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Research article

CARDIOVASCULAR RISK FACTORS IN PHYSICALLY ACTIVE FEMALE UNIVERSITY STUDENTS

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Abstract. *Cardiovascular diseases are the leading cause of death in the world, and occur as a result of many risk factors (obesity, high blood pressure, inadequate physical activity, hyperlipoproteinemia, inadequate diet and an unhealthy lifestyle). Given that in young adults most of these risk factors tend to remain at the same level or to even increase with age, especially after the second or third decade of life. This means that if young adults are in the at-risk group in terms of cardiovascular diseases, they usually stay in that group in later life. The research problem is to examine the strength and significance of possible linear correlations of certain cardiovascular risk factors in 53 physically active female university students (PE students), aged 19 to 25 years, as well as to examine possible differences between those with different lengths of sports experience (ranging from 0 to 5, 6 to 10 and 11 to 15 years). Their baseline characteristics (age, body height and mass, body mass index - BMI, resting metabolic rate - RMR, resting heart rate - RHR and length of sports experience) were determined, as well as the linear relationships of selected cardiovascular risk factors (body fat percentage - BF%, visceral fat level - Visc F, waist circumference - WC, arterial blood pressure - SBP and DBP). The data were analyzed (descriptive statistics, the Kolmogorov-Smirnov test, Pearson's and Spearman's correlation coefficient, ANOVA) using SPSS 21.0. The results of the analysis indicated a lack of statistically significant differences in cardiovascular risks factors between female PE students with different lengths of sports experience, and the existence of statistically significant ($p<0.001$), positive, mostly strong correlations, between most of the selected cardiovascular risk factors. When it comes to blood pressure parameters, although weak positive and statistically significant ($p<0.05$) correlations were established between SBP and BMI ($r=.273$), SBP and WC ($r=.308$), so as between DBP and body mass ($r=.284$), DBP and RHR ($r=.287$), DBP and RMR ($r=.292$), as well between DBP and WC ($r=.304$) and DBP and SBP ($r=.571$, $p<0.001$), it is unequivocal that the reduction of body mass at the expense of adipose tissue is necessary, as well as an increase in the moderate physical activity level and regularity, in order to reduce the risk of cardiovascular diseases in female PE students now as well as in older age.*

Key words: *adipose tissue, blood pressure, cardiovascular diseases, female PE students*

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INTRODUCTION

Health is not only the absence of disease and infirmity, but it is complex and multifactorial - it is a state of complete physical, mental and social well-being (WHO, 1948). The fact that the human population is getting older, and that chronic diseases are becoming more frequent, emphasizes the connection between physical activity and health. Namely, due to the dramatic changes in the lives of people in industrialized countries in the last 100 years, the need of most people to be physically engaged has disappeared. Numerous technological changes have encouraged sedentary habits and significantly reduced energy consumption. This reduction in physical activity is, to say the least, dramatic, so a number of various health problems, caused by a sedentary lifestyle, increased significantly in the twentieth century, i.e. by reducing physical activity, we were faced with many inactivity-related diseases (Bouchard, Blair, & Haskell, 2007). In recent years, the contribution of physical activity to human health has been strongly emphasized. In our daily lives, physical activity plays an important role in maintaining and improving health, on the condition that it is based on the rules that are focused on both content and the intensity and frequency of physical exertion required (Stănescu & Vasile, 2014). Thus, conscious and intentional physical activity has become an extremely important component of a healthy lifestyle. The problem with physical activity is the fact that its rate changes over the course of life and it significantly decreases throughout education (Selmanović, Čale-Mratović, & Ban, 2014), and especially during the study period (less need for physical efforts, more sitting-related "activities") (Small, Bailey-Davis, Morgan, & Maggs, 2013). The transition from high school to college is a critical point in the decrease in the physical activity level (Bray, 2007; Kwan & Faulkner, 2011): approximately 35% to 75% of university students fail to achieve the recommended level of physical activity (Ćurković, Andrijašević, & Caput-Jogunica, 2014). This cannot apply to students of faculties of sport and physical education (PE). Namely, PE studies have a unique combination of theoretical and practical teachings, with a larger fund of classes provided for the implementation of the practical part of teaching. This type of teaching "does not allow" PE students to be physically inactive, and the selection process itself (entrance exam) is such that these studies can be enrolled only by those candidates who have a satisfactory level of motor, functional and other abilities. Thus, PE students are mostly former or current athletes, which means that their level of physical activity is significantly higher than the rest of the student population.

Cardiovascular diseases (myocardial infarction, stroke, hypertension, coronary artery disease) are the leading causes of death in the world (Janssen, 2007), but they are also a significant cause of disability and rising health care costs (Stojanović et al., 2009). These diseases occur as a result of many risk factors (obesity, high blood pressure, insufficient physical activity, hyperlipoproteinemia, inadequate diet and unhealthy lifestyle) (Hooper et al., 2001; Wildman et al., 2005; Irazusta et al., 2007). Additionally, socio-economic changes in society, population migration and others, can affect the prevalence of certain risk factors, thus leading to a higher prevalence of cardiovascular disease (Janssen et al., 2006; Bjerregaard, Eika Jørgensen, & Borch-Johnsen, 2007; Rogacheva et al., 2007). Cardiovascular disease in adults is considered a "pediatric" problem (Rowland, 2007) because epidemiological studies have shown a high correlation between morbidity and mortality caused by adult cardiovascular disease with early atherosclerotic lesions and the presence of cardiovascular risk factors at a younger age. Thus, most risk factors in young people tend to remain at the same level in older age. The effect of each of these factors is cumulative, and the combination of factors, as well as their combined presence, lead to multiplication and increase in risk with increasing age, especially after the second or third

decade of life (Stojanović et al., 2009). This means that young people who are in the at-risk group in terms of cardiovascular risk factors, most often remain in that group in later life, which indicates the need for early recognition and preventive action. This preventive action, in terms of lowering and mitigating cardiovascular risk factors, has proven successful in a large number of cases in different population groups, especially among young people (Panunzio et al., 2007; Qian et al., 2007). The main goal of the research is to determine the significance and strength of the relations between the selected cardiovascular risk factors (body fat percentage, visceral fat level, waist circumference, systolic and diastolic blood pressure) of physically active female PE students, as well as to examine the possible differences between those with different lengths of sports experience.

