RELATIONSHIP BETWEEN PHYSICAL FITNESS, BMI, WHR AND HYPERTENSION IN ELDERLY MEN AND WOMEN

POVEZAVA MED TELESNO PRIPRAVLJENOSTJO, ITM, IPB IN HIPERTENZIJO PRI STAREJŠIH MOŠKIH IN ŽENSKAH

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Abstract

Aim: *The aim of this study was to determine the structure, characteristics and significance of the relationship between physical fitness, BMI and WHR on one hand and hypertension of elderly men and women on the other.*
Methods: *The sample consisted of 1288 participants (594 men and 694 women) who live in their own households in the cities and villages of Central, Eastern and South Serbia. After the obtained classification of participants based on arterial blood pressure, 231 patients with hypertension aged 60-80 years were selected. The subsample consisted of 138 male participants, while the subsample of women was 93 participants. Predictor variables consisted of 6 variables for the evaluation of physical fitness, Body mass index (BMI) and Waist-to Hip Ratio index (WHR). Criterion variables consisted of systolic blood pressure (SBP) and diastolic blood pressure (DBP).*
Results: *The results showed that there is a statistically significant correlation ($p < 0.05$) between predictor variables and hypertension. Higher values of higher SBP in elderly men causes an increase in body weight due to increased body fat (BMI, WHR). In elderly women, these changes occur under the influence of increased body mass index and reduced CRF. Higher values of high DBP in elderly men cause more power and flexibility of the upper body and in elderly women greater strength in the arms and less strength in legs and CRF.*
Conclusions: *Being overweight in both subsamples could be considered as a factor that contributes to high blood pressure.*

Key words: blood pressure, body weight, elderly, obesity, physical fitness

Izvirni znanstveni članek
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Izvleček

Namen: *Namen te študije je določiti strukturo, značilnosti in pomen razmerja med telesno pripravljenostjo, indeksom telesne mase (ITM) in indeksom pas-boki (IPB) na eni strani ter hipertenzijo pri starejših moških in ženskah na drugi strani.*
Metode: *V vzorec je bilo vključenih 1288 udeležencev (594 moških in 694 žensk), ki živijo v lastnih gospodinjstvih v mestih in vaseh Osrednje, Vzhodne in Južne Srbije. Po prejeti klasifikaciji udeležencev, ki je temeljila na arterijskem krvnem tlaku, je bilo izbranih 231 bolnikov s hipertenzijo, starih od 60 do 80 let. Podvzorec je vključeval 138 moških udeležencev, medtem ko je bilo v podvzorec žensk vključenih 93 udeleženk. Neodvisne spremenljivke so bile sestavljene iz 6 spremenljivk za ocenjevaje telesne pripravljenosti, indeksa telesne mase (ITM) in indeksa pas-boki (IPB). Odvisne spremenljivke pa so bile sestavljene iz sistoličnega krvnega tlaka (SKT) in diastoličnega krvnega tlaka (DKT).*
Rezultati: *Rezultati so pokazali, da obstaja statistično pomembna povezava ($p<0.05$) med neodvisnimi spremenljivkami in hipertenzijo. Višje vrednosti zgornjega SKT pri starejših moških povzroči povečanje telesne teže zaradi povečane telesne maščobe (ITM, IPB). Pri starejših ženskah se te spremembe pojavijo pod vplivom povečanega indeksa telesne mase in zmanjšanih kardio-respiratornih sposobnosti. Višje vrednosti zgornjega DKT*

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pri starejših moških povzročajo večjo moč in fleksibilnost zgornjega dela telesa, pri starejših ženskah pa več moči v rokah in manj v nogah ter slabše kardio-respiratorne sposobnosti.
Zaključek: *Pri obeh podvzorcih bi bila čezmerna teža lahko dejavnik, ki prispeva k visokemu krvnemu tlaku.*

Ključne besede: krvni pritisk, telesna teža, starostniki, debelost, telesna aktivnost

1 INTRODUCTION

Our modern way of life and advances in medical diagnostics and treatment have caused an increase in the number of elderly people. Physical activity levels decline rapidly with increasing age among males and females. In addition, the increase in body mass occurs while retaining their average food intake (1).

