monitored male seniors and female seniors according the psychosocial factors interplay the performance in the Tinneti summary balance test” was not verified based on the statistical analysis and the and the interplaying of the obtain data in seniors 65+. There were found significant psychosocial differences according gender of seniors.

It may be beneficial for the experts in area of physical activities application in senior age to respect the define predictors, which influence significantly the balance ability in both genders of the seniors 65+. Primary for the seniors is the “safety” and therefore during any planning of physical activities programs for seniors should be take into account the interplay among the balance ability, physical activities realization, anthropometric parameters and psychosocial indices in relation to gender, age and the individual specific of seniors.

## ACKNOWLEDGEMENTS

The study was supported and founded by Czech Science Foundation - GAČR ID 17-25710S “Basic research of balance changes in seniors”.

## REFERENCES

1. Orimo, H, Ito, H, Suzuki, T, Araki, A, Hosoi, A, Sawabe, M. Reviewing the definition of “elderly”. *Geriatrics and Gerontology International* 2006; 6(3): 149-158. doi: 10.1111/j.1447-0594.2006.00341.x
2. EU Senior Entrepreneurship Good Practices Manual. Brussel: Development Solutions Europe Ltd. Project number: 2016. doi: 10.2826/014341
3. Eurostat 2017 A look at the lives of the elderly in the EU today. Available at: <https://ec.europa.eu/eurostat/cache/infographs/elderly/index.html> (accessed 2019 Nov 10)
4. Krejci, M. et al. Adequate movement regime and bio-psycho-social determinants of active life style. Ceske Budejovice: University of South Bohemia; 2010 [in Czech]
5. Krejci M, Hosek V. Identification characteristics of the intervention method “Life in Balance” focused on seniors 65+. *Acta Salus Vitae*, 2018; 6(2): 45-54
6. Krejci, M. Podpora zdraví v adekvátních pohybových režimech [Health support in adequate movement regime] In: Hendl J, Dobrý J a kol. Zdravotní benefity pohybových aktivit: Monitorování, intervence, evaluace [Health benefits of physical activities: Monitoring, intervention, evaluation]. Praha: Karolinum; 2011. 75-96 [in Czech]
7. Ni Chronin, D, Ni Chronin, CH, Beveridge, A. Factors influencing deprescribing habits among geriatricians. *Age Ageing*, 2015; 44(4): 704–708. doi: 10.1093/ageing/afv028
8. Christensen K, Doblhammer G, Rau R, Vaupel JW. Ageing populations: The challenges ahead. *The Lancet* 2009; 374(9696): 1196-1208. doi: 10.1016/S0140-6736(09)61460-4
9. EU The 2018 Ageing Report Underlying Assumptions & Projection Methodologies. 2017; doi: 10.2765/286359 Available at: [https://ec.europa.eu/info/sites/info/files/economy-finance/ip065\\_en.pdf](https://ec.europa.eu/info/sites/info/files/economy-finance/ip065_en.pdf) (accessed 2019 Oct 9)
10. Oatis CA. *Kinesiology-Mechanics and pathomechanics of human movement*. California: Wolters Kluwer; 2016.
11. Frost R. *Applied Kinesiology*. Berkeley: North Atlantic Books; 2013.
12. Crimmins EM, Preston SH, Cohen B. (Eds.) *International Differences in Mortality at Older Ages. Dimensions and Sources*. Washington: The National Academies Press; 2010.
13. Benzo RP, Novotny PJ, Karpman C, Depew ZS. Correlations between gait speed, 6-minute walk distance, physical activity, and self-efficacy in patients with severe chronic lung disease. *Respiratory Care* 2013; 58(12): 2113-2119. doi: 10.4187/respcare.02471
14. Bicikova M, Jandova D, Honců P. Stárnutí, deprese, pohyb. [Aging, depression, movement] *Czech Chemical Society; Symposium Series (CCSSS) 2019; (17)4: 25-26* [in Czech]
15. Shumway-Cook A, Woollacott MH. *Motor control: translating research into clinical practice*. Philadelphia: Wolters Kluwer; 2016
16. Janeckova B, Poncarova E, Kalova H, Vostova M, Triskova J, Petr P. Rovnováha a pády jako ošetrovatelský problém [Equilibrium and falls as nursing problems (The interim report on field study)]. *Prevence úrazů, otrav a násilí [Prevention of injuries, poisoning and violence]*, 2012; 9(2):195-206. EISSN 1804-7858. Czech
17. Krejci M, Hill M, Hosek V, Jandova D, Kajzar J, Blaha P. Bio-Psycho-Social Consequences and Effects in Fall-Efficacy Scale in Seniors Using Exercise Intervention of Motor Learning According to Yoga Techniques. *International Journal of Sport and Health Sciences* 2019; 13(10): 435-440. doi.org/10.5281/zenodo
18. Charles ST, Carstensen LL. Social and Emotional Aging. *Annu. Rev. Psychol.* 2010; (61)1, 383-409. doi: 10.1146/annurev.psych.093008.100448
19. Suls J, Bunde J. Anger, Anxiety, and Depression as Risk Factors for Cardiovascular Disease: The Problems and Implications of Overlapping Affective Dispositions. *Psychological Bulletin of American Psychological Association*, 2005; 131(2): 260 –300. doi: 10.1037/0033-2909.131.2.260
20. Freund AM, Isaacowitz DM. Aging and social perception: so far, more similarities than differences. *Psychology and Aging* 2014; 29(3): 451-453. doi: org/10.1037/a0037555
21. Montepare JM. An exploration of subjective age, actual age, age awareness, and engagement in everyday behaviors. *Eur J Ageing*, 2019; 16(3): 1-9. doi: 10.1891/0198-8794.35.1
22. Blaha P. Funkční a sportovní antropologie – vybrané metody. [Functional and sports anthropology - selected methods]. Praha: VŠTVS Palestra; 2017 [in Czech]

