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THE RELATION BETWEEN PHYSICAL/FUNCTIONAL FITNESS AND THE BLOOD PRESSURE OF ELDERLY MEN AND WOMEN

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Abstract. *The aim of the research was to determine the connection between physical fitness and the blood pressure of elderly men and women. The sample of subjects encompassed 60 men and 60 women who were aged 65 to 70. The senior fitness test with six measuring instruments was used for the evaluation of hand strength, upper and lower extremity mobility, stamina and agility/dynamic balance. The values of systolic and diastolic resting blood pressure, presented in mmHg, were used to evaluate blood pressure. The data were processed by a multivariate regressional analysis. The obtained results indicate that a connection exists between the predictor variables (physical/functional fitness) and systolic and diastolic blood pressure on a sample of men and a sample of women. All of the obtained multiple correlations are significant at the 0.000 level. The greatest contribution to the explanation of systolic and diastolic blood pressure on the basis of the sample of elderly men was made by the variables for the evaluation of aerobic stamina and lower body strength. The greatest contribution to the explanation of systolic and diastolic blood pressure on the basis of the sample of women was made by the variables which were used to evaluate aerobic stamina, lower body strength, arm strength, and lower body mobility.*

Key words: *functional fitness, elderly people, blood pressure, prediction*

1. INTRODUCTION

The aging process consists of various changes which are manifested by a decrease in the functioning of organs or systems. In the case of people aged 65 and over, dominant chronic degenerative illnesses, which accompany many to end of their lives, are usually dominant. Physical activity is, mostly, recommended for prophylactic purposes, in order to "preserve" health, and more and more frequently for therapeutical purposes. More and

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more emphasis is being placed on a body in motion. Motion and movement are understood as being the condition for the normal functioning of the human body, and normal functioning is connected to fitness, or to be more precise, exercise.

Fitness means the entire physical ability of a person and the willingness necessary for being involved in various activities without getting tired. "We can talk about the physical abilities which enable an individual to successfully carry out the motion task and about the physical abilities which are necessary for everyday work"(Kostić, 1999, 5). It is difficult to determine which changes to the functional status are the result only of aging and which are connected to the decrease in physical activity. The lack of physical activity is, to a great extent, the cause of the change in functional abilities during the aging process (Nadel and DiPietrol, 1995). The cardio-respiratory system is liable to change and shows a significant decrease in the capacity for aerobic ability. The maximal decrease takes place after the age of 40 so that by someone's 65th year, it has reached almost 30%. This decrease is connected to the decrease in the maximal heart rate frequency, heart beats and arterial/venous differences (Fleg, O'Connor and Gerstenblith, 1995).

Rikli and Jones (1997, 1999a, 1999b) define functional fitness as the optimal physical capacity necessary for the performance of normal everyday activities, safely, independently and without fatigue. The concept of "functional fitness" is widely accepted in literature and can be found papers around the world. The assumption is that the level of functional fitness depends on many factors, but mainly on the way of life, on how active a person is, what he does for a living, whether he exercises and the like. In the research carried out so far the connection between functional fitness and certain other factors, such as health and social factors, has been confirmed.

Arao, Oida, and Nagamatsu (1998) researched the connection between functional fitness and demographic, health, social factors and factors of behavior in life. They used comparative data obtained from 737 people over the age of 60 who live on their own in the community. In the case of men with a previous or current history of circulatory disorders or a muscle/skeletal illness, functional fitness is at a lower level. In the case of women with a previous or current history of muscle/skeletal illness or women who suffer from obesity, functional fitness is also at a lower level.

MacAuley, McCrum, Stott, Evans, McRoberts, Boreham, Sweeney and Trinick (2006) studied the relation between physical activity, physical fitness, blood pressure and fibrinogen. The research was carried out as a comparative study which involved 1600 subjects aged 16 to 74 who were inhabitants of Northern Ireland. It was concluded that a connection exists between physical activity, physical fitness, and blood pressure, and that the relationship has a significant influence on growth. The reduction of 6 mmHg in systolic blood pressure is connected to the previous activity of the subjects, which confirms the hypothesis that physical activity is used to decrease cardiovascular risks. A lower level of fibrinogen was found among people who were physically more active.