Obesity represents a rapidly growing threat to the health of populations in an increasing number of countries. It is defined as abnormal or excessive fat accumulation that presents a risk to an individual's health (2). Obesity is an independent risk factor for cardiovascular disease and some types of cancer, and it is closely associated with other risk factors such as hypertension and diabetes (3). On the other hand, some risk factors such as inactivity, family history of obesity, behaviour habits (smoking and alcohol intake), education, genetic and gender specific factors can be used to identify individuals with a high risk of being overweight or obese. The increasing number of obese elderly people is associated with the fact that developing countries have quickly adapted themselves to an unhealthy lifestyle. In addition, the number of elderly people with hypertension is also increasing. The question is whether obesity and hypertension represent one or two outbreaks? Davy and Hall (4) consider that the relation between obesity and hypertension is well-documented by researches, but the exact nature of these relationships is not entirely clear.

Arterial hypertension is a disease characterized by elevated systolic and diastolic blood pressure ($\geq$ 140/90 mmHg), elevated only systolic blood pressure (isolated systolic hypertension) or antihypertensive therapy (5,6). Also, changes in blood pressure and the development of hypertension cause low levels of physical activity of people (7). Obesity, lack of exercise, low level of cardiorespiratory fitness, genetics, excessive alcohol intake, higher salt consumption and smoking are the most common risk factors for arterial hypertension. Hypertension and body mass index (BMI) are, among many other factors, risk factors for heart failure. It is unknown whether the presence of these risk factors in mid-adulthood affects the future development of heart failure. Higher levels of BP and BMI in midlife would be powerful determinants of heart failure risk in later life (8). Farrell et al. (9), investigating the causes of death in women, found that moderate and high cardiorespiratory fitness were significantly associated with low risk of mortality. In addition, increased BMI has no statistically significant correlation with increased mortality in women.

There are numerous studies (9-12) in which high blood pressure, BMI, obesity and fitness show a cause-effect relationship. Increases in BMI and waist circumference is related to a linearly increased adjusted risk of developing conditions with high cardiovascular risk such as impaired fasting glucose, diabetes mellitus and others (12). People with greater waist circumference have increased systolic blood pressure during exercise, regardless of insulin sensitivity or the level of cardiorespiratory fitness (13). Levine et al. (14) have stated that there is a correlation between waist circumference and a moderate prevalence of hypertension, regardless of the BMI and several risk factors of hypertension.

People who have low cardiorespiratory fitness have higher blood pressure in comparison to people with high levels of cardiorespiratory fitness. Moreover, lower levels of cardiorespiratory fitness are associated with higher visceral adiposity. People who have higher visceral adiposity tissue have higher blood pressure regardless of cardiorespiratory fitness (15). Epidemiological studies suggest an inverse relationship between physical activity or fitness and blood pressure. Meta-analysis (16) conducted on a 44 randomly selected research studies have assessed the effect of dynamic aerobic training on resting blood pressure. It was concluded that the effects of aerobic exercise on arterial blood pressure were more pronounced in those with hypertension than in those with normal blood pressure. This type of training also seems to reduce blood pressure during ambulatory monitoring and during exercise (16).

Many researchers have used various aerobic training programs in order to change the blood pressure, with or without the use of proper diet. Stewart et al. (17) applied two exercise programs that lasted six-months, with normal daily physical activity and diet. Based on the obtained results, they concluded that an applied fitness training program and resistance exercises significantly reduced diastolic blood pressure but not

systolic in older adults with hypertension. Tsai et al. (18) have reported that regular aerobic exercise can reduce blood pressure, and it is advisable to include it in daily life activities in order to reduce high blood pressure and the risk of cardiovascular disease. Ishikawa-Takata, Ohta and Tanaka (19) have also stated that regular aerobic exercise should be an integral part of life in the recommendations for reducing hypertension. A clinically significant reduction in blood pressure can be achieved through a relatively small increase in the volume of physical activity to achieve positive results with sedentary hypertensive people.