23. Tinneti ME, Richman D, Powell L. Falls efficacy as a measure of fear of falling. *J Gerontol*, 1990; 45(6): 239-243. doi: 10.1093/geronj/45.6.p239
24. RAND Health Care. 36-Item Short Form Survey (SF-36) Scoring Instructions, 2019. Available at: [https://www.rand.org/health-care/surveys\\_tools/mos/36-item-short-form/scoring.html](https://www.rand.org/health-care/surveys_tools/mos/36-item-short-form/scoring.html) accessed on 01.09.2019 (accessed 2019 Nov 20).
25. Best H, Wolf Ch. *The SAGE Handbook of Regression Analysis and Causal Inference*. London: SAGE; 2014.
26. Meloun M, Militky J, Hill M, Brereton RG. Crucial problems in regression modelling and their solutions. *Analyst*, 2002; 127(4): 433-450. doi 10.1039/b110779h
27. Balogun J, Akindele KA, Nihinlola JO, Marzouk DF. Age-related changes in balance. *Disabil Rehabil* 1994; 16(2): 58-62. doi: org/10.3109/09638289409166013
28. Lehnert K, Sudeck G, Conzelmann A. Subjective well-being and exercise in the second half of life: a critical review of theoretical approaches. *Eur Rev Aging Phys Act* 2012; 9(2): 87-102. doi: 10.1007/s11556-012-0095-3
29. Rehor P, Kornatovska Z. Measuring of health - related benefits of physical activity in high school students. *Acta Salus Vitae*, 2013; 2(2): 151-160.
30. Bukova A, Hagovska M, Drackova D, Horbacz A, Wasik J, Krucanica L. Awareness of patients suffering from selected chronic diseases of the importance of physical activity in treating their disorders. *Phys Activ Rev* 2019; 7: 234-239. doi: 10.16926/par.2019.07.27
31. Ortenburger D, Wařik J, Bukova A, Gora T. Comparison of strategies used by patients undergoing treatment for chronic pain people performing taekwon-do – a pilot study. *Ido Movement For Culture. Journal of Martial Arts Anthropology* 2016; 16(3): 40-46. doi: 10.14589/ido.16.3.5
32. Ortenburger D, Wařik J, Bukova A. Taekwondo training in the context of dealing with negative emotions. *Arch Budo Sci Martial Art Extreme Sport* 2015; 11: 99-104
33. Krejci M, Kornatovska Z. Yoga applications in persons with disabilities. In: Bolach E, Kawczynski A. (Eds.). *Adapted Physical Activity*. Wroclaw: AWF; 2018.
34. Bicikova M, Kolatorova L, Macova L, Bestak J, Hill M, Formanova P, Jandova D, Moravek O, Novotny J. Steroidní metabolom jako indikátor efektu lázeňské léčebně rehabilitační péče. [Steroidal metabolomic biomarkers as an indicator of the effect of spa therapy and balneotherapy], *Rehabil. fyz. Léč* 2018; 25(3): 99-108. [in Czech]
35. Marcinko I. The moderating role of autonomous motivation on the relationship between subjective well-being and physical health. *PloS One* 2015; (10)5: e0126399. doi: 10.1371/journal.pone.0126399