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Blood pressure relation to body composition and age: Analysis of a nurse-led investigation and consultation program

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Background: Blood pressure (BP) increases with age and obesity. We have assessed the relative contribution of age and fatness to BP regulation in a healthy population investigated by nurse practitioners.

Material/Methods: Preventive investigation and counseling was offered at the entrance hall of the regional authority's office in the town of Nitra by 2 nursing specialists who investigated 120 men and 276 women. In men the mean body mass index (BMI) was 26.8 kg/m², mean weight was 84.4 kg, mean fat percentage was 23.3, mean age was 46.1 years, mean systolic BP was 133.1 mmHg, and mean diastolic BP was 82.5 mmHg. In women the mean BMI was 24.8 kg/m², mean weight was 67.3 kg, mean fat percentage was 29.4, mean age was 45.4 years, mean systolic BP was 127.7 mmHg, and mean diastolic BP was 78.5 mmHg. Correlation analysis was performed and in multiple regression analysis we used BP values as the dependent variable and fat percentage and age as independent variables. Normality of variables distribution was checked and found satisfactorily.

Results: Most of the subjects had an untreated component of metabolic syndrome. There was a correlation between BP values, age, and percent body fat. BP was regulated only to a certain degree by fatness and age, with the influence being relatively small. Our results showed that BP was more influenced by fatness than age, and body fatness was more related to higher systolic than to diastolic BP.

Conclusions: Age and fatness could explain BP values by only 3–30%, although BP was more influenced by fatness than by age. Nurse practitioners can effectively detect and motivate people with metabolic syndrome.

Key words: **body mass index • body fat • blood pressure • ageing**

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Background

Evaluating the presence of metabolic syndrome components in a healthy population is not easy because it is difficult to find a reasonably defined healthy population. Nurse specialists can design and perform such studies. Essential hypertension is an important disease with a great impact on the mortality and morbidity of all populations. The precise pathogenesis of this common type of hypertension is still unresolved. The role of genetic factors is very likely, but the most important causality is its relation to metabolic syndrome including obesity [1]. It is known that blood pressure typically increases with age and obesity [2,3]. In the present study, we have, therefore, assessed in more detail the relative contribution of age and fatness to blood pressure regulation in a healthy population.

Material and Methods

We have investigated a sample of 120 men and 276 women in a relatively non-selected population. The subjects visited the office of the regional authority in the town of Nitra, Slovakia, for non-medical reasons. At the entrance hall nursing specialists offered them a basic preventive exam that included a blood pressure measurement, measurement of percentage of body fat content, and weight and height measurements. Body mass index (BMI) was calculated. Percentage of body fat was measured bimanually using an OMRON 306 device. Blood pressure was measured 3 times during 90 seconds using a classical mercury sphygmomanometer and the mean value was calculated. Subjects who were treated for hypertension, cardiovascular or other severe disease including diabetes were not included in the final calculation. Since the aim of the study was to investigate the presence of obesity and hypertension in younger and older adults and the role of age and fatness on blood pressure regulation, we have grouped subjects into two main categories: below and above the age of 40.

The NCCS 2007 program [4] was used for statistical calculations. Mean values of BMI, weight, height, fat percentage, age, and systolic and diastolic blood pressure were calculated. Pearson's correlation coefficients were calculated in both samples after confirmation of normality. According to the interdependence of anthropometric variables, we have used only fat percentage and age in the regression analysis.

The protocol of this study was approved by the ethics committee of Nitra Faculty Hospital and all participants signed an informed consent.

Results

Means and standard deviations of variables are shown in Table 1. Mean value of BMI in men was found to be in the lower range of overweight and in women in upper range of normal. The percentage of fat was slightly above normal in men and in the upper range of normal in women – normal 20% and 30%, respectively, according to Jaffrin [5]. Mean age was comparable in men and women (approximately 45 years). Mean blood pressure was in the normal range in women and in the upper normal range in men [6].

Correlation analysis is shown in Table 2. In both men and women, significant correlation of systolic and diastolic blood pressure was found with weight, BMI, fat percentage, and age. No significant correlation of blood pressure to height was found. In both men and women a negative correlation of height and age was present as a typical secular trend, as was a negative correlation of fat percentage with height.

In multiple regression analysis we used blood pressure values as the dependent variable and fat percentage and age as independent variables. The following models were obtained:

Table 1. Basic sample characteristics – men.

Variable	Count	Mean	Standard deviation
BMI	120	26.8	3.9
Weight [kg]	120	84.4	13.2
Fat percentage	120	23.3	7.0
Age [years]	120	46.1	16.6
Height [cm]	120	176.9	7.6
BPs [mmHg]	120	133.1	17.0
BPd [mmHg]	120	82.5	11.6

BMI – Body Mass Index [kg/m^2]; Fat percentage – percentage of total body fat [%]; BPs – systolic blood pressure; BPd – diastolic blood pressure.

