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CORRELATION BETWEEN CIRCULATORY AND SOMATIC VARIABLES IN YOUNG AND ELDERLY MEN

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Abstract

Aim of the study: The aim of the study was to find out, whether arterial blood pressure measured at rest correlates with chosen somatic parameters in healthy young and elderly men.

Materials and Methods: In the study participated 3 groups of different age (12 healthy men each group): Group I: 23.9 ±4.2 years, Group II: 51.7 ±5.5 years, Group III: 66.5 ±5.7 years. Resting systolic pressure (RRs [mmHg]), diastolic pressure (RRd [mmHg]) and heart rate (HR [beats/min]) were determined in finger using non-invasive, compensation method (Portapres). Body weight (BW [kg]) and body height (BH [cm]) were measured and the body mass index (BMI [kg/m^2]) was calculated. Body fat (BF [%]), body fat mass (BFM [kg]), fat-free mass (FFM [kg]), and total body water (TBW [kg]) were determined using electric impedance measurement performed with Analyzer – Tanita TBT 300 (Japan). Basal metabolic rate (BMR [kJ/24h] estimate was calculated by the device.

Results: The highest arterial pressure measured in Group I: RRs: 141.6 ±22.5 mmHg, RRd: 92.0 ±19.5 mmHg, exceeded the cut-off value for normal arterial pressure. The arterial pressure in the two other groups was within range of normality. Correlation between arterial blood pressure and somatic parameters were found for the Group I and when three groups were pooled. In Group I (young subjects) RRs positively correlated with following parameters strongly and significantly (in order of strength of correlation): TBW, FFM, BW, BMR, BMI, BF. RRd correlated with these parameters slightly less, and the same order of correlation strength was preserved. For all subjects pooled into one group age correlated negatively with RRd, somatic parameters correlated more strongly with RRd than with RRs, however generally order of correlation strength was retained.

Conclusions: Our results differ from those, which would be predicted on the ground of commonly accepted view: arterial blood pressure was negatively correlated with age and correlated least with the indices of body fat. Our results rise the possibility, that other causes, than those commonly accepted, may be instrumental in causing elevation of arterial blood pressure in young subjects.

Key words: *blood pressure, heart rate, somatic variables*

Introduction

Normal systolic and diastolic arterial blood pressure in a young adult measured on the brachial artery and in recumbent position reaches 120/80 mmHg and gradually increases with age. In the seventh decade of life systolic pressure equals 150-160 mmHg and diastolic 90 mmHg. Age-related increase in diastolic pressure results from increased peripheral vascular resistance whilst the increase in systolic pressure is the consequence of progressive lowering of arterial elasticity (1). In the second half of last century WHO/ISH Commission defined systolic pressure of 140-160 mmHg and diastolic pressure of 90-95 mmHg as cut-off values for hypertension (2). At present, blood pressure of 130/85 is considered borderline of high normal correct pressure, whereas pressure of 140/90 mm Hg is considered borderline for diagnosing hypertension (3). Following the suggestion of the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure (JNC-7) a new term "prehypertension" has been introduced (4), and defined as systolic blood pressure ranging from 120 to 139 mmHg, diastolic ranging from 80 to 89 mmHg, measured at least twice in a sitting position (5). Once even an early prehypertensive stage has been diagnosed lifestyle modifications are recommended so as to prevent further increase in blood pressure and to lower the risk of other diseases of the circulatory system. The gravity of the hypertension prevalence and therapy derives from the fact that 60% of adult Americans have been diagnosed with prehypertension or hypertension. Moreover, in the last decade an approximately 10% increase in the number of hypertensive subjects was observed (6), and the number of people with appropriately monitored arterial hypertension ranges from just several to 30% (7). Over the last few years it has been shown that the number of cardiac events in men aged 45-55 with high-normal pressure (130-139/85-89 mmHg) (8), or prehypertension (120-139/80-89 mmHg) (9) who did not use antihypertensive medicines increased.

An important parameter in the evaluation of functional state of the circulatory system is heart rate. In people with arterial hypertension a considerably higher heart rate is observed as compared with individuals with normal pressure. This is explained by means of increased sympathetic activity and diminished parasympathetic resulting in tachycardia (10,11), which together with increased cardiac output is typical of early hypertension (12). Increased heart rate increases risk for developing hypertension in persons with normal arterial blood pressure blood and increases mortality in patients with arterial hypertension. An increment of heart rate by 10 beats/min is connected with a 14% increase in cardiovascular mortality and a 20% increase in general mortality (13).

Arterial blood pressure correlates with age (14-17) and somatic characteristics: body mass (3), body height (18,19), fat content (20), waist circumference (3,18), fat-free body mass (20) and BMI (14-16,18,21,22,). The aim of this work is to examine systolic and diastolic blood pressure and the heart rate measured at rest and their correlation with somatic parameters of men of various ages.