Stewart, Bacher, Turner, Fleg, Hees, Shapiro, Tayback and Ouyang (2005) studied whether exercise could influence the reduction of blood pressure. The sample of subjects, at the end of the study, consisted of 51 subjects who made up the experimental group and 53 subjects who made up the control group, all of whom were aged 55 to 75. The study lasted for 6 months. The experimental group exercised following a combination of aerobic and load exercises, and the control group followed the usual physical activities program and diet. The study was completed by 51 subjects from the experimental group and 53 subjects from the control group. Before the exercise, the subjects were not undergoing

treatment for their systolic blood pressure and it ranged from 130 to 159mm Hg; the diastolic blood pressure ranged from 85 to 99 mmHg. It was concluded that a six-month fitness and load exercise program decreased diastolic blood pressure, but not systolic, in the case of elderly patients with hypertension. The common lack of improvement to the strength of the aorta during exercise indicated that in the case of elderly people, a resistance to the reduction in systolic blood pressure exists.

In a study conducted by Chen Tsai, Yu Yang, Hsin Wang, Hsiung Hsieh, Ti Chen, Chiu Kao, Feng Kao, Hiu Wang and Chan (2004) the aim was to evaluated the effects of exercise training for the improvement of stamina on quality of life and blood pressure. Patients suffering from medium and mild hypertension (with systolic blood pressure of 140-180 mmHg or diastolic blood pressure of 90-110 mmHg) were divided into a medium intensity aerobic exercise group which trained 3 times a week over a period of 10 weeks and a control group that did not exercise. Out of the 102 participants, 47 men (who on average were 47 years old) completed the study, and the reduction in blood pressure among the members of the experimental group after an exercise period of 10 weeks (−13.1±6.3 mmHg) was significant ($P < 0.001$) compared to the initial results and the control group.

Ishikawa-Takata, Ohta, and Tanaka (2003) believe that regular aerobic exercise is a key factor and it is widely recommended for reducing hypertension. It is still not clear how much exercise is necessary in order to reduce blood pressure. The relationship between exercise training and blood pressure was determined after a period of 8 weeks and the study involved 207 subjects who were not undergoing any treatment and who were divided into groups of level 1 and level 2 hypertension. The subjects were divided into five groups depending on the duration and frequency of the weekly exercise: a seated control group, a group of 30-60 min of exercise a week, 61-90 min exercise a week, 91-120 min exercise a week and a group of more than 120 min exercise a week). Age, sex, height, BMI, and diet were on average the same for all of the groups. The results for diastolic and systolic resting blood pressure did not change among the non-exercising members of the control group. All four of the exercise groups displayed a significant reduction in systolic and diastolic resting blood pressure. The extent of the reduction in systolic blood pressure was greater for the group which exercised from 61 to 90 min a week in comparison to the group which exercised from 30-60 min a week or more than 120 min. The degree of the reduction of diastolic blood pressure had increased significantly among the members of the four exercise groups.

The aim of the research carried out by Young, Appel, Jee and Miller (1999) was to compare the effects of a 12-week aerobic exercise program of medium intensity and a Tai Chi program of mild activities on blood pressure. The sample of subjects was made up of 62 elderly, mostly sedentary old men (60 or older) with systolic blood pressure of 130-159 mmHg and diastolic pressure of 95 mmHg or less and who were not undergoing treatment for hypertension. They determined that the aerobic medium intensity and mild exercise program could have similar effects on blood pressure in previously elderly subjects who previously led sedentary lifestyles.

Kocharov, Britov, Kobal and Grishenkov (1993) did not find the connection between the muscle execution and blood pressure. The dependency between muscle execution and diastolic pressure was indirectly determined only in the case of physically active subjects.

Yanagibori, Kawakubo, Aok and Gunji (1993) studied the relationship between everyday physical activities, physical fitness and risk factors for coronary heart disease. The study compared 477 pre-menopausal women (36.1±7.6 years old) and 178 post-meno-

pausal women (56.7 ± 5.8 years old). The results showed that there is no statistically significant relationship between physical fitness and everyday activities in either group. In the case of post-menopausal women, their daily activities were connected to blood pressure, triglycerides, and blood sugar levels, for the mild intensity fitness group. There was no relationship between the risk factors and level of daily activities for the group who exercised more intensely.

Kusuma, Babu and Naidu (2001) dealt with the influence of age, body composition and pulse on the varieties in blood pressure. The data were collected from 1316 people (646 men and 670 women) who belonged to tribes (Khondh and Valmiki) who inhabit the mountainous region divided between the tribes and between two castes (Wadabalija and Settibalija) from the village and city environment of the Visakhapatnam district, Andhra Pradesh India. The effects of aging were more pronounced on systolic than diastolic blood pressure and influenced the blood pressure of women more than that of men. Measuring obesity also influenced the prediction of systolic and diastolic pressure. It was determined that pulse often influenced the blood pressure of women.

In the research of Cornelissen and Fagard (2005) it was concluded that aerobic stamina training decreases blood pressure through the reduction of vascular load, which includes the sympatic nervous system and renin-antagonizing system.

