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Changes in Blood Pressure After Single Bout of Aerobic Exercise in Young Healthy People-Influence of Body Composition

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A b s t r a c t

Amount of change in blood pressure after exercise is related to risk of hypertension and cardiovascular diseases. The aim of this study was to determine whether there is a difference in the amount of change of blood pressure after exercise among people with different morphological characteristics, especially with differences in percent of body fat. 30 healthy subjects (15 males and 15 females) aged 25–30 years were included in the study. They were measured for weight and height, and their body composition was assesed by bioelectrical impendance device GAYA 357. Blood pressure was measured at rest and immediately after performing Cooper´s test. After classification of subjects according to BMI (body mass index) and according to percent of body fat (PBF) differences in the size of change in blood pressure among categories were compared. Results indicate that there is no difference between sexes in amount of change for DBP, but there is difference in change of SBP; in males this change was significantly higher than in females. We also found difference in SBP results at rest between different categories of BMI (p=0,023), that was not influenced by gender, while the difference between categories based on different PBF were under the influence of gender. Based on results conclusion can be made that percent of body fat is a factor that influence amount of change in blood pressure with exercise, and is potentially important, and could be predictive factor, like BMI or together with it, in determining the risk of hypertension in young healthy people.

Key words: *blood pressure, exercise, body composition, percent of body fat, body mass index*

Introduction

Morphological characteristics are among very important factors in development of cardiovascular diseases[1]. Overweight is well recognized as one of the risk factors for developing heart and vessels disease[2,3], and it can be very dangerous for health in general from early stages in life[4,5]. One of the most commonly used parameters that describe nutritional status of a person is body mass index (BMI) which is often used as a risk factor for development of cardiovascular disease[6]. Since it is not precise enough on its own to predict risk of hypertension or cardiovascular disease[7], it is usually used in compliance with other parameters. This lack of precision may be influenced by its poor ability to reflect composition of body weight. The morphological characteristics such as lean body mass (LBM), mass of body fat (MBF) and percent of body fat (PBF) could be more precise in determination of nutritional status than BMI[2,7,8]. In order to asses risk of cardiovascular disease and to develop treatments for prevention, it is necessary to know which morphological characteristic are relevant[9] for the risk of hypertension and cardiovascular diseases. Since composition of body weight, specially lean body mass and mass of body fat are in tight correlation to physical activity level, it is clear that connections of morphological characteristics to blood pressure level could facilitate the choice of the best type of physical activity for minimalizing risks for developing hypertension and cardiovascular disease[10].

One bout of maximum intensity aerobic exercise is followed by increase in systolic blood pressure (SBP), and decrease in diastolic blood pressure (DBP). Studies made in 80´s and 90´s years of the last century[11–13] showed that the intensity of these changes is related to risk of hypertension and cardiovascular diseases. Results of those studies indicate that size of increase in SBP during physical activity could be a prognostic factor for the risk of development of hypertension and heart disease, and that big increase in SBP after exercise is associated to increased risk of hypertension and increase in mortality of cardiovascular disease[13].

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The aim of this study is to asses in what way morphological characteristics affect the size of change in blood pressure after exercise. That could be determined by testing differences in size of change in systolic and diastolic blood pressure among people divided according to their morphological characteristics. Therefore, subjects in this study are classified in categories according to their BMI and PBF in order to compare the differences in amount of change in blood pressure, for finding if presence of fatty tissue is relevant for changes in blood pressure after exercise. Due to the facts that correlation of BMI and hypertension is established and confirmed[2,3], this study aim is to compare if connection of BMI and hypertension is associated with amount of body fat, and whether PBF could have any prognostic value for predicting hypertension as a risk factor. We expect that PBF will be in similar connection to changes in blood pressure after exercise as BMI.

Materials and Methods

The study included 30 healthy subjects of both sexes, aged 20–25 years (15 males and 15 females). Subjects were volunteers, who signed a document on the voluntary agreement to participate in research, after being informed on main objectives and methods of the study. All subjects were measured for height by standard method using altimeter SECA type 700. Body composition was assessed using the segmental analyzer GAYA 357, which works on the principle of bioelectrical impedance. After 12-hour fasting subjects stood barefoot on the electrodes built in the podium of device, while in the hands holding the other two electrodes. Instrument gives information on body composition based on different electric properties of different tissues composing body: adipose tissue mass (MBF = mass of body fat) and fat free mass (LBM = lean body mass), consisting of muscle mass (SLM = soft lean mass) and minerals (in the bones and electrolytes). SLM could be divided into a mass of proteins and water (TBW = total body water). In addition to these data, the results on waist-to-hip ratio (WHR) and total energy expenditure (TEE), and body mass index (BMI) can be obtained by device. The measurements were performed according to manufacturer's instructions. For this study values of BMI and percent of body fat (PBF) were obtained.

