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Original empirical article

A COMPARATIVE ANALYSIS OF THE INDICATORS OF THE FUNCTIONAL FITNESS OF THE ELDERLY*

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Abstract. *With the aim of analyzing the dependence of indicators of functional fitness on the body weight of the elderly, a battery of the Senior Fitness Test was used (Rikli & Jones, 2001), which consists of the 8-Foot Up-and-Go, Back Scratch, Chair Sit-and-Reach, 2-Minute Step Test, 30-Second Chair Stand, and the Arm Curl. The sample of subjects consisted of 59 males and 60 females, aged from 65 to 70. On the basis of the Body Mass Index (BMI) the subjects were divided into two groups, depending on gender: individuals with normal body weight and individuals with increased body weight. In order to calculate the statistical significance of the differences between the groups, we used a single factor analysis, the ANOVA (the conclusions were all made at the 0.05 level of significance). On the basis of the discussion of the obtained results, it was concluded that the statistically significant difference between the indicators of functional fitness depending on body weight, in favor of individuals with normal body weight in the case of the subsamples consisting of men and women.*

Key words: *functional fitness, elderly people, BMI.*

INTRODUCTION

The concept of fitness within physical exercise and sport includes general physical ability and the level of fitness, which is necessary in order for everyday and other activities to be carried out with the possibility of postponing the onset of fatigue.

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Functional fitness is a concept which represents the optimum physical capacity which is needed to renew normal everyday activities, independently and without the early onset of fatigue. It is assumed that the level of functional fitness depends on one's lifestyle, the level of physical activity and one's health status.

The aging process and the lack of adequate physical activity change the indicators of functional fitness. The lack of physical activity to a great extent is the cause of the changes in functional abilities during the aging process (Nadel & DiPietrol, 1995). The cardio-respiratory system is susceptible to changes and indicates a significant decrease in the aerobic capacity after the age of 40, so that by the age of 65 it is approximately 30% less. This is related to the decrease in the indicators of maximum heart frequency, heart rate and arteriovenous difference (Fleg, O'Connor, & Gerstenblith, 1995).

If elderly individuals do not take part in physical exercise, they expose themselves to risk of having their muscle mass and joint motion reduced, while the loss of muscle strength is related to the decrease in muscle mass.

The daily needs for energy expenditure diminish during the aging process, which leads to a lower basal metabolism.

Physical exercise which relies on movement and motion is taken to be the precondition for the normal functioning of the elderly, while the optimum functioning of an individual is connected to the level of the fitness indicators.

Rikli & Jons (1999b) were able, on the basis of the evaluation of strength, aerobic endurance, flexibility, agility and balance to determine the norms of functional fitness among the elderly. A statistically significant difference in relation to gender in the case of the entire battery of fitness tests was determined, which meant that the males had better results for strength, aerobic endurance and agility, and the women had better results for flexibility. Lower levels of fitness were determined in the case of men with circulatory disease or musculoskeletal disease, as well as in the case of women with circulatory problems or musculoskeletal disease, or obesity. It was pointed out that the level of the functional fitness of the elderly who live in a community is higher among those who took part in physical activities Arao, Oida, & Nagamatsu (1998).

Heuvelen, Stevens, & Kempen (2002) studied the significance of the differences in the results for physical fitness between physically active (1108) and inactive individuals (824). Differences were also determined between all age groups across all of the tests, except in the case of the tests of flexibility of the hips and a visual reaction between younger men and middle aged men.

The level of functional fitness contributes to the prediction of the decrease in function, which is necessary for independent living. The results have shown that the level of physical fitness is significantly connected to the decrease in the functions necessary for everyday life in the case of men (Nagamatsu, Oida, Kitabatake, Kohno, Egawa, Nezu, & Arao, 2003).

The characteristics of the relationship between the age, functional abilities and physical activities of elderly women were studied by Wong & Cheung (2005). The results of the active participants were better than the results of the female participants who led a sedentary lifestyle. This research confirmed that the physical activity of the female participants had a positive influence on the indicators of the functional fitness of elderly women.

That a decrease takes place in the values of all of the applied variables in the case of the participants of most age groups was determined by Rikli & Jons (1999a); Heuvelen et al. (2002). This was not manifested in the tests for the evaluation of flexibility of the hip and the visual reaction between the youngest and middle-aged male subjects, as well as in

the tests for the evaluation of upper body strength, aerobic endurance, flexibility of the upper body and agility of younger women Wong & Cheung (2005).