MATERIALS AND METHODS

Study participants

Fifty-three undergraduate female PE students, aged 19 to 25, volunteered to participate in this cross-sectional study, after being informed about the research and its scientific values and benefits. The most numerous are basketball and volleyball players (n=9 and n=8, respectively), then football and handball players (n=7, each), karate girls (n=4), dancers and swimmers (n=3, each), folk dancers, boxers, athletes and artistic gymnasts (n=2, each), and just one judoka, one tennis player, one rhythmic gymnast and one non-athlete. Based on the length of sports experience all of the study participants were divided into three groups: Group 1- from 0 to 5 years of sports experience (n=13), Group 2- from 6 to 10 years of sports experience (n=26) and Group 3- from 11 to 15 years of sports experience (n=14).

Measures and procedures

The study protocol was approved by the local ethics committee (No. 04-336/2), and the testing was performed in accordance with the ethical standards of the Declaration of Helsinki (WMA, 2013). All the measurements were taken by the authors in optimal climatic conditions, with the participants in their underwear, and according to the methods proposed by the International Biological Program (Weiner & Lourie, 1969). By interviewing the participants we collected the data on their age (date of birth) and length of sports experience, whereas their body height (cm) was determined by a Martin Anthropometer. The following body composition parameters, such as Body Mass (Weight, in 0.1 kg), Body Mass Index (BMI, in 0.1 kg/m^2), Body Fat percentage (BF%, in 0.1 %), Visceral Fat (Visc F, level) and Resting Metabolic Rate (RMR, in kcal), were assessed with a tetrapolar bioimpedance device – the Omron BF511 (Kyoto, Japan), after entering the data on participants' age, gender and body height. Using a measuring tape the Waist Circumference (WC, in 0.1 cm) data of the participants were obtained, and using the Omron digital tensiometer, the value of Resting Heart Rate (RHR, in bpm) was determined, as well as the values of systolic (SBP, in mmHg) and diastolic blood pressure (DBP, in mmHg).

Statistical analysis

The data were analyzed using the Statistical Package for the Social Sciences, version 21.0 (IBM SPSS 21.0, SPSS Inc, Chicago, USA). The descriptive statistics [average value (Mean), Standard Deviation (SD), minimum (Min) and maximum (Max)] were summarized for all the variables. The normality was tested using the one-sample Kolmogorov-Smirnov test (K-S). In order to determine the significance and the strength of the linear relationship

between the selected cardiovascular risk factors in physically active female university students, Pearson's correlation coefficient (r) was applied (for normally distributed variables), i.e. Spearman's correlation coefficient (for variables with statistically significant deviation from normal data distribution). In order to examine whether cardiovascular risk factors are lower in students who are involved in sport longer, a univariate analysis of variance (ANOVA), followed by Tukey's HSD Post Hoc test was applied and eta value determined to establish how pronounced possible differences between female PE students of different length of sport experience are. The level of significance was set at $p<0.05$.

RESULTS AND DISCUSSION

The baseline characteristics of the three subsamples and sample in total are presented in Table 1, and the descriptive statistics data of the selected cardiovascular risk factors are presented in Table 2.

Table 1 The baseline characteristics of female PE students

Subsamples	Variables	Mean±SD	Min - Max	K-S (Sig.)
Group 1, n=13	Age (yrs)	21.09 ± 1.11	19.01 – 22.34	.420
	Height (cm)	164.26 ± 4.22	156.5 – 170.0	.766
	Weight (kg)	63.55 ± 11.56	46.0 – 88.4	.431
	BMI (kg/cm^2)	23.52 ± 3.99	18.8 – 32.5	.533
	RMR (kcal)	1341.54 ± 119.94	1145.0 – 1583.0	.684
	RHR (bpm)	80.31 ± 8.99	68.0 – 102.0	.575
	SPEXP (yrs)	3.19 ± 1.6	0 – 5	.915
Group 2, n=26	Age (yrs)	21.05 ± 1.5	18.82 – 23.79	.285
	Height (cm)	167.28 ± 5.98	158.4 – 182.4	.910
	Weight (kg)	63.65 ± 7.32	46.2 – 80.5	.965
	BMI (kg/cm^2)	22.78 ± 2.39	18.4 – 28.1	.999
	RMR (kcal)	1366.58 ± 99.68	1148.0 – 1566.0	.987
	RHR (bpm)	79.77 ± 15.28	59.0 – 123.0	.727
	SPEXP (yrs)	8.33 ± 1.39	6 – 10	.288
Group 3, n=14	Age (yrs)	21.41 ± 1.74	18.7 – 24.97	.434
	Height (cm)	162.31 ± 7.45	153.0 – 179.0	.362
	Weight (kg)	59.76 ± 7.89	50.4 – 74.5	.922
	BMI (kg/cm^2)	22.69 ± 2.92	19.5 – 28.9	.454
	RMR (kcal)	1303.71 ± 105.97	1153.0 – 1537.0	.666
	RHR (bpm)	79.29 ± 12.22	63.0 – 107.0	.964
	SPEXP (yrs)	12.07 ± 1.27	11 – 15	.413
Sample in total, N=53	Age (yrs)	21.15 ± 1.46	18.7 – 24.97	.033*
	Height (cm)	165.23 ± 6.31†	153.0 – 182.4	.884
	Weight (kg)	62.6 ± 8.67	46.0 – 88.4	.950
	BMI (kg/cm^2)	22.94 ± 2.94	18.4 – 32.5	.380
	RMR (kcal)	1343.83 ± 107.69	1145.0 – 1583.0	.835
	RHR (bpm)	79.77 ± 12.98	59.0 – 123.0	.559
	SPEXP (yrs)	8.06 ± 3.49‡	0 – 15	.369