Table 2. Basic sample characteristics – women.

Variable	Count	Mean	Standard deviation
BMI	276	24.8	4.6
Weight [kg]	276	67.3	12.8
Fat percentage	276	29.4	8.3
Age [years]	276	45.4	15.4
Height [cm]	276	164.7	6.1
BPs [mmHg]	276	127.7	17.5
BPd [mmHg]	276	78.5	10.6

BMI – Body Mass Index [kg/m²]; Fat percentage – percentage of total body fat [%]; BPs – systolic blood pressure; BPd – diastolic blood pressure.

Women:

Blood pressure systolic = 100.13 + 0.332 × fat percentage + 0.365 × age

Blood pressure diastolic = 65.56 + 0.214 × fat percentage + 0.141 × age

Men:

Blood pressure systolic = 112.15 + 0.89 × fat percentage – 0.003 × age

Blood pressure diastolic = 73.87 + 0.27 × fat percentage + 0.045 × age

40 years of age and less:

Women:

Blood pressure systolic = 99.55 + 0.417 × fat percentage + 0.352 × age

Blood pressure diastolic = 61.93 + 0.205 × fat percentage + 0.267 × age

Men:

Blood pressure systolic = 103.72 + 0.994 × fat percentage + 0.295 × age

Blood pressure diastolic = 69.28 + 0.313 × fat percentage + 0.207 × age

Above 40 years of age:

Women:

Blood pressure systolic = 89.92 + 0.333 × fat percentage + 0.549 × age

Blood pressure diastolic = 71.35 + 0.204 × fat percentage + 0.045 × age

Men:

Blood pressure systolic = 101.24 + 0.952 × fat percentage + 0.148 × age

Blood pressure diastolic = 72.53 + 0.294 × fat percentage + 0.056 × age

Validity of the calculated models (Tables 3 and 4) is low for diastolic pressure, especially in the age 40 and over group

(Table 5) (R² below 10% is low by convention according to Cohen 2002 and Hendl 2009 [7]).

Discussion

It is very difficult to find a well-defined healthy population. Using blood donors, volunteers, or sports participants does not include a sample typical for all aspects of healthy populations. Nurse practitioners usually offer preventive and educational health services in schools, sport matches, and social and cultural events. Our sample formed by visitors of the regional authority (excluding persons already treated for hypertension or other serious diseases) is perhaps a very typical sample of healthy people of all ages.

Hypertension is a disease with increasing prevalence in obese and older people [8–10]. However, results of our study based on a large population of healthy subjects only partially confirmed such previous findings.

First, we showed that there was a correlation between blood pressure values and age and fatness. Specifically, we showed that blood pressure was regulated only to a certain degree by fatness and age, with the influence being relatively small (R² from 2.9% to 29.6% in regression models). Thus, increased age and fatness could explain higher blood pressure values by only 3–30%. Furthermore, our results show that blood pressure was more influenced by fatness than age, and body fatness was more related to higher systolic than to diastolic BP values. However, we found a negative correlation between height and fatness, with shorter subjects more frequently obese than those who were taller. One explanation could be that the large overnutrition that is present in most populations these days is more harmful for those who are short.

Elkhalifa [11] found in a similar sample of a healthy population that hypertension is influenced by 3 factors: diabetes, age, and

Table 3. Correlation Report 276 women (Pearson Correlations and significance levels p).

	Age	Weight	Height	FatPercentage	BPs	BPd	BMI
Age	1.00	0.36	-0.23	0.63	0.46	0.33	0.44
p	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Weight	0.36	1.00	0.20	0.73	0.37	0.36	0.91
p	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Height	-0.23	0.20	1.00	-0.25	-0.00	0.02	-0.16
p	0.00	0.00	0.00	0.00	0.93	0.62	0.00
Fat percentage	0.63	0.73	-0.25	1.00	0.39	0.32	0.81
p	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BPs	0.46	0.37	-0.00	0.39	1.00	0.70	0.37
p	0.00	0.00	0.93	0.00	0.00	0.00	0.00
BPd	0.33	0.36	0.02	0.32	0.70	1.00	0.35
p	0.00	0.00	0.62	0.00	0.00	0.00	0.00
BMI	0.44	0.91	-0.16	0.81	0.37	0.35	1.00
p	0.00	0.00	0.00	0.00	0.00	0.00	0.00

BMI – Body Mass Index [kg/m²]; Fat percentage – percentage of total body fat [%]; BPs – systolic blood pressure; BPd – diastolic blood pressure; p – p-value. Age was calculated in years. Weight was calculated in kg. Height was calculated in cm.