With the aim of studying the dependence of physical fitness on nationality, a comparative analysis of physical fitness on the basis of nationality was carried out (Malina, 2001; Yiiksek & Ciciogl, 2005). Physical fitness and the frequency of physical exercise in the case of individuals of all ages are greater in the case of Europeans than in the case of Americans (Malina, 2001), but upon analyzing the remaining studies, we concluded that the level of physical fitness among Europeans is not at a satisfactory level. Yiiksek & Cicioglu (2005) studied physical fitness achievements in the case of elderly subjects in Turkey. The results have shown that the physical fitness of Turkish citizens is lower than in the case of elderly individuals in other countries.

The connection between cardio-respiratory fitness, body composition and mortality was studied by Sui, La Monte, Laditka, Hardin, Chase, Hooker, et al. (2007)**.** The level of cardio-respiratory fitness was evaluated by using maximum intensity exercises, while body composition, or in other words the level of obesity, was evaluated based on the values of the BMI, waist circumference and percentage of body fat. The results of the research have shown that the indicators of physical fitness are a significant predictor of mortality in the case of elderly individuals, irrespective of the overall or abdominal obesity.

There is an entire group of studies which had as their aim to determine the effects of various exercise programs on the fitness achievements of the elderly. Suomi, & Collier (2003) determined the effects of water exercise programs. Hruda, Hicks, & McCartney (2003) wanted to determine the influence of simple progressive exercises of the lower body on strength and functional abilities. Toraman, Erman, & Agyar (2004) set as the aim of their research to evaluate the effects of a controlled nine-week diverse exercise program on the functional fitness and posture of independent elderly individuals. Seynnes, Fiatarone Singh, Hue, Pras, Legros, et al. (2004) carried out a study with the aim of comparing the effects of training programs with and without weights, and of two intensities: from light to moderate, and high intensity exercise. Yamauchi, Islam, Koizumi, Rogers, Rogers, & Takeshima (2005) evaluated the effectiveness of a planned exercise program for the elderly, which was carried out in their homes, while Simon, & Andel (2006) focused their research on the effects of resistance training and the effects of training based on walking on the results for functional fitness.

All of these studies mainly confirmed the positive effects of physical exercise on the fitness of the elderly.

It is assumed that increased body weight among elderly individuals, and the closely related values of their BMI, have an influence on the performance of motion tasks which require strength, mobility, endurance and agility/dynamic balance.

The aim of this research is to determine the statistical significance of the differences in the indicators of functional fitness between the male and female participants with normal weight and overweight male and female participants.

THE METHOD

The sample of participants

The sample of participants was selected from a population of elderly individuals aged 65 to 70, including individuals of both sexes. On the basis of the indicators of the Body Mass Index (BMI), the participants were divided into two groups: 59 men (29 of whom

had normal weight and 30 of whom had increased body weight) and 60 women (30 of whom had normal weight 30 of whom had increased body weight).

The division of the participants into groups of normal body weight and increased body weight was carried out on the basis of the values of the BMI. In order to calculate the values of the BMI, we used a standard procedure based on the following formula: BMI = Body weight [kg] / Body Height [m^2] (WHO, 1997; WHO, 2000; American College of Sports Medicine, 2006; Seidell & Flegal, 1997). In the research, we classified participants as having normal body weight if their BMI ranged from 18.50 to 24.99 kg/m^2, while the values of the of the BMI in the case of overweight participants were defined as ranging from 25.00 to 29.99 kg/m^2, irrespective of gender (WHO, 1997).

The measuring of the parameters of functional fitness was carried out on the participants who fulfilled the following criteria: the participants lived in their own households in the cities of Nis or Kraljevo (Serbia); on the day the measuring took place, their blood pressure did not exceed a value of 170/95; they were tested in the facilities in which they lived; they voluntarily agreed to be tested. The overall sample of participants included 59 men (39 from Nis and 20 from Kraljevo) and 60 women (45 from Nis and 15 from Kraljevo). The testing was carried out by trained measurers and a doctor of sports medicine.

Table 1 shows the descriptive statistical parameters of the basic bodily characteristics of the elderly participants included in this study.