Young et al. (20) have compared the effects of 12-week moderate-intensity aerobic exercise and a low intensity Tai-Chi program on changes in blood pressure and found that these two programs have similar effects on blood pressure in sedentary elderly people. Also, it was determined that there is a significant relation between physical activity, physical fitness and blood pressure, but that this relationship is significantly affected by age (21). Along with increasing number of elderly, the number of people who are less physically active, who have become obese or who have higher body mass has increased (22). In addition, the number of people with diagnosed hypertension has increased (23). This study will show the basic problem of relations that hypertension has with increased body mass and body size, which are presented by BMI index, WHR index and physical fitness. We have assumed that insufficient physical fitness, increased body weight and increased blood pressure act as a single factor in causing hypertension of elderly men and women or that statistically significant relations between hypertension and indicators of physical fitness, BMI and WHR can be observed.

Therefore, the aim of this study was to determine the structure, characteristics and significance of relations between physical fitness, BMI and WHR on one hand and hypertension of elderly men and women on the other.

2 METHODS

2.1 Subjects

The present study was a cross-sectional population-based study. The sample of participants was selected from a population of the elderly aged from 60 to 80, of both genders. The sample consisted of 1288 participants (594 men and 694 women) who live in their own households in the cities and villages of Central, Eastern and South Serbia. Our classification selected those with systolic pressure greater than 140 mmHg and diastolic blood pressure of 90 mmHg or more, regardless of whether a person is taking medication for reducing hypertension.

After the obtained classification of participants based on arterial blood pressure, 231 patients with hypertension aged 60-80 years were selected. The subsample consisted of 138 male participants (mean ± SD age 68.1 ± 5.9, body height 176.1 ± 7.0, body weight 83.0 ± 13.9) and 93 female participants (mean ± SD age 68.6 ± 5.7, body height 163.4 ± 6.6, body weight 72.8 ± 4.3). The data of the subsample of women and men were analysed separately. Criteria for selecting participants were: age between 60 and 80 years, physically independent person - able to walk 20 feet without assistance or rest, lack of cognitive impairment and dementia, achieved 24 points for the educated and 18 points for the unqualified participants in a mini mental state evaluation (24).

Participation in the study was voluntary, and each of the participants could redraw from the study in any moment. All the participants provided written consent after being informed of the test protocol. The study was approved by the Research Ethics Committee of the Faculty of Sport and Physical Education, University of Nis, and according to the Declaration of Helsinki. All participants were fully informed about risks and benefits that this research could have on their age group. Testing of all participants was in the period from August to December 2011. All participants were mentally and physically healthy and able to participate in the study (24).

2.2 Predictor variables

This set consisted of 6 variables for the evaluation of physical fitness, Body mass index (BMI) and Waist-to Hip Ratio index (WHR). The senior fitness test consists of six measures of physical fitness: 1) *Back scratch* that assesses upper body (shoulder) flexibility. With one hand reaching over the shoulder and one up the middle of the back, the result is the number of inches (cm) between extended middle fingers (+ or -), 2) *Chair sit and reach* is a test that assesses the flexibility of the lower extremities. As with the previous test, each subject performed two test trials and two attempts to be measured and included in further analysis. From a sitting position at the front of a chair, with leg extended and hands reaching toward toes, the result is the number of inches (cm) (+ or -) between extended fingers and tip of toe, 3) *8-foot up and go* assesses agility/dynamic balance. The result is the number of seconds required to get up from a seated position, walk 8 feet (2.44 m),

turn and return to seated position, 4) *Chair stand up for 30 sec* assesses lower body strength. The result is the number of full stands that can be completed in 30 seconds with arms folded across chest, 5) *Arm curl* assesses upper body strength. The result is the number of repetitions that can be completed in 30 seconds holding a hand weight of 5 lbs (2.27 kg) for women and 8 lbs (3.63 kg) for men, 6) 2-minutes step test isan alternate aerobic endurance test, used when space limitations or weather prohibits taking the 6-minute walk test. The result is the number of full steps completed in 2 minutes, raising each knee to a point midway between the patella (kneecap) and iliac crest (top hip bone). The senior fitness test is a battery of tests for the assessment of the physical fitness of older persons. This test assesses the physiological capacity for carrying out normal daily activities independently and safely without the appearance of fatigue. Before testing, the subjects performed 10 minutes warm up with the instructions given by highly skilled persons. After warm up, SFT was conducted with the tasks ordered as referred to in this test (25). This test has validity according to Rikli and Jones (26) for testing individuals older than 60 years.