On the basis of the available research, it can be concluded that the values of blood pressure significantly differ among people who are physically active and those who are physically inactive. Research has confirmed that moderate physical activity has a positive influence on the value of blood pressure, as well as the fact that the values of blood pressure of the individuals who exercise are smaller in comparison to the values of those who are physically inactive.

The aim of this research was to determine the connection between functional fitness and the blood pressure of elderly men and elderly women, inhabitants of Niš and Kraljevo. The assumption is that a significant multiple correlation exists between functional fitness (on the one hand) and systolic and diastolic blood pressure (on the other) as well as the fact that it is possible to explain the values of blood pressure of elderly people with the help of functional fitness.

2. METHOD

Sample of subjects

The sample of subjects for this research encompassed men and women aged 65 to 70 who live in their own homes in Niš and Kraljevo in Serbia. The overall sample of subjects included 120 subjects: 60 men (40 from Niš and 20 from Kraljevo) and 60 women (45 from Niš and 15 from Kraljevo). Average body height for the men was 168.55cm ± 10.43, and average body mass was 73.06 kg ± 7.20. The average body height for women was 157.37 cm ±8.59, and the average body mass was 61.58 kg ± 8.11. There was no kind of discrimination among the subjects in regards to their physical activities and generally in regards to health. The sample did not include those individuals who at the time of the measuring had blood pressure that exceeded 170 mmHg for systolic and 110 mmHg for diastolic blood pressure, as well as those who suffered from acute joint pain. All of the subjects voluntarily participated in the testing and gave their consent for having the results published. A smaller number of subjects took medication for high blood pressure during the research.

The sample of measuring instruments for the evaluation of functional fitness

The Senior Fitness Test was used for the evaluation of functional fitness, a test which was constructed by Rikli and Jones (1999a; 1999b). Six measuring instruments were used: the 30-Second Chair Stand, which evaluates lower body strength; the Arm Curl, which evaluates arm strength; the 2-Minute Step Test, which evaluates aerobic and muscle stamina; the Chair Sit-and-Reach, which evaluates lower body mobility; the Back Scratch, which evaluates shoulder belt mobility and the 8-Foot Up-and-Go, which evaluates agility/dynamic balance.

The systolic and diastolic blood pressures were measured with cuff instruments of the "Teleoptik"brand, which was of Serbian manufacturing. The cuff was positioned around the forearm of the male and female subjects at around three centimeters above the elbow, in a sitting position. The results were read in mmHg. Before the measuring, the subjects rested in a seated position.

Statistical method

To determine the level of functional fitness and the systolic and diastolic blood pressure of elderly men and women, the coefficients of descriptive statistics were calculated. In order to determine the differences in the functional fitness and blood pressure of elderly men and women, the student t-test was used.

In order to determine the connection between functional fitness and systolic blood pressure, as well as functional fitness and diastolic blood pressure, a multiple regression analysis for the sample of men and the sample of women was calculated.

The variables for functional fitness made up the predictor system, while the variables for the evaluation of blood pressure made up the criterion.

3. THE RESULTS AND THE DISCUSSION

Table 1 shows the parameters of the basic statistical calculations for the men, and Table 2 shows the basic statistical parameters for the sample of women.

Table 1.The descriptive statistical parameters for the men

The variables	Mean	Min	Max	SD
SISTP	135.63	101.00	155.00	12.35
DIAP	88.63	75.00	101.00	7.07
8FUG	111.10	5.00	12.10	15.07
BS	1.85	-20.00	104.00	28.34
CSR	16.71	-10.00	104.00	32.35
2MST	99.66	84.0	125.0	10.06
30SCS	17.31	12.0	22.0	1.16
ARMC	18.73	13.0	24.0	1.12

Legend: Mean (the mean), Min (minimal value), Max (maximal value), SD (standard deviation), SISTP (systolic blood pressure), DIAP (diastolic blood pressure), 8FUG (8-Foot Up-and-Go), BS (Back Scratch), CSR (Chair Sit-and-Reach), 2MST (2-Minute Step Test), 30SCS (30-Second Chair Stand), ARMC (Arm Curl).

On the basis of the obtained results which are related to the descriptive statistical indicators, and with the insight into the contents of Table 1, it could be concluded that tests of reduced or good sensitivity have been used on this sample. For the tests: diastolic blood pressure (DIAP), the 30 Second Chair Stand (30SCS) and the Arm Curl (AC), sensitivity is good because in the range of minimal and maximal value, an adequate number of standard deviations can be found. The rest of the tests show decreased sensitivity. Systolic blood pressure in the case of elderly men is 135.63±12.35, and diastolic blood pressure is 88.63±7.07.