Table 1 The physical characteristics of the participants

	Men		Women	
	Normal weight[§] (n=29)	Overweight[§] (n=30)	Normal weight[§] (n=33)	Overweight[§] (n=27)
Body Height [cm]	170.86±6.21	168.57±4.64	157.52±5.27	159.07±5.23
Body weight [kg]	69.45±4.43	75.63±6.32	56.88±4.44	66.00±4.67
Age (year)	67.55±1.62	67.03±1.52	67.06±1.80	68.07±1.66
BMI [kg /m^2]	23.81±0.82	26.60±1.03	23.04±1.09	26.25±1.22

Values are Means ± Standard deviation; [§] Classification of Normal and Overweight based on BMI

Measuring instruments

The people who constructed the battery of the Senior Fitness Tests for the evaluation of functional fitness, which was used in this research, were experts from the California State University at Fullerton (Rikli & Jones, 2001). The battery consisted of six measuring instruments, which were meant to test people aged from 60 to 90.

In this research the following measuring instruments from the battery of the Senior Fitness Tests were used: the 8-Foot Up-and-Go (used to evaluate agility/dynamic balance), Back Scratch (used to evaluate shoulder mobility), Chair Sit-and-Reach (used to evaluate the lower extremities), 2-Minute Step Test (used to evaluate aerobic and muscle endurance), 30-Second Chair Stand (used to evaluate lower body strength) and the Arm Curl (used to evaluate arm strength). The metric characteristics of the cited tests were published in the research of Rikli & Jones (1999a).

The statistical analysis

The basic descriptive statistical parameters were calculated for all of the obtained data (means and standard deviation). The means of the BMI were used to classify the participants into groups based on body weight. In order to determine whether any significant differences exist between the studied groups, an analysis of variance was used (the one-way ANOVA). The level of significance was defined as 0.05. The results were processed with the help of the statistical package STATISTICA 7.0 (StatSoft. Inc., Tulsa, OK, USA).

THE RESULTS

Table 2 shows the means and standard deviations of the results on the tests of functional fitness for men and women who had normal or increased body weight.

Table 2 The basic indicators of the descriptive statistical parameters of functional fitness

	Men		Women	
	Normal weight[§] (n=29)	Overweight[§] (n=30)	Normal weight[§] (n=33)	Overweight[§] (n=27)
8-Foot Up-and-Go	4.78 ±0.80	5.07±0.46	4.46 ±0.95	5.23 ±0.70
Back Scratch	1.43±4.86	-11.30±5.32	-1.30±5.14	-6.26±6.38
Chair Sit-and-Reach	11.53±7.14	0.12±5.86	9.76±6.17	6.67±4.57
2-Minute Step Test	106.62±8.35	92.77±6.28	98.55±11.91	88.07±10.20
30-Second Chair Stand	16.31±2.22	15.50±1.78	15.33±1.61	14.04±1.60
Arm Curl	19.00±2.25	15.73±1.98	16.21±1.80	15.22±1.72

Values are Means ± Standard deviation; [§] Classification of Normal and Overweight based on BMI

Table 3 and Table 4 show the calculated coefficients of the single factor analysis of variance for the men (Table 3) and the women (Table 4), with an emphasis of the degree of significance (Sig) between the participants with normal body weight and overweight participants.

Table 3 The One-Way ANOVA between the two groups (the men)

	Normal weight[§]	Overweight[§]	F	Sig.
8-Foot Up-and-Go	4.78	5.07	2.91	.093
Back Scratch	1.43	-11.30	92.00	.000**
Chair Sit-and-Reach	11.53	0.12	45.18	.000**
2-Minute Step Test	106.62	92.77	52.07	.000**
30-Second Chair Stand	16.31	15.50	2.40	.127
Arm Curl	19.00	15.73	35.05	.000**

Values are Means; [§] Classification of Normal and Overweight based on BMI; * p< .05; ** p< .01;

Table 4 The One-Way ANOVA between the two groups (the women)

	Normal weight§	Overweight§	F	Sig.
8-Foot Up-and-Go	4.46	5.23	12.16	.001**
Back Scratch	-1.30	-6.26	11.12	.001**
Chair Sit-and-Reach	9.76	6.67	4.66	.035*
2-Minute Step Test	98.55	88.07	13.04	.001**
30-Second Chair Stand	15.33	14.04	9.63	.003**
Arm Curl	16.21	15.22	4.68	.035*

Values are Means; § Classification of Normal and Overweight based on BMI; * p< .05; ** p< .01;

In the case of the "8-Foot Up-and-Go" test which was used to evaluate agility, or dynamic balance, the results achieved by the sample of men ranged from 4.78 for the subsample of participants with normal body weight to 5.07 for the subsample of overweight participants. The obtained difference is not statistically significant. For the sample of women, the obtained results ranged from 4.46 for the female participants with normal body weight to 5.23 for overweight participants. The obtained difference is statistically significant at the .001 level, in favor of the female participants with normal body weight.