Material and methods

In the study participated 36 healthy men (mean age, 47.4 ±18.6 years), divided into three age groups: Group I (mean age, 23.9 ±4.2 years); Group II (mean age, 51.7 ±5.5 years; Group III (mean age, 66.5 ±5.7 years). Group I was comprised mainly of students and 4 employees, group II encompassed individuals of a stable financial situation, i.e. scientists and administrative staff, whilst group III was made up largely of pensioners, former scientists, administrative staff and executives, of whom 4 were still professionally active. All participants consented to the experiment approved by the Bioethics Committee of the Medical Academy in Warsaw. Patient history prior to the examination revealed that none of the participants was diagnosed hypertensive or subjected to antihypertensive therapy. Detailed anthropometric profile of the groups is presented in Table 1.

The examination was performed in the afternoon, three hours after the last meal, starting from a 10-min rest in a sitting position ensuring physical and mental comfort. Subsequently systolic pressure (RRs [mmHg]), diastolic pressure (RRd [mmHg]) and heart rate (HR [b/min]) were measured on a finger in a continuous, non-invasive manner with the compensation method (Portapres). Values of these parameters were calculated as 1 min averages. Body weight (BW [kg]) and body height (BH [cm]) were measured and the body mass index (BMI [kg/m^2]) was calculated. Body fat (BF [%]), body fat mass (BFM [kg]), fat-free mass (FFM [kg]), and total body water (TBW [kg]) were determined using electric impedance measurement performed with Analyzer – Tanita TBT 300 (Japan). Basal metabolic rate (BMR [kJ/24h] estimate was calculated by the device.

The results were analysed statistically with one-way ANOVA and Tukey's test. Pearson's „r" linear correlation coefficient was calculated. The level of statistical significance was assumed for p<0.05

Results

Findings presented in Table 1 show that Group I was significantly taller than Group III (p<0.05). The estimated basal metabolism was significantly higher in Group I than in Group II (p<0.05) and Group III (p<0.001).

Table 2 presents arterial blood pressure at rest and heart rate. In Group I (the youngest) both systolic and diastolic blood pressure was highest, the difference

Table 1. *Somatic characteristic of subjects*

	n		AGE (years)	BH (cm)	BW (kg)	BMI (kg/m^2)	BMR (kJ)	BF (%)	BFM (kg)	FFM (kg)	TBW **(kg)**
All participants	36	X ±SD	47.4 18.6	176.5 6.9	82.0 12.2	26.3 3.2	7363.6 1050.8	21.2 5.4	17.7 6.4	64.2 7.6	47.0 5.6
Group I	12	x ±SD	23.9^{aaa} 4.2	179.8 6.4	83.9 16.6	25.8 4.1	8207.8^{a} 1050.1	18.1 6.7	16.0 8.7	67.9 8.9	49.7 6.5
Group II	12	x ±SD	51.7^{ccc} 5.5	177.1 6.6	83.0 9.2	26.5 2.6	7313.5 638.4	22.5 3.9	18.9 4.8	64.1 6.2	47.0 4.6
Group III	12	x ±SD	66.5^{bbb} 5.7	172.6^{b} 6.3	79.0 9.9	26.5 3.1	6569.6^{bbb} 731.5	22.8 4.4	18.3 5.3	60.7 6.2	44.5 4.6

Markers of significant between groups: 1-2 – ^{a}; 1-3 – ^{b}, 2-3 – ^{c}
Significant level: ^{a,b,c} p<0.05; ^{aa,bb,cc} p<0.01; ^{aaa,bbb,ccc} p<0.001
BH-body height; BW-body weight; BMI-body mass index; BMR-basal metabolic rate; BF-body fat; BFM-body fat mass; FFM- fat-free mass; TBW-total body water

Table 2. *Resting values of cardiovascular data*

	n		RRs (mmHg)	RRd (mmHg)	HR (b/min)
All participants	36	x ±SD	138.4±18.9	82.6±15.7	73.6±10.8
Group I	12	x ±SD	141.6±22.5	92.0±19.5	75.4±10.5
Group II	12	x ±SD	137.1±18.2	79.0±11.2	73.7±11.6
Group III	12	x ±SD	136.6±16.8	76.7^{b}±11.2	71.7±10.9

Markers of significant between groups: 1-3 – ^{b}
Significant level: ^{b} p<0.05

Table 3. *Values of significant correlations coefficients of „r" Spearman*

	n	RR	AGE	BH	BW	BMI	BMR	BF	FFM	TBW
All participants	36	RRs			0.537^{111}	0.443^{11}	0.461^{11}	0.427^{11}	0.501^{11}	0.501^{11}
		RRd	-0.449^{11}	0.449^{11}	0.537^{111}		0.647^{111}		0.643^{111}	0.641^{111}
Group I	12	RRs			0.727^{11}	0.639^{11}	0.699^{11}	0.587^{1}	0.782^{11}	0.784^{11}
		RRd			0.669^{11}	0.598^{1}	0.638^{11}		0.710^{11}	0.723^{11}

Significant level: ^{1} – p<0.05; ^{11} – p<0.01; ^{111}– p<0.001

between diastolic pressure in groups I and III was statistically significant (p<0.05).