Legend: Mean - average value, SD - standard deviation, Min - minimum value, Max - maximum value, K-S - Kolmogorov-Smirnov test, Sig. - significance, n, N - number, Group 1 - with sports experience length from 0 to 5 years, Group 2 - with sports experience length from 6 to 10 years, Group 3 - with sports experience length from 11 to 15 years, yrs - years, BMI - body mass index, RMR - resting metabolic rate, RHR - resting heart rate, SPEXP - length of sports experience.

* absence of normal distribution (significant at $p<0.05$), † Group 2 vs. Group 3, F=3.299, Sig.=0.045 (in favor of Group 2)

‡ Between all of the three groups, F=133.565, Sig.=0.000 (in favor of Group 3, as well as Group 2), eta=.918

Table 1 shows the basic statistics for the baseline characteristics of the study participants for whom a normal distribution of data is observed. Based on an analysis of the data presented in the table, and based on the BMI cut-off point scale for adults (WHO, 1998), the highest percentage of participants (83.02%) is of normal weight; six of them (11.32%) are obese, two (3.77%) are obese - class I, and one (1.89%) is malnourished (BMI=18.4 kg/m^2). In a study conducted nine years ago, on a sample of PE student population from Belgrade, Serbia (Moskovljević, 2013), a slightly lower average value of BMI (21.17±1.93 kg/m^2) was recorded, as were in a study conducted on PE students from Niš, Serbia (Popović et al., 2020), but with higher average value of body height recorded (169.3±5.15 cm). When it comes to body mass, female student-athletes from Belgrade had a slightly lower average value (60.32±5.86 kg). There is a study conducted on the non-athlete student population - 120 students of the Medical Faculty of the University of Zagreb (Mašina, Zečić, & Pavlović, 2014), in which a similar average value was found (BMI=21.59 kg/m^2), as well as on 80 Dubrovnik (Croatia) students from different departments (Selmanović et al., 2014): 22.5 kg/m^2. However, in a study conducted on the American population of 2828 non-athlete university students (Pribis et al., 2010), a slightly higher average value (BMI=24.0±5.3 kg/m^2) was recorded, which can be attributed to the fact that higher BMI goes along with a sedentary lifestyle (the leading cause of student fat gain), but also to better socio-economic conditions in a country (Subramanian et al., 2011).

Pulse is an easily accessible parameter that provides information about various changes in the body, so many consider it "the key to the biological information system". Some authors (Alhalabi et al., 2017) consider RHR a marker of an individual's overall well-being, and not just a marker of cardiovascular health, so it is a parameter that should not be neglected. In healthy young people, normal RHR ranges from 60 to 80 bpm, and decreases with age. In well-trained athletes, due to higher stroke volume, but also increased parasympathetic activity, the pulse is lower, and in physically inactive persons it is higher due to the lower heart rate and sympathetic dominance. When it comes to the resting heart rate of physically active female PE students, on average, recorded RHR is at the upper limit of the health desirable range (79.77±12.98 bpm), which is slightly higher than the RHR values recorded in non-athlete female university students from America, and their average RHR value was 78.7±12.9 bpm (Pribis et al., 2010). In most of the participants (n=30, i.e. 56.6%) normal RHR values were recorded; a third of female PE students (n=18, i.e. 33.96%) had slightly increased RHR values; in four participants (7.55%) tachycardia was noted, and bradycardia in only one (1.89%), and she is one of two that train Athletics. Due to the fact that bradycardia (RHR<60 bpm) is a common physiological phenomenon among the population of athletes, especially in endurance sports (Doyen, Matelot, & Carré, 2019), like Athletics, as a chronic response of the cardiovascular system to intense training (Bahrainy et al., 2016), the obtained data are bit of a surprise. A possible explanation for such a small percentage of good training evidence among female PE students is the fact that many of them are probably former athletes, whose physical activity is now limited to attending practical classes at university.

Both bradycardia and tachycardia belong to cardiac arrhythmias, and are present among the population of athletes. Namely, long-term training leads to structural and electrical remodeling of a heart, which is a phenomenon known as the Athletic heart syndrome (Prior & La Gerche, 2012), characterized by dilatation and hypertrophy of all of four heart chambers and by the increased tone of the vagus at rest (Miljoen et al., 2019). Unfortunately, the Athletic heart syndrome has been recognized as a risk factor for the development of atrial arrhythmias,

and in one study (Miljoen et al., 2019), among 85 athletes, 50% of them had tachycardia. Of course, given that RHR is easily accessible, but also a very sensitive parameter, which at rest shows large variations (depending on gender, age, level of training, ambient temperature, body position, diet, hydration levels, the presence of caffeine in the blood, use of medication, emotional state, illness, etc.), we believe that these four recorded high values of RHR of the participants are probably only a reflection of their current (emotional) state, or possible device errors. Namely, measurement errors occur through three main sources: device errors, user errors, and patient errors (Padwal, Straus, & McAlister, 2001). Device errors are potentially the most common of these three sources (NICE, 2006). For many years, the standard instrument for measuring blood pressure was the mercury sphygmomanometer, but in recent years it has been replaced by automated electronic devices in many clinical settings (Wan et al., 2010), and electronic devices can cause measurement errors.