In the case of the "Back Stretch" test which was used to evaluate the mobility of the shoulders, the results achieved by the sample of men range from 1.43 for the participants with normal body weight to -11.30 for the overweight participants. The difference was significant at the .000 level in favor of the participants with normal body weight. In addition, in the case of the sample of women, a statistically significant difference in favor of the female participants with normal body weight was also noted at the .001 level. The results ranged from -1.30 for the female participants with normal body weight to -6.26 for the overweight female participants.

In the case of the "Chair Sit-and-Reach"test which was used to evaluate the mobility of the lower body, we obtained values ranging from 11.53 for the subsample of men with normal body weight to 0.12 for the subsample for the overweight participants. In the case of sample of women, the female participants with normal body weight had a value of 9.76 in relation to the overweight participants, who had a value of 6.67. A statistically significant difference of .000 was obtained in favor of the participants with normal body weight and at the level of .035 in favor of the female participants with normal body weight.

In the case of the "2-Minute Step Test" test for the evaluation of aerobic and muscle endurance, the results of the sample of men ranged from 106.62 for the subsample of participants with normal body weight to 92.77 for the subsample of overweight participants. The obtained difference is statistically significant at the .000 level in favor of the participants with normal body weight. The results of the sample of women ranged from 98.55 for the female participants with normal body weight to 88.07 for the overweight participants. The obtained difference is statistically significant at the .001 level in favor of the female participants with normal body weight.

The results of the "30-Second Chair Stand" test which was used to evaluate lower body of the sample of men ranged from 16.31 for the participants with normal body weight to 15.50 for the overweight participants. The obtained difference is not statistically significant. On the other hand, in the case of the sample of women, a statistically significant difference of .003 was obtained in favor of the female participants with normal weight. The results ranged from 15.33 for the female participants with normal body weight to 14.04 for the overweight participants.

In the case of the "Arm Curl" test which was used to evaluate arm strength the results of the men ranged from 19.00 for the subsample with normal body weight up to 15.73 for the subsample of overweight participants. The obtained difference is significant at the .000 level in favor of the female subjects with normal body weight. In the case of the subsample of women, the female participants with normal body weight achieved values of 16.21 in comparison to the overweight participants, who achieved values of 15.22. The difference is statistically significant at the .035 level in favor of the female participants with normal body weight.

Figure 1 shows a graphic representation of the results of the univariate analysis of variance of the subjects with normal and increased body weight, for the subsamples of men and women.