Blood pressure was measured at rest (before exercise), and immediately after physical exertion, which consisted of running on a treadmill for 12 minutes, according to the protocol of Cooper's test for determining the physical condition[14]. Blood pressure measurement was done by a standard method using a manual sphygmomanometer[15].

Subjects were classified according to the calculated BMI in three categories: I – low weight BMI <18; II – normal weight BMI 18–25; III – overweight BMI> 25. Other classification was made on base of the PBF (percent of body fat), and subjects were classified in two categories: I: normal for M (male) <15%, F (female)<21%; II: increased for M> 15%, F> 21%, and the observed difference in the size of changes in blood pressure following exercise among the categories were tested.

Statistical analysis

The normality of the distribution of numerical data was determined by the Kolmogorov-Smirnov test. Data with normal distribution are presented as mean and standard deviation, and for their processing were used parametric methods (ANOVA, t-test), while data not normally distributed were presented by median and range, and were analyzed by non-parametric methods (Kruskal-Wallis, Mann-Whitney test). The differences in the size of change in blood pressure (diastolic and systolic) between the categories of BMI and PBF were tested by two-way ANOVA, and differences in distribution by categories of BMI and PBF were tested by χ^2 test. All statistical analysis were performed using statistical software MedCalc (10.2.0.0, MedCalc Software, Broekstraat 52, 9030 Mariakerke, Belgium). The level of significance was set at p=0.05.

Results

The characteristics of the sample are shown in Table 1.

Diastolic blood pressure (DBP) in this sample significantly decreased after exercise for an average of 14.33 mm Hg (p<0.0001), while the systolic pressure (SBP) significantly increased for an average of 12.33 mm Hg, (p<0.0001), which is in compliance with published studies [16]. Gender did not affect the difference in the amount of reduction of diastolic pressure (p=0.182), but it influenced the difference in the size of increase in systolic pressure (p= 0.001), so that the increase in SBP following aerobic exercise was higher in males. The mean systolic blood pressure after exercise for the female subjects was 124.54 mm Hg, while for males it was 139.25 mmHg.

Classification by categories of BMI and PBF produced frequencies presented in Table 2. Distribution of subjects over categories of BMI and PBF are different. That is evident in groups of normal weight and overweight, where distribution among categories of PBF does not follow distribution based on BMI. In category overweight (by BMI) there are subjects with normal PBF, while in category normal weight (by BMI) there are more subjects with PBF above the recommended value.

There was no difference between gender in the distribution of BMI categories (χ^2=4.84, p=0.088), nor in the distribution by category PBF (χ^2=4, p=1). The distribution of different gender over categories of BMI and PBF is presented in Table 3.

We found no difference in systolic blood pressure after exercise among categories PBF (p=0.133) (p=0.133), and the difference that exists between the sexes is not influenced by PBF category (p=0.250).

After classification into three groups according to BMI: group I (underweight) included subjects with BMI<18, group II (normal weight) included subjects with BMI 18–25, and group III (overweight) included subjects with BMI>25). No difference was found in size of change for DBP between subject of different BMI categories

TABLE 1
SAMPLE CHARACTERISTICS

	N=30	Male (N=15)	Female (N=15)
Height (cm)	174.5 (163–190)	182 (174–190)	165 (163–175)
Weight (kg)	70.6 (47.8–85.7)	80.5 (62.9–85.7)	55.7 (47.8–70.8)
BMI (kg/m^2)	22.3±2.5	23.9±1.6	20.8±2.2
WHR	0.75±0.04	0.78±0.03	0.74±0.04
SLM (kg)	50.37±11.65	60.97±5.31	39.78±3.50
MBF (kg)	14.13±3.68	14.1±3.33	14.17±4.13
PBF (%)	21.03±5.4	17.67±3.79	24.38±4.66
SBP – initial measurement (mm Hg)	118±11	123±8	113±11
SBP – final measurement(mm Hg)	130±13	139±7	122±12
DBP – initial measurement (mm Hg)	75±7	78±8	73±6
DBP – final measurement (mm Hg)	61±9	62.6±10.3	60±8.45