Table 2 Cardiovascular risk factors of female PE students

Subsamples	Variables	Mean±SD	Min - Max	K-S (Sig.)
Group 1, n=13	BF%	34.22 ± 6.94	25.2 – 47.6	.921
	Visc F	4.0 ± 1.23	2 – 6	.722
	WC (cm)	73.79 ± 9.55	60.0 – 97.3	.562
	SBP (mmHg)	110.77 ± 9.55	100.0 –130.0	.499
	DBP (mmHg)	70.0 ± 8.61	61.0 – 89.0	.303
Group 2, n=26	BF%	32.22 ± 5.45	22.2 – 43.9	.970
	Visc F	3.65 ± 0.98	2 – 6	.081
	WC (cm)	72.57 ± 5.29	63.5 – 92.0	.495
	SBP (mmHg)	115.27 ± 11.89	90.0 –143.0	.777
	DBP (mmHg)	73.58 ± 7.66	58.0 – 92.0	.907
Group 3, n=14	BF%	30.84 ± 6.99	15.5 – 43.5	.740
	Visc F	3.71 ± 1.2	2 – 6	.175
	WC (cm)	70.2 ± 4.65	63.0 – 81.0	.522
	SBP (mmHg)	113.36 ± 6.98	99.0 –123.0	.669
	DBP (mmHg)	73.86 ± 6.54	62.0 – 86.0	.907
Sample in total, N=53	BF%	32.35 ± 6.25	15.5 – 47.6	.743
	Visc F	3.75 ± 1.09	2 – 6	.003*
	WC (cm)	72.24 ± 6.46	60.0 – 97.3	.194
	SBP (mmHg)	113.66 ± 10.23	90.0 – 143.0	.690
	DBP (mmHg)	72.77 ± 7.66	58.0 – 92.0	.533

Legend: Mean - average value, SD - standard deviation, Min - minimum value, Max - maximum value, K-S - Kolmogorov-Smirnov test, Sig. - significance, n, N - number, Group 1 - with sports experience length from 0 to 5 years, Group 2 - with sports experience length from 6 to 10 years, Group 3 - with sports experience length from 11 to 15 years, BF% - body fat percentage, Visc F - visceral fat level, WC - waist circumference, SBP - systolic blood pressure, DBP - diastolic blood pressure.
* absence of normal distribution (significant at $p<0.05$)

Table 2 shows the basic statistics of the selected cardiovascular risk factors in physically active female PE students. The mean values of all the parameters are within the recommended ones, i.e. health-appropriate values, and deviation from the normal distribution of data was observed only when it comes to the level of visceral fats (K-S, Sig.= .003), although all participants have a level of Visc F that is in the range of normal values (Omron Healthcare, 2017).

Although the mean value of the body fat percentage is in the range of the recommended ones (Omron Healthcare, 2017), and more than half of the participants (n=30, i.e. 56.6%) have BF% corresponding to normal values for that age and sex, the percentage of participants with high BF% value is not negligible: in 14 female students (26.42%) a high percentage of body fat was found, and in 9 of them (16.98%) even higher values of this parameter (39.2%≤BF%≤43.9%).

Abdominal obesity assessed by the WC value is a significant predictor of cardiovascular diseases (Huxley et al., 2010) and of type 2 diabetes (Rexrode et al., 1998), while some authors argue that it is not yet sufficiently known whether waist circumference can predict abdominal fat and associated comorbid conditions in young people (Lee et al., 2006). When it comes to this parameter, the largest percentage of participants (90.38%, i.e. 47 of them) have a waist circumference that does not indicate a risk of health complications (Ross & Janssen, 2007); three of them (5.66%) have a waist circumference that indicates a slightly increased risk of health complications (80 cm ≤ WC ≤ 88 cm), while two female PE students (3.77%) have a significantly increased risk (WC is 92 cm, and 97.3 cm, respectively).

The relationship between blood pressure values and the risk of cardiovascular disease is continuous, consistent and independent of other factors. Thus, the higher the values of BP, the greater the chance of heart attack, stroke, kidney disease (NHLBI, 2004), which indicates the huge importance of monitoring this parameter. When it comes to blood pressure, the largest percentage of participants (67.92%, i.e. 36 of them) have normotension (90<SBP<120 mmHg and 60<DBP<80 mmHg); five participants (9.43%) have elevated blood pressure (120<SBP<129 mmHg and 60<DBP<80 mmHg); as many as nine (16.98%) have stage I hypertension (130<SBP<139 mmHg or 80<DBP<89 mmHg), of which the blood pressure of one participant is classified in this category at the expense of both the SBP and DBP value (her BP is 131/83 mmHg), and the remaining eight an elevated value of DBP (Börjesson, Kjeldsen, & Dahlöf, 2010; AHA, 2018). These data are not surprising, because in young adults diastolic pressure is a better predictor of cardiovascular disease than systolic (unlike older adults), but it is not uncommon for people aged 15 to 25 to have elevated systolic blood pressure and normal values of diastolic (O'Rourke, Vlachopoulos, & Graham, 2000). In addition, young adults with untreated diastolic hypertension have a better prognosis than those with elevated systolic and diastolic blood pressure (Fang et al., 1995). Stage II hypertension (SBP>140 mmHg or DBP>90 mmHg) was found in two participants (3.77%), and one had this stage of hypertension at the expense of both the SBP and DBP value (her BP is 143/92 mmHg). A very high body fat percentage (42.0%), increased BMI value (27.7 kg/m^2, which indicates preobesity) is found in that participant, but all the other parameters (WC, Visc F, RHR) are within the recommended values. When it comes to hypotension (SBP<90 mmHg and DBP<60 mmHg), it was recorded in only one participant (her BP is 90/60 mmHg), and it is around the limit values. Compared with the established results of blood pressure in physically active female university students, slightly higher average value of SBP (118.4±14.1 mmHg) was found in 2828 American non-athlete female university students (Pribis et al., 2010), while the average DBP value was similar (73.5±9.4 mmHg) to those recorded in this study. However, American non-athlete female university students have a lower body fat percentage (22.4±6.7 %) in comparison to our participants.