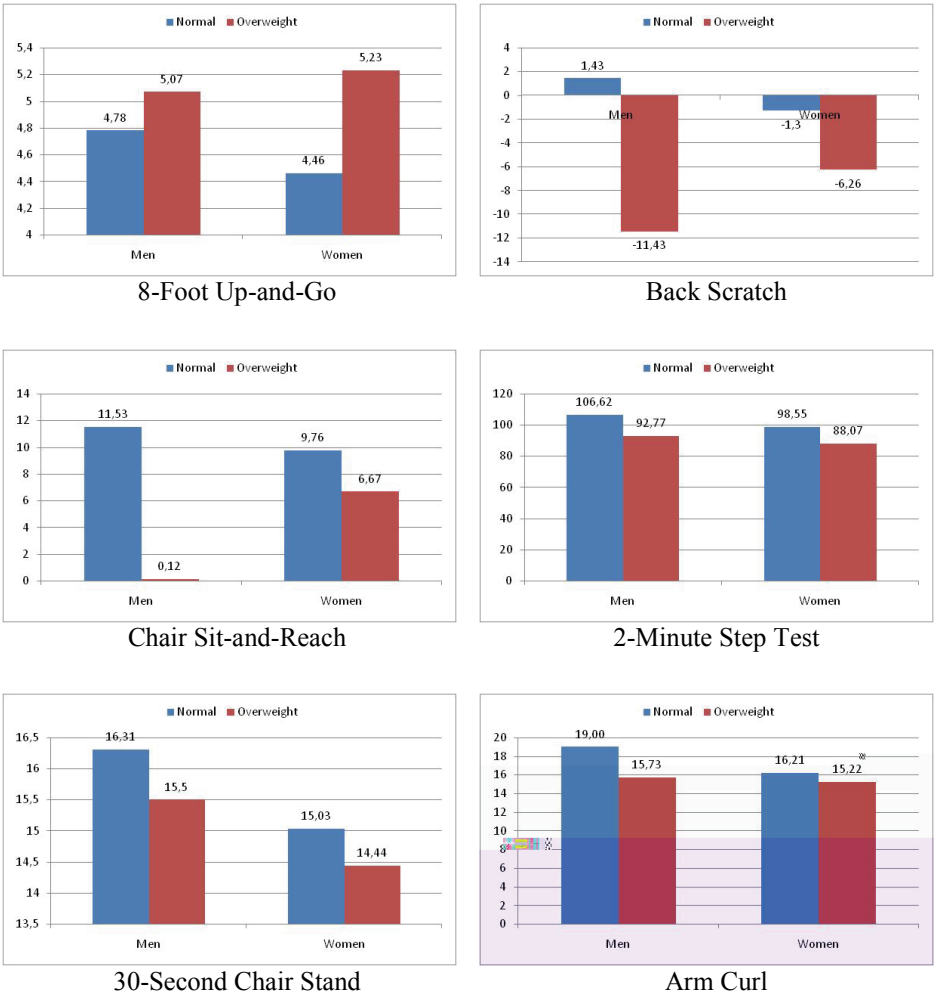

Fig. 1 A graphic representation of the One-Way ANOVA between the groups

THE DISCUSSION

On the basis of the analysis of the obtained data we can conclude that for the 8-Foot Up-and-Go test, there is no statistically significant difference between the participants with normal body weight and the overweight participants in the case of the sample of men, while such a difference does exist for the subsample of women. This test is used to evaluate agility, or dynamic balance. Elderly individuals need these abilities in their everyday lives for proper movement in space, to be able to board the bus, move around the house, take care of their grandchildren and play with them. It is assumed that overweight elderly women will find it more difficult to manage everyday activities for which agility and dynamic balance are needed.

For the tests used to evaluate upper body mobility, a statistically significant difference was obtained in favor of the participants with normal body weight. The Back Scratch test was used to evaluate upper body mobility, that is, the shoulder belt. There are numerous activities in life for which this type of mobility is important: combing one's hair, lifting one's arms above their head, reaching their seatbelt in the car, reaching things above their heads and shoulders. The Chair Sit-and-Reach test was used to evaluate lower body mobility, which is necessary for normal walking, but also for specific movement situations in everyday life, such as leaving the bathtub or the car, putting on one's shoes, gardening and the like. It is assumed that the movements and activities of individuals with increased body weight and decreased mobility are significantly limited.

In order to evaluate strength abilities, we applied two tests. The 30-Second Chair Stand test used to evaluate lower body strength. Lower body strength among elderly individuals is necessary for their everyday activities: climbing stairs, rising from chairs or the bathtub, leaving the car and the like. Nevertheless, the sample of men shows no statistically significant differences between the participants with normal body weight and the overweight participants. On the other hand, for the Arm Curl test, which was used to evaluate upper body strength, a statistically significant difference was obtained in favor of the participants with normal body weight. Upper body strength is necessary for the performance of household and other activities which include grocery shopping, lifting weights such as luggage for instance, picking up one's grandchild and the like. The performance of the mentioned movements, as well as the performance of the cited test requires arm flexor strength. Increased body weight can be a disturbing factor for the manifestation of upper body strength. These results agree with some of the results of other authors Apovian, Frey, Wood, Rogers, Still, & Jensen (2002) who studied the physical functions of elderly women. The set aims were set to evaluate physical fitness based on the combination of tasks and to quantify the correlation between the obtained factors and the BMI. Higher values of BMI are connected to poor upper and lower body functions in a statistically significant manner, but not to strength and coordination. It was concluded that higher values of BMI probably have a different effect on the specific aspects of physical functions, especially upper body functions, and to a smaller extent on lower body functions. The influence of the BMI on physical functions can better be determined through an intervention, which is organized in such way so as to influence the independent lives of elderly, overweight, women.