Abbreviations: BMI – body mass index; WHR – waist to hip ratio; SLM – soft lean mass; MBF – mass of body fat; PBF – percent of body fat; SBP – systolic blood pressure; DBP – diastolic blood pressure

TABLE 2
DISTRIBUTION OF SAMPLE BY BMI AND PBF CATEGORIES

		BMI Categories			Total
		Underweight	Normal weight	Overweight	
PBF categories	Normal PBF	2	6	1	9 (30%)
	Increased PBF	0	16	5	21 (70%)
Total		2 (7%)	22 (73%)	6 (20%)	30

Abbreviations: BMI – body mass index; PBF – percent of body fat

TABLE 3
MEN AND WOMEN DISTRIBUTION OF BY BMI AND PBF CATEGORIES

	Gender		Total
	Female	Male	
BMI categories			
Underweight	2	0	2 (7%)
Normal weight	12	10	22 (73%)
Overweight	1	5	6 (20%)
PBF categories			
Normal PBF	4	5	9 (30%)
Increased PBF	11	10	21 (70%)
	15 (50%)	15 (50%)	30

Abbreviations: BMI – body mass index; PBF – percent of body fat

(p=0.963). Similar results were obtained after classification by PBF. In the group I- normal PBF all men with PBF<15% and all women with PBF<21% were included, while in group II-increased PBF were all others (men with PBF>15% and women with PBF>21%). No difference was found in size of change DBP between those two categories (p=0.960). Change of SBP was also not different in size for BMI categories (p=0.191), nor for PBF categories (p=0.298).

No differences were found for initial DBP (measured before exercise) between sexes (p=0.245), or between categories PBF (p=0.321). Similar findings were for final DBP (after exercise) with no differences between sexes (p=0.57), or between categories PBF (p=0.492). Same results were found for size of change DBP following exercise.

For data on initial SBP (at rest, before exercise) difference was found between sexes, SBP had higher values for men than for women (p=0.016). No difference was found for PBF categories (p=0.413), or interaction of sex and PBF categories (p=0.876). Results of SBP measurements after exercise, however, yielded interaction of gender and PBF categories (p=0.035)

Test for differences among BMI categories and sex did not found difference in initial DBP (measured at rest) between sexes (p=0.50), or between categories BMI (p=0.11). Similar results were obtained by analyzing data of DBP measured after exercise (for sex p=0.84, for BMI p=0.163) and for size of change DBP following exercise (for sex p=0.373, for BMI p=0.785). No interaction of those variables (sex and BMI category) was found for data collected before (p=0.855) or after exercise (p=0.601), or for size of change in DBP following exercise (p=0.612).

However, difference between BMI categories was found for SBP measured before exercise (p=0.023), which is in compliance with similar published studies[6,17,18], and with no difference between sexes and no interactions of variables sex and BMI category (p=0.263). Size of change SBP was not different for sexes (p=0.064), or for BMI categories (p=0.464). Final measurement of SBP (after exercise) was different for sexes (p=0.028), and different for BMI categories (p=0.003), but there was no interaction of those two variables (p=0.272).

Discussion

Results of presented study confirm the importance of body composition for blood pressure regulation. The major finding of this study is the connection of percent body fat and difference in amount of change in blood pressure during exercise between sexes. Analysis of results of change in SBP after exercise yielded interaction of sex and PBF categories (p=0.035), and that brings us to conclusion that PBF influences the size of change SBP differently for men and women. It could be a potential risk factor for cardiovascular disease[19].

Although initial measurement of SBP before exercise was not different for groups formed by PBF, difference in size of change SBP following exercise between males and females is influenced by PBF category affiliation.

For data on initial SBP (at rest, before exercise) difference was found between sexes, with higher SBP in males compared to females, which is expected and in compliance with similar published studies[20,21]. It was interesting that no difference was found in initial DBP between sexes or between categories formed on PBF. Since the subjects in the study were healthy young people we did not expect results to be different from obtained. This study was designed to study only nonhypertensive, healthy people, and to asses risks for potential development of hypertension that could be result of influence of their body composition. Probable reason for the differences between genders is intensity of aerobic activity; since average speed during the 12 minutes test for females was 5.58 km/h, while the rate for men was 7.15 km/h.