Table 3 Intercorrelation matrix of all of the examined variables

Variables	Age	Height	Weight	BMI	RMR	RHR	SPEXP	BF%	Visc F	WC	SBP	DBP
Age	1.00											
Height	.110	1.00										
Weight	-.070	.431**	1.00									
BMI	-.078	-.119	.811**	1.00								
RMR	-.032	.653**	.901**	.597**	1.00							
RHR	-.267	-.031	.082	.098	.142	1.00						
SPEXP	.091	-.052	-.095	-.066	-.044	-.043	1.00					
BF%	-.078	-.179	.663**	.846**	.333*	-.016	-.172	1.00				
Visc F	-.109	-.196	.632**	.900**	.451**	.115	-.063	.779**	1.00			
WC	.112	.095	.807**	.844**	.627**	.073	-.118	.733**	.688**	1.00		
SBP	.016	-.019	.263	.273*	.215	-.094	.127	.250	.167	.308*	1.00	
DBP	.068	.063	.284*	.247	.292*	.287*	.261	.228	.200	.304*	.571**	1.00

Legend: BMI - body mass index, RMR - resting metabolic rate, RHR - resting heart rate, SPEXP - length of sports experience, BF% - body fat percentage, Visc F - visceral fat level, WC - waist circumference, SBP - systolic blood pressure, DBP - diastolic blood pressure.
* significant at $p<0.05$, ** significant at $p<0.01$

Table 3 represents the intercorrelation matrix of all of the examined variables of physically active female PE students. A large number of positive, mostly moderate to strong, and statistically significant correlations ($p<0.001$) are established. The body fat percentage of female PE students is statistically significant and positively correlated with the body mass index, visceral fat, waist circumference, body mass, resting metabolic rate. In the case of visceral fat levels and waist circumference the situation is similar: both obesity parameters are statistically significant and positively correlated with body mass, the body mass index, resting metabolic rate, and also with body fat percentage. In addition, waist circumference and the visceral fat level have a strong and positive, statistically significant correlation, while only waist circumference has a statistically significant ($p<0.05$) and positive, but weak correlation with both blood pressure parameters. Besides the positive and statistically significant correlation of SBP with WC, this parameter has a weak positive, but statistically significant correlation ($p<0.05$) with BMI, but also a moderate positive, statistically significant correlation with DBP. Unlike SBP, DBP records weak positive and statistically significant correlations ($p<0.05$) with waist circumference, resting metabolic rate, resting heart rate as well as body mass. These established, statistically significant relationships of blood pressure with residual risk factors, mostly coincide with the results of a study conducted on a sample of 142 female university students from South Africa (Nkeh-Chungag, Mxhosa, & Mgoduka, 2015), aged 21.7±0.3 years, body height 159.7±0.6 cm, body mass 65.7±1.1 kg, body mass index 26.1±0.6 kg/m^2, waist circumference 77.9±0.9 cm, body fat percentage 43.1±3.0%, visceral fat level 5.1±0.3, systolic blood pressure 115.0±1.0 mmHg and diastolic blood pressure 72.0±1.0 mmHg. The following relationships with blood pressure were determined: BMI, WC, BF% and Visc F are in a statistically significant ($p<0.05$) correlation with SBP, while WC and BF% are in a statistically significant correlation with DBP.

When comparing female PE students from three different groups formed based on the length of their sports experience, no statistically significant differences in cardiovascular risk factors were established. This result can be explained by the possible fact that, regardless of the length of their sports experience, most of them are no longer active athletes and share the same level of physical activity (achieved through practical classes only). Also, there are authors who claim that independently of the physical activity carried out, it is sedentary behaviour that is related to cardiovascular risk factors (Young, Hivert, Alhassan, Camhi, Ferguson, Katzmarzyk et al., 2016), and all university students do have increased sedentary behaviour - their sitting time can exceed 9h a day (Castro, Bennie, Vergeer, Bosselut, & Biddle, 2020).

CONCLUSION

Given this global situation (obesity epidemic, hypokinesia, chronic diseases, most of which are cardiovascular), of which even young people are not spared, not even PE students, it is necessary to make some efforts to develop and identify techniques and markers that can be used to assess cardiovascular risks, which would enable triage of the population and the start of monitoring, and necessary therapy, as early as possible. So far attention has been paid to the health status of the elderly, but unfortunately it is necessary to direct it to younger populations too, and even to those who exercise regularly, have a healthy lifestyle, and may not show, at first glance, the presence of some risk factors. All of this is necessary because cardiovascular diseases in adults, but also many other diseases, are actually a "pediatric" problem. Thus, young people, who are in the at-risk group in terms of cardiovascular risk factors, most often remain in that group later in life, which indicates the need for early recognition and preventive action, i.e. work on the reduction and mitigation of cardiovascular risk factors. In this study, although weak positive, but statistically significant correlations were established (correlations of systolic blood pressure with body mass index and waist circumference, as well of diastolic blood pressure with body mass, resting metabolic rate, waist circumference and resting heart rate, but also with systolic blood pressure), and some participants have even been diagnosed with obesity, as well as with high percentage of body fat, and even with a risk value of waist circumference, it is unequivocal that the reduction of body mass at the expense of adipose tissue is necessary, as well as increase in the moderate physical activity level and regularity and decrease of sedentary behavior as much as possible, in order to reduce the risk of cardiovascular diseases in female PE students now as well as in older age.