Table 3 shows „r" coefficients of linear correlation between systolic and diastolic pressure at rest and somatic parameters described in methods, only if the correlation was statistically significant. Statistically significant correlations between systolic and diastolic pressure at rest and somatic parameters were found only for all subjects pooled together and for Group I, hence only coefficients related to these groups are shown in Table 3. Heart rate did not correlate with any somatic parameter, therefore relevant data are not presented.

Discussion

Mean heart rate in young adults equals 72 beats per minute (1); heart rate at rest in our study was within physiological norm. Sympathetic activity increases with age (24); however mean heart rate did not differentiate the three studied age groups. Similar observations are made by Baldi et al. (23). Normal heart rate despite elevated blood pressure seems may be surprising as it has been shown that in cases of primary hypertension the level of activity in sympathetic fibres aiming at blood vessels is increased (24) and heart rate at rest is elevated (17,24). Furthermore, it was observed that overweight and obesity may increase heart rate at rest (20,22,25). Our study did not show a significant correlation between heart rate at rest and body mass and body fat.

Average systolic pressure at rest of all subjects was 138.4 ±18.9 mmHg, and average diastolic was 82.6 ±15.7 mmHg, (Table 2). Following the current classification these values were within high normal pressure (26) or indicated prehypertension (6). High values of standard deviation suggest however, that among the participants there were individuals with cut-off pressure or hypertension. Table 2 confirms these reasoning: average systolic and diastolic pressure exceeded 140 mmHg and 90 mmHg in Group I, thus were above cut-off values for hypertension. The study results indicating that blood pressure in the youngest group was elevated as compared to the normal values, and what is more, as compared to the older participants, remain at odds with the standard belief that blood pressure increases with age (14-16). This unusual correlation between blood pressure and age in our study was confirmed by statistically significant negative correlation between diastolic blood pressure and age calculated for all participants collectively. No increase in arterial blood pressure with age was noted by Baldi et al. (23)**,** they did not observe differences in systolic and diastolic blood pressure both in recumbent and upright position between the group of older (x=69.8 ±4.2 years) and younger (x=35.1 ±7.0 years) men who did not differ with regard to body mass and BMI, although body fat in the older group was significantly higher than in younger men (p<0.01). Beside reversed correlation between age and arterial blood pressure, our study revealed also unexpected order in the strength of correlation between arterial blood pressure and somatic parameters. One expects, based on literature evidences, strongest correlation between arterial blood pressure and BMI (14-16,19-22,27,28), BF (22,27,29,30), BW (22,27,29,31), BH (29) and FFM (20,29). Correlation between arterial blood pressure and somatic parameters were found in this study for the Group I and when three groups were pooled. In Group I (young subjects) RRs positively correlated with following parameters strongly and significantly (in order of strength of correlation): TBW, FFM, BW, BMR, BMI, BF. RRd correlated with these parameters slightly less, and the same order of correlation strength was preserved. For all subjects pooled into one, somatic parameters correlated more strongly with RRd than with RRs, however generally order of correlation strength was retained. It is conceivable, that correlation observed for all subjects pooled in one group were due mainly to correlation present in Group I, as no significant correlation was found in Group II and III.

The elevated arterial blood pressure in group of youngest subjects, the reverse order in correlation strength between arterial blood pressure and somatic parameters in this group, with TBW most strongly correlating with arterial blood pressure, rise the possibility, that other causes, than those commonly accepted, may be instrumental in causing elevation of arterial blood pressure in young subjects. The latter correlation, between arterial blood pressure and total body water present for all groups collectively and in group I may be explained by Lohmeier's observations (32), who noticed a connection between increased water retention and elevated arterial blood pressure. Importantly, mild hypertension observed in youngest group should not be qualified as hyperkinetic, as heart rate neither correlated with age nor with arterial blood pressure.

The presence of elevated arterial blood pressure in the group of youngest men in our study suggests that large scale research is warranted aiming at determining the real scale of this phenomenon in young population and at finding its cause. Drukteinis et al. (33) postulate such research among American population. It is a significant issue as it concern individuals living in the industrialised part of the globe where elevated arterial blood pressure has become a pandemic leading to structural changes and functional disorders to the circulatory system already in teenagers and young adults.

Our findings of elevated arterial blood pressure in young adults and normal values in the older groups remain at odds with current views claiming that hypertension affects mainly older people. Further research on a larger group is needed, with particular emphasis on obtaining information that may disclose the cause of the problem.

Conclusions

Based on the data obtained in this study the following conclusions have been drawn:

1. Mean arterial blood pressure in the youngest group of studied men was elevated and exceeded cut-off values for hypertension, in older individuals the pressure remained within normal range.
2. The reverse order in correlation strength between arterial blood pressure and somatic parameters in this group, with TBW most strongly correlating with arterial blood pressure, rise the possibility, that other causes, than those commonly accepted, may be instrumental in causing elevation of arterial blood pressure in young subjects.
3. Lack of correlation between heart rate and age as well as somatic parameters speaks against, though does not excludes, hyperkinetic type of hypertension in young subjects.

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