To compare influence of BMI, which is proven to be important risk factor for hypertension, but is poor indicator of body composition, and influence of PBF that is a measure of fatty tissue in the body, we conducted the same analysis for groups formed according to BMI value and according to PBF value.

Difference between BMI categories was found for SBP measured before exercise, which is in compliance with similar published studies[6,17,18], but no difference was found between sexes and no interactions of variables sex and BMI category. Final measurement of SBP (after exercise) was different for sexes, and different for BMI categories, but there was again no interaction of those two variables. When compared size of change SBP, it was not different for sexes, or for BMI categories. These results are consistent to proven and well known connection of BMI and blood pressure level, but also confirm that there is no difference in size of change of blood pressure following exercise between groups formed by differences in BMI. No differences were found even after accounting for gender affiliation.

When compared for affiliation to groups of normal weight and normal PBF it can be seen that in group of normal weight according to BMI there are approximately 3 times more subjects that have PBF above the values that are considered normal. That is the main problem of BMI classification, it does not account for body composition in assessment of nutritional status. And that is why we considered there was need for investigation of connections of percent of body fat and values of blood pressure. The finding presented here showed differences of two factors investigated: BMI and PBF in their influence on how blood pressure responds to exercise. It is evident that systolic blood pressure following exercise is influenced by nutritional status assessed by BMI, but although the difference is noticed in initial and in final measurements of systolic blood pressure, the amount of change is not different for different groups of BMI, or between sexes. On the other hand when analyzed in sense of body composition the difference between men and women in systolic blood pressure elevation after exercise is affected by percent of body fat.

Limitations of study include use of very young subjects, which limits the generalization of findings to older populations. We assessed percent of body fat only based on bioelectric impedance method, with no additional measurement that would confirm these results. Third, blood pressure was measured only at rest and immediately after Coopers test, and was not monitored after that, for possible differences in recovery. This study, as all cross-sectional studies cannot determine causal relationships, but only establish is there correlations between variables of interest, and not what is a cause and what consequence, but it is a starting point for future investigations.

Conclusions

Presented results could lead to conclusion that PBF is a factor that influences the size of change blood pressure following exercise differently for men and women. Since it is a measure of body fat and more connected to body composition than BMI, it would be interesting to investigate its importance as possible risk factor for hypertension in older ages. This study is a base for future investigations that could determine true values of PBF as prediction factor for hypertension and cardiovascular disease. Maine questions that should be answered are is there correlation between change of blood pressure following single bout of exercise and percent of body fat, or soft lean mass, or some other component of body mass.

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PROMJENE KRVNOG TLAKA KOD MLADIH ZDRAVIH LJUDI NAKON AEROBNOG TRENINGA – UTJECAJ SASTAVA TJELESNE MASE

S A Ž E T A K

Veličina promjene krvnog tlaka nakon vježbanja povezana je s rizikom od hipertenzije I kardiovaskularnih oboljenja. Cilj ovog istraživanja bio je utvrditi postoji li razlika u veličini promjene krvnog tlaka nakon vježbanja među ljudima različitih morfoloških karakteristika, a posebno s razlikama u postotku tjelesne masti. Studija je izvedena na uzorku od 30 zdravih ispitanika (15 muškaraca i 15 žena) u dobi od 25–30 godina. Izmjerena im je težina i visina, a sastav tjelesne mase određen je metodom bioelektrične impedance, uređajem Gaya 357. Krvni tlak je mjeren u mirovanju i odmah nakon izvođenja Cooper-ovog testa. Ispitivane su razlike u veličini promjene krvnog tlaka među ispitanicima koji pripadaju različitim kategorijama klasificiranim prema vrijednostima indeksa tjelesne mase (BMI) i postotka masnog tkiva u tijelu (PBF). Rezultati pokazuju da nema razlike među spolovima u veličini promjene za DBP, ali je nađena razlika u promjeni SBP; kod muškaraca je ta promjena bila veća nego kod žena. Nađena je razlika u SBP mjerenom u mirovanju između različitih kategorija BMI (p=0.023), koja nije povezana sa spolom, dok je razlika između kategorijama s različitim PBF pod utjecajem spola. Na temelju rezultata može se zaključiti da je postotak tjelesne masti povezan sa veličinom promjene krvnog tlaka nakon vježbanja, te ima potencijal biti prediktivni čimbenik, kao što je BMI ili zajedno s njim, u određivanju rizika od hipertenzije u mladih zdravih ljudi.