Study limitations

This study has various limitations that should be considered. Firstly, it is a transversal study realized only on a sample of PE students. The global COVID-19 pandemic prevented the inclusion of students from other faculties, which was the original plan. The prevented comparison of PE students with other non-PE students would give a more realistic picture about the presence of cardiovascular risk factors among young adults as well as about the role of physical activity in the solution of this major public health problem. Another study limitation is the insufficiently addressed level and intensity of physical activity (hours per day, week, type of training, etc.), which would have been done properly if the comparison with other university students had not been originally planned and then prevented by the

pandemic (for comparison of student-athletes and student non-athletes the data collected would be quite sufficient). Finally, the lack of significance in some of the strata analyzed could be due to a lack of statistical power because of the low number of study participants in the subsamples and in the sample in total.

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REFERENCES

American Heart Association (2018). *Understanding blood pressure readings*. Retrieved on February 01, 2022 from https://www.heart.org/en/health-topics/high-blood-pressure/understanding-blood-pressure-readings

Alhalabi, L., Singleton, M.J., Oseni, A.O., Shah, A.J., Zhang, Z.M., & Soliman, E.Z. (2017). Relation of higher resting heart rate to risk of cardiovascular versus noncardiovascular death. *The American Journal of Cardiology*, *119*(7), 1003-1007.

Bahrainy, S., Levy, W. C., Busey, J. M., Caldwell, J. H., & Stratton, J. R. (2016). Exercise training bradycardia is largely explained by reduced intrinsic heart rate. *International Journal of Cardiology*, *222*, 213-216.

Bouchard, C., Blair, S.N., & Haskell, W.L. (2007). Why study physical activity and health? In C. Bouchard, S.N. Blair, & W.L. Haskell (Eds.), *Physical activity and health*, (pp. 3-19). Champaign, IL: Human Kinetics.

Börjesson, M., Kjeldsen, S., & Dahlöf, B. (2010). Hypertension. In M. Börjesson, M. Hellenius, E. Jansson, J. Karlsson, M. Leijon, A. Ståhle, C.J. Sundberg, & J. Taube (Eds.), *Physical activity in the prevention and treatment of diseases*, (pp. 410-425). Stockholm, SE: Swedish National Institute of Public Health.

Bjerregaard, P., Eika Jørgensen, M., & Borch-Johnsen, K. (2007). Cardiovascular risk amongst migrant and non-migrant Greenland Inuit in a gender perspective. *Scandinavian Journal of Public Health*, *35*(4), 380-386.

Bray, S.R. (2007). Self-efficacy for coping with barriers helps students stay physically active during transition to first year university. *Research Quarterly for Exercise & Sport*, *78*(2), 61-70.

Castro, O., Bennie, J., Vergeer, I., Bosselut, G., & Biddle, S.J. (2020). How sedentary are university students? A systematic review and meta-analysis. *Prevention Science*, *21*(3), 332-343.

Ćurković, S., Andrijašević, M., & Caput-Jogunica, R. (2014). Physical activity behaviors among university students In D. Milanović, & G. Sporiš (Eds.), *Book of Proceedings of the 7th International Scientific Conference on Kinesiology "Fundamental and applied kinesiology - Steps forward*" (pp. 703-706). May 22-25, 2014, Opatija, HR: Faculty of Kinesiology of University of Zagreb.

Doyen, B., Matelot, D., & Carré, F. (2019). Asymptomatic bradycardia amongst endurance athletes. *The Physician & Sports Medicine*, *47*(3), 249-252.

Fang, J., Madhavan, S., Cohen, H., & Alderman, M.H. (1995). Isolated diastolic hypertension: a favorable finding among young and middle-aged hypertensive subjects. *Hypertension*, *26*(3), 377-382.

Hooper, L., Summerbell, C.D., Higgins, J.P.T., Thompson, R.L., Capps, N.E., Smith, G.D., Riemersma, R.A., & Ebrahim, S. (2001). Dietary fat intake and prevention of cardiovascular disease: systematic review. *BMJ*, *322*(7289), 757-763.

Huxley, R., Mendis, S., Zheleznyakov, E., Reddy, S., & Chan, J. (2010). Body mass index, waist circumference and waist: hip ratio as predictors of cardiovascular risk- a review of the literature. *European Journal of Clinical Nutrition*, *64*(1), 16-22.

Irazusta, A., Hoyos, I., Irazusta, J., Ruiz, F., Díaz, E., & Gil, J. (2007). Increased cardiovascular risk associated with poor nutritional habits in first-year university students. *Nutrition Research*, *27*(7), 387-394.

Janssen, I. (2007). Physical activity, fitness, and cardiac, vascular, and pulmonary morbidities. In C. Bouchard, S.N. Blair**,** & W.L. Haskell (Eds.), *Physical activity and health*, (pp. 161-171). Champaign, IL: Human Kinetics.

Janssen, I., Boyce, W.F., Simpson, K., & Pickett, W. (2006). Influence of individual-and area-level measures of socioeconomic status on obesity, unhealthy eating, and physical inactivity in Canadian adolescents. *The American Journal of Clinical Nutrition*, *83*(1), 139-145.