Waist circumference was measured at the midpoint between the inferior margin of the last rib and the top of the iliac crest. Hip circumference was measured at the largest posterior extension of the buttocks. Waist and hip circumferences were measured to the nearest 0.1 cm. Waist-to Hip Ratio index (WHR) was calculated by dividing the measurement of waist by the measurement of hips (27). Measurement of body height was conducted by anthropometer according to Martin (Martin metal anthropometer – GPM Swiss Made) with 0.1 cm accuracy. Body weight was measured on digital scale TANITA UM-72 (Body Composition Monitor, Tanita Corp, Tokyo, Japan) with 0.01 kg accuracy. To calculate the values of the BMI, we used a standard procedure based on the formula BMI=Body weight [kg] / Body Height [m^2] (28).

2.3 Criterion variables

This set consists of systolic blood pressure (SBP) and diastolic blood pressure (DBP). Evaluation of blood pressure was conducted by automatic digital device OMRON M4-1 (OMRON Healthcare Europe BV, Netherlands). The cuff was positioned around the forearm of the male and female subjects at around three centimetres above the elbow, in a sitting position. The results were read in mmHg. Before the measuring, the subjects rested in a seated position. Three minutes of rest was given to the participant in between three successive readings of blood pressure. Although the three readings were different with the largest value being the first reading and the smallest being the third reading on average, these differed by no more than 2 mmHg of systolic blood pressure and no more than 4.5 mmHg of diastolic blood pressure. We chose to take an average of the second and third readings as recommended by World Health Organisation (29) in order to increase the degrees of freedom for the mean.

2.4 Statistical analysis

Descriptive statistics were calculated for all experimental data. The Kolmogorov-Smirnov test was used to test if data were normally distributed. Level, significance and structure of relationships between hypertension as criterion and SFT, BMI and WHR as predictors were assessed by calculating the canonical-correlation analysis supported by the statistical program Statistica 7.0 (StatSoft. Inc., Tulsa, OK, USA). The purpose of canonical correlation is to explain the relation of the two sets of variables, predictors and criterion. The level of significance was set to $p \leq .05$.

Table 1. *Basic descriptive parameters for predictor and criterion variables in elderly men and women.*
Tabela 1. *Osnovni opisni parametri za neodvisne in odvisne spremenljivke pri starejših moških in ženskah.*

	Men/Moški (*n*=138)		Women/ Ženske (*n*=93)	
	Mean/ Povprečje	SD	Mean/ Povprečje	SD
Body mass index (kg/m^2)/ Indeks telesne mase (kg/m^2)	26.71	1.62	27.29	1.50
Systolic blood pressure (mmHg)/ Sistolični krvni tlak (mmHg)	149.30	4.79	160.37	22.16
Diastolic blood pressure (mmHg)/ Diastolični krvni tlak (mmHg)	96.02	4.02	96.89	3.32
Back Scratch (cm)/ Dotik za hrbtom (cm)	- 3.76	2.05	- 1.58	1.13
Chair Sit-and-Reach (cm)/ Dotik stopala v sedečem položaju (cm)	1.96	4.54	2.48	4.76
8-Foot Up-and-Go (sec)/ Vstani in pojdi (sek)	6.84	0.59	6.80	0.41
30-Second Chair Stand (repetition)/ 30-sekundni test vstajanja iz stola (ponovitev)	14.26	2.71	11.86	1.40
Arm Curl (repetition)/ Upogib in izteg roke (ponovitev)	16.74	2.88	11.92	1.81
2-Minute Step Test (repetition)/ 2-minutni test stopanja (ponovitev)	90.04	7.28	79.37	6.08
Waist-to-Hip Ratio/ Razmerje med obsegom pasu in bokov	0.97	0.04	0.91	0.04

Table 2. *Canonical correlation for predictor and criterion in elderly men and women.*
Tabela 2**.** *Kanonična korelacija med neodvisno in odvisno spremenljivko pri starejših moških in ženskah.*

		Can.R	Can.R^2	Chi-sqr.	df	p
Men/ Moški	0	0.32	0.10	116	16	.000
	1	0.22	0.05	36	7	.000
Women/ Ženske	0	0.29	0.08	91.2	16	.000
	1	0.19	0.04	26.7	7	.000

Legend: Can.R-maximal correlation beetwen predictor and criterion variables; Can.R^2.- % of total variability for investigated area; Chi-sqr- testing of statistical significance Can.R; Df- level of freedom; p- level of significance.
Legenda: Can.R-maksimalna korelacija med neodvisnimi in odvisnimi spremenljivkami; Can.R^2.- % celotne spremenljivosti za raziskovano področje; Chi-sqr- preizkušanje statistične pomembnosti Can.R; Df- stopnja neodvisnosti; p- stopnja pomembnosti.