Table 2. The descriptive statistical parameters for women

The variables	Mean	Min	Max	SD
SISTP	138.69	101.00	170.0	12.87
DIAP	87.82	75.00	101.0	6.40
8FUG	112.06	6.3	128.0	20.67
BS	31.58	-20.00	109.0	53.33
CSR	9.74	0.00	101.0	13.07
2MST	99.82	75.0	115.0	12.33
30SCS	16.09	11.0	19.0	1.19
ARMC	17.09	12.0	20.0	1.98

Legend: Mean (the mean), Min (minimal value), Max (maximal value), SD (standard deviation), SISTP (systolic blood pressure), DIAP (diastolic blood pressure), 8FUG (8-Foot Up-and-Go), BS (Back Scratch), CSR (Chair Sit-and-Reach), 2MST (2-Minute Step Test), 30SCS (30-Second Chair Stand), ARMC (Arm Curl).

On a sample consisting of elderly women, the following tests were found to have good sensitivity: the Chair Sit and Reach (CSR) and the 30-Second Chair Stand (30 SCS), whereas all of the other tests have diminished sensitivity (Table 2).

The systolic blood pressure of women was 138.69±12.87, and the diastolic one was 87.82±6.40.

Table 3 shows the values of the student t-test and its significance for all of the variables used in the research. The obtained statistically significant differences in functional fitness between the sample of men and the sample of women came from the following variables: the Back Scratch (BS), the 2-Minute Step Test (2MST), the 30-Second Chair Stand (30SCS) and the Arm Curl (ARMC).

Table 3. The t-test between men and women

The variables	T-test	P
SISTP	-1.37	0.17
DIAP	0.51	0.60
8FUG	-0.97	0.33
BS	-4.05	0.00
CSR	1.71	0.08
2MST	2.71	0.00
30SCS	3.32	0.00
ARMC	3.76	0.00

Legend: T-test- the relation between the difference in means and the standard error of their differences; P- the statistical significance of the T-test.

A significant multiple correlation was found (R=.69) between systolic blood pressure and the variables for functional fitness on a sample of elderly men (Table 4). The predictor variables (functional fitness) gave a significant explanation of 47% of the variance of systolic blood pressure. The greatest statistical contribution to the significant connection between predictor variables and systolic blood pressure was found for: the 2-Minute Step Test (2MST) – (-0.53) and the 30-Second Chair Stand (30SCS) – (-0.54).

The multiple correlation for diastolic blood pressure for the sample of men (Table 4) has a numerical value of R= .62, and is significant at the .000 level. The variables for functional fitness explained 39% of the variance of diastolic blood pressure. The following variables made the greatest contribution to the explanation of the criterion: the 2-Minute Step Test (2MST) – (-0.59) and the 30-Second Chair Stand (30SCS) – (-0.97).

Table 4. The multiple regression of the blood pressure of men

The variables	Systolic blood pressure		Diastolic blood pressure	
	Beta		Beta	
8FUG	-.09	R= .69	.14	R= .62
BS	-.05	R^2= .47	-.10	R^2= .39
CSR	.00	F= 8.05	.02	F= 5.63
2MST	-.53	Df= 6.53	-.59	Df= 6.53
30SCS	-.54	P= .000	-.97	P= .000
ARMC	.13		.12	

R- the multiple correlation coefficient of the criterion variable and the system of predictors; R2- the coefficient of determination; F- F-test, P- the significance of the influence; Beta- the standard coefficient of partial regression of each predictor variable with the criterion.

Table 5. The multiple regression of the blood pressure of women

The variables	Systolic blood pressure		Diastolic blood pressure	
	Beta		Beta	
8FUG	-.00	R= .75	.07	R= .59
BS	.22	R^2= .56	-.01	R^2= .35
CSR	-.88	F= 11.98	-.95	F= 5.07
2MST	-.49	Df= 6.55	-.27	Df= 6.55
30SCS	1.10	P= .000	.35	P= .000
ARMC	-.70		.77	

R- the multiple correlation coefficient of the criterion variable and the system of predictors; R2- the coefficient of determination; F- F-test, P- the significance of the influence; Beta- the standard coefficient of partial regression of each predictor variable with the criterion.

Table 5 shows the results of the multiple regression analysis of the blood pressure of elderly women. Between functional fitness on the one hand and systolic blood pressure on the other, a significant (.000) multiple correlation was obtained (R=.75), and 35% of the criterion variance was explained. The following variables made the greatest contribution to the explanation of the criterion: the Chair Sit-and-Reach (CSR) – (-0.88), the 2-Minute Step Test (2MST) – (-0.49), the 30-Second Chair Stand (30SCS) – (1.10) and the Arm Curl (AC) - (-0.70).