Kwan, M., & Faulkner, G. (2011). Perceptions and barriers to physical activity during the transition to university. *American Journal of Health Studies*, *26*(2), 87-96.

Lee, S., Bacha, F., Gungor, N., & Arslanian, S.A. (2006). Waist circumference is an independent predictor of insulin resistance in black and white youths. *The Journal of Pediatrics*, *148*(2), 188-194.

Mašina, T., Zečić, M., & Pavlović, D. (2014). Gender differences in some anthropometric and motor characteristics among students of Zagreb University School of medicine. In D. Milanović, & G. Sporiš (Eds.), *Book of Proceedings of the 7th International Scientific Conference on Kinesiology "Fundamental and applied kinesiology - Steps forward*" (pp. 722-725). May 22-25, 2014, Opatija, HR: Faculty of Kinesiology of University of Zagreb.

Miljoen, H., Ector, J., Garweg, C., Saenen, J., Huybrechts, W., Sarkozy, A., Willems, R., & Heidbuchel, H. (2019). Differential presentation of atrioventricular nodal re-entrant tachycardia in athletes and non-athletes. *EP Europace*, *21*(6), 944-949.

Moskovljević, L. (2013). *Faktori uspešnosti usvajanja programskih sadržaja ritmičke gimnastike kod osoba različitog pola [Success factors of Rhythmic Gymnastics syllabus acquisition in persons of different gender.* In Serbian*]*. Neobjavljena doktorska disertacija, Beograd, RS: Fakultet sporta i fizičkog vaspitanja Univerziteta u Beogradu.

National Heart, Lung, and Blood Institute (2004). *The seventh report of the Joint National Committee on Prevention, detection, evaluation, and treatment of high blood pressure*. Retrieved on February 2nd, 2022 from https://www.ncbi.nlm.nih.gov/books/NBK9630/pdf/Bookshelf_NBK9630.pdf

National Institute for Clinical Excellence (2006). *Clinical guideline 34: Hypertension Management of hypertension in adults in primary care*. Retrieved February 2nd, 2022 from https://www.nice.org.uk/guidance/CG34

Nkeh-Chungag, B.N., Mxhosa, T.H., & Mgoduka, P.N. (2015). Association of waist and hip circumferences with the presence of hypertension and pre-hypertension in young South African adults. *African Health Sciences*, *15*(3), 908-916.

Omron Healthcare (2017). *BF511 Body composition monitor: Instruction manual*. Retrieved February 20, 2019 from https://www.manualslib.com/manual/887289/Omron-Bf511.html

O'Rourke, M.F., Vlachopoulos, C., & Graham, R.M. (2000). Spurious systolic hypertension in youth. *Vascular Medicine*, *5*(3), 141-145.

Padwal, R., Straus, S.E., & McAlister, F.A. (2001). Cardiovascular risk factors and their effects on the decision to treat hypertension: evidence based review. *BMJ*, *322*(7292), 977-980.

Panunzio, M.F., Antoniciello, A., Pisano, A., & Dalton, S. (2007). Nutrition education intervention by teachers may promote fruit and vegetable consumption in Italian students. *Nutrition Research*, *27*(9), 524-528.

Popović, R., Aleksić-Veljković, A., Purenović-Ivanović, T., & Popović, A. (2020). Assessment of body composition in physical education female students of University of Niš. *Advances in Sciences & Humanities*, *6*(1), 36-51.

Prior, D.L., & La Gerche, A. (2012). The athlete's heart. *Heart*, *98*(12), 947-955.

Pribis, P., Burtnack, C.A., McKenzie, S.O., & Thayer, J. (2010). Trends in body fat, body mass index and physical fitness among male and female college students. *Nutrients*, *2*(10), 1075-1085.

Qian, J., Wang, B., Dawkins, N., Gray, A., & Pace, R.D. (2007). Reduction of risk factors for cardiovascular diseases in African Americans with a 12-week nutrition education program. *Nutrition Research*, *27*(5), 252-257.

Rexrode, K.M., Carey, V.J., Hennekens, C.H., Walters, E.E., Colditz, G.A., Stampfer, M.J., Willett, W.C., & Manson, J.E. (1998). Abdominal adiposity and coronary heart disease in women. *Jama*, *280*(21), 1843-1848.

Rogacheva, A., Laatikainen, T., Tossavainen, K., Vlasoff, T., Panteleev, V., & Vartiainen, E. (2007). Changes in cardiovascular risk factors among adolescents from 1995 to 2004 in the Republic of Karelia, Russia. *The European Journal of Public Health*, *17*(3), 257-262.

Ross, R., & Janssen, I. (2007). Physical activity, fitness and obesity. In C. Bouchard, S.N. Blair, & W.L. Haskell (Eds.), *Physical activity and health*, (pp. 173-189). Champaign, IL: Human Kinetics.

Rowland, T.W. (2007). Physical activity, fitness, and children. In C. Bouchard, S.N. Blair**,** & W.L. Haskell (Eds.), *Physical activity and health*, (pp. 259-270). Champaign, IL: Human Kinetics.

Selmanović, A., Čale-Mratović, M., & Ban, Đ. (2014). Analysis of the impact of health-related habits on the body composition of students in Dubrovnik. In D. Milanović, & G. Sporiš (Eds.), *Book of Proceedings of the 7th International Scientific Conference on Kinesiology "Fundamental and applied kinesiology - Steps forward*" (pp. 734-738). May 22-25, 2014, Opatija, HR: Faculty of Kinesiology of University of Zagreb.