The results of the 2-Minute Step Test indicated a statistically significant difference in favor of the participants with normal body weight. This test is used to evaluate aerobic and muscle endurance, and is used only in situations where there are no suitable conditions to carry out the six-minute walk test. On the basis of the obtained results, we can

say that increased body mass is a disturbing factor, and thus that a statistically significant difference was obtained between the participants. The obtained data can indicate difficulties in carrying out everyday tasks, which was confirmed in the research of Davison, Ford, Cogswell & Dietz (2002), who evaluated the connection between functional limitations and body composition. In their study, the dependent variable was defined as the level of difficulty in performing at least three of five functional tasks from everyday life. The results have shown that women with the highest percentage of body fat were twice as likely to suffer from a functional limit, while elderly males were 1.5 times more likely to suffer from these limitations. The authors concluded that preventing extensive accumulation of fatty tissue in the body and maintaining the values of the BMI within the normal range can reduce the probability of the occurrence of functional limitations due to old age.

Difficulty of movement and problems with everyday activities have also been noted in the research of Newton, Cromwell & Rigers (2009), who analyzed the relations between physical activities and overweight elderly individuals. Overweight individuals and individuals with normal weight were evaluated using physical activities from everyday life, and physical functions were evaluated with the help of the Medical Outcomes Short Form-36, and the physical activity scale for the elderly. The result showed that overweight individuals scored significantly lower results in some of the physical measurements when compared to the individuals with normal weight.

Blair, Cheng & Holder (2001) studied whether physical activity and physical fitness were useful to health, based on the analysis of 9831 studies. They analyzed whether there were any relations between physical activity and health, whether there is a relation between cardio-respiratory fitness and health, and whether it is possible to determine which is more important. On the basis of the analysis of numerous studies carried out by various authors, it can be concluded that increased physical activity of the people is connected to a longer lifespan, decreased risk of hip dysplasia, CVD, brain stroke and colon cancer. This is one of the numerous studies which pointed out the significant relations between physical activities and health.

CONCLUSION

On the basis of the results of the research into the indicators of functional fitness of elderly individuals with normal body weight and increased body weight, we can conclude that there is a statistically significant difference for the men in the case of the Back Scratch, Chair Sit-and-Reach, 2-Minute Step Test, and the Arm Curl, and in the case of the sample of women, the 8-Foot Up-and-Go, Back Scratch, Chair Sit-and-Reach, 2-Minute Step Test, 30-Second Chair Stand, and Arm Curl tests. On the basis of the results and the discussion, we can conclude that increased body weight in the case of men significantly decreases the indicators of functional fitness for the Back Scratch, which is used to evaluate the mobility of the shoulder belt, the Chair Sit-and-Reach, which is used evaluate mobility of the lower body, the 2-Minute Step Test, which is used to evaluate aerobic and muscle endurance, and the Arm Curl, which is used to evaluate arm strength.. In the case of elderly overweight females, increased body weight decreases the values of all the indicators of functional fitness which were studied, in a statistically significant manner. It is for this reason that for proper physical functioning in everyday life we can recommend physical activity and the decrease in body weight for all elderly individuals.

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KOMPARATIVNA ANALIZA POKAZATELJA FUNKCIONALNOG FITNESA STARIH LJUDI

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Sa ciljem da se istraži zavisnost pokazatelja funkcionalnog fitnesa od telesne težine starih osoba primenjena je baterija Senior fitnes testa (Rikli i Jones, 2001) koja sadrži 8-Foot Up-and-Go, Back Scratch, Chair Sit-and-Reach, 2-Minute Step Test, 30-Second Chair Stand, i Arm Curl. Uzorak ispitanika činilo je 59 muških i 60 ženskih osoba, starih od 65 do 70 godina. Na osnovu Body Mass Index-a (BMI) ispitanici su, u odnosu na pol, podeljeni na grupe: osobe sa normalnom telesnom težinom i osobe sa povećanom telesnom težinom. Za izračunavanje statističke značajnosti razlika između grupa primenjena je jednofaktorska analiza varijanse ANOVA (zaključivanje na nivou značajnosti 0.05). Na osnovu diskusije dobijenih rezultata zaključeno je da je utvrđena statistička značajna razlika u pokazateljima funkcionalnog fitnesa u zavisnosti od telesne težine u korist osoba sa normalnom telesnom težinom na subuzorcima žena i muškaraca.

Ključne reči: *funkcionalni fitnes, stari ljudi, BMI.*