Table 4. Correlation Report 120 men (Pearson Correlations and significance levels p).

	Age	Weight	Height	FatPercentage	BPs	BPd	BMI
Age	1.00	-0.09	-0.28	0.38	0.16	0.16	0.64
p	0.00	0.31	0.00	0.00	0.07	0.06	0.48
Weight	-0.09	1.00	0.38	0.50	0.37	0.30	0.81
p	0.31	0.00	0.00	0.00	0.00	0.00	0.00
Height	-0.28	0.38	1.00	-0.28	0.03	0.13	-0.20
p	0.00	0.00	0.00	0.00	0.67	0.15	0.02
Fat percentage	0.38	0.50	-0.28	1.00	0.38	0.22	0.69
p	0.00	0.00	0.00	0.00	0.00	0.01	0.00
BPs	0.16	0.37	0.03	0.38	1.00	0.70	0.37
p	0.07	0.00	0.67	0.00	0.00	0.00	0.00
BPd	0.16	0.30	0.13	0.22	0.70	1.00	0.23
p	0.06	0.00	0.15	0.01	0.00	0.00	0.00
BMI	0.06	0.81	-0.20	0.69	0.37	0.23	1.00
p	0.48	0.00	0.02	0.00	0.00	0.00	0.00

BMI – Body Mass Index [kg/m²]; Fat percentage – percentage of total body fat [%]; BPs – systolic blood pressure; BPd – diastolic blood pressure; p – p-value. Age was calculated in years. Weight was calculated in kg. Height was calculated in cm.

Table 5. Validity of models R² a significance p of regression coefficients.

	Women						Men					
	BP _{syst}			BP _{diast}			BP _{syst}			BP _{diast}		
	All	<40	40≤	All	<40	40≤	All	<40	40≤	All	<40	40≤
R ² %	26.1	14.7	15.3	13.3	9.5	2.9	18.3	29.6	14.6	6.7	10.8	3.7
%F	0.00	0.03	0.04	0.01	0.19	0.06	0.00	0.00	0.00	0.03	0.06	0.13
Age	0.00	0.03	0.00	0.00	0.04	0.59	0.96	0.27	0.41	0.40	0.24	0.64

R²% – coefficient of determination; BP_{syst} – systolic blood pressure; BP_{diast} – diastolic blood pressure; <40 – age less than 40 years; 40≤ – age of 40 years or more; %F – fat percentage (%). Age was calculated in years. Blood pressure was calculated in mm Hg.

obesity. The influence of socioeconomic factors and stress on hypertension could be important in an adult population [12].

Blood pressure can be influenced from 65% to 75% [13] by various factors related closely to the degree of fatness (e.g., high sympathetic tonus; sodium retention; hormonal levels like renin, angiotensinogen, angiotensin II, aldosterone and leptin; subclinical inflammation; and insulin resistance [14]. Furthermore, low levels of adipose tissue hormones could also play an important role, as demonstrated previously [15]. Low levels of adiponectin [16] and ghrelin are linked to obesity [17].

It is very well known that arterial hypertension is more common in people with type 2 diabetes, especially the isolated systolic hypertension. In people with diabetes, higher blood pressure is more common in women, and in diabetic women there is a higher correlation between age and blood pressure [18]; therefore, we excluded diabetic populations. In postmenopausal women, blood pressure is more dependent on the duration of menopause than on age [19]. We have not registered data about menopause in our sample, but some differences in the 2 groups of women below 40 years and over 40 years could be explained by menopause.

Many sociological factors could influence the prevalence of hypertension, like low education and alcoholism [20]. The importance of these factors is decreasing [21].

As for epidemiological and biological factors, the presence of metabolic syndrome components is very predictive for hypertension [22]. One biological factor that is very important is low birth weight; the influence of low birth weight on hypertension increases with age [23]. Blood pressure variability is also very predictive for later hypertension [24]. Another very important factor for hypertension is arterial stiffness [2].

The risk of hypertension in obese people is 2 times higher than in non-obese people [25]. Etiologically, cross-talk between vessels and adipose tissue could be very important [26].

Conclusions

The present study suggests that percent body fat is a better predictor of blood pressure regulation than is age. Nevertheless, age is a relatively good predictor of systolic and diastolic blood pressure, more so in women than in men. Nurse practitioners can effectively detect and motivate persons with components of metabolic syndrome. This strategy is very important because the majority of the supposed healthy population had an untreated component of metabolic syndrome (overweight, obesity, and hypertension).

Statement

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