Small, M., Bailey-Davis, L., Morgan, N., & Maggs, J. (2013). Changes in eating and physical activity behaviors across seven semesters of college: living on or off campus matters. *Health Education & Behavior*, *40*(4), 435-441.

Subramanian, S.V., Perkins, J.M., Özaltin, E., & Davey Smith, G. (2011). Weight of nations: a socioeconomic analysis of women in low-to middle-income countries. *The American Journal of Clinical Nutrition*, *93*(2), 413-421.

Stănescu, M., & Vasile, L. (2014). Using physical exercises to improve mental health. *Procedia- Social & Behavioral Sciences*, *149*, 921-926.

Stojanović, D., Višnjić, A., Mitrović, V., & Stojanović, M. (2009). Faktori rizika od nastanka oboljenja kardiovaskularnog sistema u studentskoj populaciji [Risk factors for the occurrence of cardiovascular system diseases in students. In Serbian]. *Vojnosanitetski Pregled*, *66*(6), 453-458.

Wan, Y., Heneghan, C., Stevens, R., McManus, R.J., Ward, A., Perera, R., Thompson, M., Tarassenko, L., & Mant, D. (2010). Determining which automatic digital blood pressure device performs adequately: a systematic review. *Journal of Human Hypertension*, *24*(7), 431-438.

Weiner, J.S., & Lourie, J.A. (1969). *Human biology, a guide to field methods. International Biological Programme*. Edinburgh, UK: Blackwell Scientific Publications.

Wildman, R.P., Gu, D., Reynolds, K., Duan, X., Wu, X., & He, J. (2005). Are waist circumference and body mass index independently associated with cardiovascular disease risk in Chinese adults? *The American Journal of Clinical Nutrition*, *82*(6), 1195-1202.

World Health Organization (1948). *Constitution of the World Health Organization. Basic documents.* Geneva, CH: World Health Organization.

World Health Organization (1998). *Obesity: Preventing and managing the global epidemic* (WHO/NUT/NCD/98.1.1998). Geneva, CH: World Health Organization.

World Medical Association (2013). *World Medical Association Declaration of Helsinki: Ethical principles for medical research involving human subjects*. Retrieved February 18, 2019 from file:///C:/Users/PC/Downloads/wma-declaration-of-helsinki-ethical-principles-for-medical-research-involving-human-subjects.pdf

Young, D.R., Hivert, M.F., Alhassan, S., Camhi, S.M., Ferguson, J.F., Katzmarzyk, P.T., ... & Yong, C.M. (2016). Sedentary behavior and cardiovascular morbidity and mortality: a science advisory from the American Heart Association. *Circulation*, *134*(13), e262-e279.

KARDIOVASKULARNI FAKTORI RIZIKA FIZIČKI AKTIVNIH STUDENTKINJA

Kardiovaskularne bolesti vodeći su uzrok smrtnosti u svetu, a nastaju kao rezultat delovanja mnogobrojnih faktora rizika (gojaznost, visok krvni pritisak, nedovoljna fizička aktivnost, hiperlipoproteinemija, neadekvatna ishrana i nezdrav stil života). S obzirom na to da većina ovih faktora rizika kod mladih odraslih ima tendenciju održavanja na istom nivou, pa čak i pogoršavanja sa godinama, posebno nakon druge, odnosno treće decenije života, to znači da mladi odrasli, ako se nalaze u rizičnoj grupi u pogledu kardiovaskularnih oboljenja, najčešće ostaju u toj grupi i u kasnijem životnom dobu. Problem ovog istraživanja jeste ispitivanje postojanja mogućih korelacija određenih kardiovaskularnih faktora rizika 53 fizički aktivnih studentkinja, uzrasta 19 do 25 godina, kao i da se ispitaju moguće razlike između onih sa različitom dužinom sportskog staža (u rasponu od 0 do 5, 6 do 10 i 11 do 15 godina). Utvrđeni su njihovi opšti pokazatelji (uzrast, telesna visina, telesna masa, indeks telesne mase- BMI, bazalni metabolizam- RMR, frekvenca srca u miru- RHR i dužina sportskog staža), kao i relacije odabranih kardiovaskularnih faktora rizika (procenat masnog tkiva- BF%, nivo visceralnih masti- Visc F, obim struka- WC, arterijski krvni pritisak- SBP i DBP). Podaci su analizirani (deskriptivna statistika, Kolmogorov-Smirnov test, Pearson-ov i Spearman-ov koeficijent korelacije, ANOVA) primenom SPSS 21.0. Rezultati analize ukazali su na izostanak statistički značajnih razlika u kardiovaskularnim faktorima rizika između studentkinja fakulteta sporta različite dužine sportskog staža, ali i na postojanje statistički značajnih ($p<0.001$), pozitivnih korelacija, uglavnom velike jačine, većine odabranih kardiovaskularnih faktora rizika. Kada je reč o parametrima krvnog pritiska, iako male pozitivne i statistički značajne ($p<0.05$), ustanovljene su korelacije SBP sa BMI ($r=.273$), SBP sa WC ($r=.308$), kao i DBP sa telesnom masom ($r=.284$), DBP sa RHR ($r=.287$), DBP sa RMR ($r=.292$), kao i DBP sa WC ($r=.304$),ali i sa SBP ($r=.571$, $p<0.001$), nedvosmisleno je da je neophodna redukcija telesne mase na račun masnog tkiva, ali i povećanje nivoa i redovnosti umerene fizičke aktivnosti, kako bi se umanjio rizik od kardiovaskularnih bolesti studentkinja sportistkinja sada, ali i u starijim godinama.

Ključne reči: *masno tkivo, krvni pritisak, kardiovaskularne bolesti, studentkinje sportistkinje*