3 RESULTS

The Kolmogorov-Smirnov test showed that the data were normally distributed. Males represent 60% of participants in this study, while females represent 40%, which is similar to the ratio of elderly men and women in the Republic of Serbia. Average values of body mass index showed that both the men and women were overweight (overweight, BMI> 25, Table 1). Canonical correlation analysis has showed two isolated factors with statistical significance (p= .000) in males (Table 2). First, the canonical factor explains 10% of total

variability for predictor and criterion variables with statistically significant correlation (p= .000) between sets of variables. The second canonical factor explains 5% of total variability for predictor and criterion variables with statistically significant correlation (p= .000) between sets of variables.

The analysis of data from a subsample of elderly women has shown two isolated factors with statistical significance (p= .000, Table 2). The first canonical factor explains 8% of total variability for predictor and criterion variables with statistically significant correlation (p= .000) between sets of variables. The second canonical factor explains 4% of total variability for predictor and criterion variables with statistically significant correlation (p= .000) between sets of variables.

Table 3. *Cross-correlation matrix for the variables SFT, BMI, WHR and SBP and DBP in elderly men and women.*

Tabela 3. *Matrika navzkrižne korelacije med spremenljivkami kožna guba, ITM, IPB ter SKT in DKT pri starejših moških in ženskah.*

	Men/Moški		Women/Ženske	
	SBP/SKT	DBP/DKT	SBP/SKT	DBP/DKT
Body mass index (kg/m^2)/ Indeks telesne mase (kg/m^2)	0.15	-0.05	0.18	0.01
Back Scratch (cm)/ Dotik za hrbtom (cm)	0.07	0.10	- 0.02	- 0.06
Chair Sit-and-Reach (cm)/ Dotik stopala v sedečem položaju (cm)	- 0.09	- 0.06	0.10	0.05
8-Foot Up-and-Go (s)/ Vstani in pojdi (s)	0.12	0.02	- 0.01	0.00
30-Second Chair Stand (rep)/ 30-sekundni test vstajanja iz stola (pon)	- 0.04	0.10	0.05	- 0.06
Arm Curl (rep)/ Upogib in izteg roke (pon)	- 0.01	0.15	- 0.07	- 0.06
2-Minute Step Test (rep)/ 2-minutni test stopanja (pon)	- 0.02	- 0.03	- 0.14	0.17
Waist-to-Hip Ratio/ Razmerje med obsegom pasu in bokov	0.13	- 0.00	- 0.04	0.01

SBP-systolic blood pressure; DBP-diastolic blood pressure; rep-repetitions
SKT-sistolični krvni tlak; DKT-diastolični krvni tlak; pon-ponovitve

Table 3 shows the relationship between the group of predictor variables (SFT, BMI and WHR) and criterion variables (systolic and diastolic pressure). The results show that values are considerably lower. On a subsample of elderly men, SBP has the highest correlation with BMI (0.15) and WHR (0.13), and DBP has the highest correlation with Arm Curl (0.15). On a subsample of elderly women, SBP has the highest correlation with BMI (0.18) and 2-Minute Step Test (-.14), and DBP has the highest correlation with 2-Minute Step Test (0.17).