A multiple correlation was found to exist (R=.59) between functional fitness as a predictor variable and diastolic blood pressure (Table 5) for the sample of elderly women, and which was significant at the .000 level. The predictor variables explained 35% of the criterion variance. The following variables made the greatest contribution to the explanation of diastolic blood pressure of elderly women: the Chair Sit-and-Reach (CSR) – (-0.95), the 2-Minute Step Test (2MST) – (-0.27), the 30-Second Chair Stand (30SCS) – (.35), the Arm Curl (AC) - (-0.77).

Between the sample of elderly women and the sample of elderly men, a statistically significant difference exists in the case of the variables for the evaluation of mobility of the shoulder belt, aerobic and muscle stamina, lower body strength and arm strength (Table 3). The mobility of the shoulder belt is better in men, aerobic stamina is better in women, leg strength is better in men and arm strength is better in men. Mobility of the lower body is close to statistical significance, and elderly women showed better results there. The obtained results were probably conditioned by everyday activities of the men and women aged 65 to 70. The assumption is that women are more active, and that the men are stronger.

Functional fitness gives a statistically significant explanation of 47% of the variance of systolic blood pressure and 39% of the variance of diastolic blood pressure on a sample of elderly men (Table 4). The greatest contribution to the explanation of systolic and diastolic blood pressure was made by aerobic and muscle strength and lower body strength. The results indicate the possibility of predicting the values of blood pressure on the basis of functional fitness.

Functional fitness gives a statistically significant explanation of 35% of the variance of systolic blood pressure and 35% of the variance of diastolic blood pressure on a sample of elderly women (Table 5). The greatest contribution to the explanation of systolic blood pressure was made by arm strength, lower body strength, aerobic and muscle strength and lower body mobility.

Up to a point, this confirms the results obtained in the research of Stewart et al. (2005), Ishikawa-Takata et al. (2003), Kocharov et al. (1993), Yanagibori et al. (1993), Cornelissen and Fagard (2005).

Considering the fact that a statistically significant difference exists at the level of functional fitness between the sample of men and the sample of women, it is assumed that this difference influenced the results of the prediction between the samples, which resulted in different percentages of the explanation of blood pressure and different individual contributions to the variables of functional fitness.

4. CONCLUSION

A statistically significant multiple correlation can be found between the sample of elderly men and elderly women in terms of functional fitness (the predictor system) and the criterion (systolic blood pressure and diastolic blood pressure). On the basis of the values of the multiple correlation and the percentage of the explanation of the variance, it can be concluded that it is possible to predict the values of blood pressure of elderly men and women on the basis of the variables of functional fitness.

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RELACIJE FIZIČKOG/FUNKCIONALNOG FITNESA SA KRVNIM PRITISKOM STARIH MUŠKARACA I ŽENA

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Istraživanje je sprovedeno sa ciljem da se utvrdi povezanost fizičkog fitnesa sa krvnim pritiskom starih muškaraca i žena. Uzorak ispitanika je obuhvatio 60 muškaraca i 60 žena koji su imali od 65 do 70 godina starosti. Za procenu funkcionalnog fitnesa primenjen je Senior-fitnes-test sa šest mernih instrumenata: za procenu snage gornjeg i donjeg dela tela, pokretljivosti gornjeg i donjeg dela tela, aerobnu izdržljivost i agilnost/dinamičku ravnotežu. Za procenu krvnog pritiska primenjene su vrednosti sistolnog i dijastolnog krvnog pritiska u miru u mmHg. Podaci su obrađeni multivarijantnom regresionom analizom. Dobijeni rezultati pokazuju da postoji povezanost između prediktorskog skupa varijabli (fizičkog/funkcionalnog fitnesa) i sistolnog i dijastolnog krvnog

pritiska na uzorku muškaraca i na uzorku žena. Sve dobijene multiple koralacije, značajne su na nivou 0.000. Najveći doprinos u objašnjenju sistolnog i dijastolnog krvnog pritiska na uzorku starih muškaraca imaju varijable kojima se procenjuje aerobna izdržljivost i snaga donjeg dela tela. Najveći doprinos u objašnjenju sistolnog i dijastolnog krvnog pritiska na uzorku žena imaju varijable kojima se procenjuje aerobna i mišićna izdržljivost, snaga donjeg dela tela, snaga ruku i pokretljivost donjeg dela tela.

Ključne reči: *funkcionalni fitnes, stari ljudi, krvni pritisak, predikcija, razlike*