The analysis of structure for the first canonical factor on a sample of elderly men (Table 4) for variables SFT, BMI and WHR has shown that the first canonical factor is mainly explained by: BMI (-.68) and WHR (-0.50). This factor could be defined as the factor of increased body weight. In the structure of the first canonical factor in the area Hypertension, the obtained canonical factor is mainly defined by high SBP (-.68), so it could be defined as the factor of high systolic blood pressure (Table 4). Analysis of the second canonical factor on a subsample of elderly men (Table 4) in the area of predictor variables has shown that the second canonical factor is mainly defined by: Back Scratch (-.48) and Arm Curl (-0.55). This factor could be defined as strength and flexibility of upper body. The second canonical function in the area Hypertension is mainly defined by high diastolic blood pressure (- .97), so this factor could be defined as the factor of high diastolic blood pressure (Table 4). Analysis of the first canonical factor on a sample of elderly women (Table 4) for variables SFT, BMI and WHR has shown that the first canonical factor is mainly defined by: BMI (- .58) and 2-Minute Step Test (0.68). This factor could be defined as a factor of increased body weight and cardiorespiratory fitness. The first canonical function in the area Hypertension is mainly

defined by high systolic blood pressure (-0.92), so the obtained factor could be defined as high systolic blood pressure (Table 4). Analysis of the second canonical factor on a sample of elderly women (Table 4) for space of predictor variables has shown that the second canonical factor is mainly defined by: Chair Sit-and-Reach (-.43), Arm Curl (.43) and 2-Minute Step Test (-.56). This factor could be defined as strength and cardiorespiratory fitness. The second canonical function in the area Hypertension is mainly defined by high diastolic blood pressure (.94), so this factor could be defined as high diastolic blood pressure (Table 4).

Table 4. *Structure of isolated canonical factors in the area of predictor and criterion variables in elderly men and women.*
Tabela 4. *Struktura izoliranih kanoničnih dejavnikov na področju neodvisnih in odvisnih spremenljivk pri starejših moških in ženskah.*

		Men/Moški		Women/Ženske	
		Root 1	Root 2	Root 1	Root 2
Predictor variables/ Neodvisne spremenljivke	Body mass index (kg/m^2)/ Indeks telesne mase (kg/m^2)	- 0.68	- 0.01	- 0.58	- 0.37
	Back Scratch (cm)/ Dotik za hrbtom (cm)	0.03	- 0.48	- 0.01	0.35
	Chair Sit-and-Reach (cm)/ Dotik stopala v sedečem položaju (cm)	0.17	0.34	- 0.26	- 0.43
	8-Foot Up-and-Go (s)/ Vstani in pojdi (s)	- 0.39	- 0.23	0.03	- 0.01
	30-Second Chair Stand (rep)/ 30-sekundni test vstajanja iz stola (pon)	0.45	- 0.34	- 0.23	0.19
	Arm Curl (rep)/ Upogib in izteg roke (pon)	0.44	- 0.55	0.13	0.43
	2-Minute Step Test (rep)/ 2-minutni test stopanja (pon)	- 0.01	0.14	0.68	- 0.56
	Waist-to-Hip Ratio/ Razmerje med obsegom pasu in bokov	- 0.50	- 0.16	0.15	0.04
Criterion variables/ Odvisne spremenljivke	Systolic blood pressure/ Sistolični krvni tlak	- 0.68	- 0.73	- 0.92	- 0.39
	Diastolic blood pressure/ Diastolični krvni tlak	- 0.22	- 0.97	0.34	0.94

Legend: Root - isolated canonical factors; rep-repetitions
Legenda: Root - izolirani kanonični dejavniki; pon-ponovitve

4 DISCUSSION

The starting point for setting the main hypothesis of this study was the results of the previously mentioned studies (4, 7, 12, 13, 15, 16, 21), which pointed to the significant correlation of decreased physical fitness, increased body weight, obesity and increased arterial blood pressure in elderly people. Data presented in this article support the hypothesis that a statistically significant relationship exists between hypertension on one hand and physical fitness (BMI and WHR) on the other hand in elderly men and women in Central, Southern and Eastern Serbia. The structure of relations for the first canonical factor in the subsample of elderly men indicates that the factor of high systolic blood pressure has a significant relationship with the factor increased body weight. The structure of relationships for the first canonical factor system for SFT, BMI and WHR and the first canonical factor for the system of variables that assess hypertension indicates that elderly men with increased body weight have higher systolic blood pressure. Similar results were found in several other studies (10, 30, 31), which showed a linear relationship between body weight and adiposity on one hand and blood pressure on the other. One study showed that a 1 kg/m2 increase in BMI was related to a 12% increase in the risk of hypertension (30). The results are acceptable because obesity has an impact on the increase in the length of blood vessels and the number of capillary blood vessels, which represents an additional stress on the heart pump, causing the increase in SBP (32).
The largest contribution to the explanation of systolic and diastolic blood pressure on a sample of elderly men is presented by the variables for the evaluation of aerobic endurance and lower body strength (11). On the other hand, the results of our study show that in an elderly men the factor of high diastolic blood pressure has a statistically significant correlation with the factor of power and flexibility of the upper body, which is in contrast to the research of Kostic et al. (11) The sign of the coefficient implies that a higher DBP leads to greater strength and mobility of the upper body. The flexibility and power of the upper body can lead to disturbance of venous and capillary flow, which can lead to increased stress on the heart (32). This, along with at heromatous changes in blood vessels in the elderly, can affect the increase in diastolic blood pressure (DBP). In addition, the elasticity of blood vessels was lower in the elderly, causing anincrease indiastolic blood pressure (32).
The first canonical factor in elderly women indicates that the factor of systolic blood pressure has a statistically significant correlation with the factor of increased body weight and cardiorespiratory fitness. According to the sign of coefficients, elderly women with higher systolic blood pressure have increased body mass, and elderly women with lower systolic blood pressure have better cardiorespiratory fitness. The Cross-sectional population study showed that hypertension was related to BMI and WHR in women, which was not the case with men, where only BMI was related to hypertension (33). Compared to the research of Huang et al. (33), our results show that BMI and WHR are related to hypertension, regardless of gender. In addition, Doll et al. (10) concluded that there is a linear relationship between obesity and blood pressure, regardless of age and body fat distribution, in developed countries and countries in transition. Kaur and Mogro (31) found in a subsample of women with elevated blood pressure that BMI has a statistically significant relationship with systolic and diastolic blood pressure. However, in women with normal BP, the relations were not statistically significant. The same authors concluded that WHR has no statistically significant relationship with BP. Moreover, abdominal adiposity is high among those with increased BP, which is similar to the results of our study.
Compared with the first, the structure of the relations for the second canonical factor in elderly women suggests that the factor of diastolic blood pressure has a significant relationship with the factor of strength and cardiorespiratory fitness (aerobic capacity). The results are expected and consistent with numerous studies (4, 7, 12, 13, 15, 16, 21). The largest contribution to the explanation of systolic and diastolic blood pressure on the sample of older women are the variables for the evaluation of aerobic and muscular endurance, lower body strength, hand strength and lower body mobility (11). According to the sign of the coefficients, it follows that if DBP is greater, cardio-respiratory fitness and leg strength are lower, while the power in the upper extremities is higher. Elderly women have lower muscle pump effects and the mechanism is not sufficient to improve the circulatory capabilities of the organism, which leads to a change in diastolic blood pressure. This could be due to the changes that have occurred in blood vessels of elderly women in terms of reduced elasticity, changes in atheroma and arterio-venous low oxygen difference (32). Our results partially confirm the results of the previous studies mentioned above and generally indicate the statistically significant relationship that hypertension has with BMI and WHR index as well as muscular strength, agility and cardiorespiratory fitness (aerobic capacity) in subsamples of elderly men and women of Central, Southern and Eastern Serbia. It

is therefore recommended that older people, regardless of their gender, should be involved in aerobic types of exercise in order to reduce the impact of obesity and arterial blood pressure, either systolic or diastolic.

The obtained results indicate that the two canonical roots could be distinguished that were statistically significant. Being overweight in both subsamples can be considered as a factor that contributes to high systolic blood pressure. Functional fitness variables are related to different high diastolic pressure in subsamples of elderly men and women. In elderly men, higher values of diastolic blood pressure are associated with better indicators of upper-body strength and flexibility and in women with better arm strength and indicators of poor leg strength and cardiorespiratory fitness. The main limitation of this study was its cross-sectional design, which does not allow identification of changes over acertain time period. Also, this study does not include correlation between physical fitness, BMI and WHR and other diseases associated with obesity such as dyslipidaemia and diabetes, which is another limitation. Thus, future studies need to continue research with the implementation of additional parameters related to physical activity, physical fitness, increased body weight, obesity and hypertension among elderly people, which will provide new information necessary to explain their relationships.

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