



Research Article

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Which Anthropometric Indices has stronger Correlation with Blood Pressure among 14-17 Year Old Girls?

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Abstract

Background: Hypertension is a chronic non-communicable disease becoming epidemic in recent decades. Studies show this disease is more prevalent among overweight, obese, and sedentary people. The purpose of this study was to examine which selected body composition indices have a stronger correlation with hypertension deals. **Methods:** 510 female students (Age: 15.36 ± 0.94 years, height: 160.18 ± 6.28 cm, and weight: 55.73 ± 10.35 kg) of the city of Khoy aged 14-17 years, were selected randomly. Body Mass Index (BMI), waist circumference (WC), waist to hip ratio (WHR), waist to stature ratio (WSR), body fat percent (BF%), as well as systolic, diastolic, and mean blood pressure were measured using standard methods. **Results:** There was a significant positive correlation between BMI, BF%, and WC with all blood pressure indices ($P < 0.05$). WSR showed significant correlation with systolic and mean blood pressure, whereas WHR has just significant correlation with systolic blood pressure ($p < 0.05$). **Conclusion:** The overall results showed BMI and WHR had strongest and weakest correlation with hypertension indices in 14-17 year old females, respectively.

Keywords: BMI, WC, WSR, WHR, BF%, Blood pressure.

INTRODUCTION

Due to urbanization, industrialization of societies, increased economic growth and the globalization of the market, rapid changes have been made in the diet and lifestyle patterns of people [1]. Low mobility in the workplace, urbanization, use of vehicles, improper physical activity and lower energy consumption have reduced physical activity and led to an increase in the prevalence of obesity and an increase in lifestyle diseases among people [2]. Overweight and obesity is an obstacle to physical, psychological and social health and cause serious illnesses and disorders [3]. Obesity has now been set as a global crisis, and in many countries, as well as families, there is a huge cost to reduce the prevalence of obesity and the treatment of related diseases. Studies have shown that in developed and developing countries, 25% of children aged 6 to 14 are overweight in the range of 11 to 29% [4]. Overweight and obesity among children and adolescents in Iran are also increasing, and their relationship with lifestyle, especially lack of mobility, has been shown [2]. To evaluate the anthropometric of obesity and overweight, various anthropometric indices have been introduced to predict the risk of cardiovascular disease, the most common of which is the BMI as an indicator recommended by the World Health Organization (WHO), which causes general obesity in the body [5]. Although BMI has been studied more than other indicators in relation to the risk of chronic diseases and its consequences for health, there are some limitations that affect its use. For example, the BMI does not provide information on the distribution of fat in the body. Some studies have shown that lipid distribution patterns in the body have a more decisive role in identifying disease risk factors [6]. Other indicators that are most commonly used to distribute fat in the body are Waist Circumference (WC), Waist to Hip ratio (WHR), Waist to Height (WSR), and Body Fat Percentage (BF%). These indicators are considered useful indicators in relation to the prediction of health problems associated with obesity and are not complicated and easily measurable in comparison with other methods, such as underwater densitometry, computer tomography, and so on [5]. On the other hand, hypertension, which is one of the most important complications of obesity and overweight, is one of the main problems in the field of health [7].

According to statistics, roughly half of the heart and brain strokes occur due to hypertension, and one out of every eight deaths worldwide occurs, due to hypertension [8]. Studies have shown that hypertension in

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overweight young people is twice as high and in elderly people 50% more than those with normal weight [9]. Studies also show that there is a significant relationship between blood pressure and the above mentioned anthropometric indices [10-12]. However, the results are inconsistent in which of the indicators are more correlated with blood pressure. Therefore, the main purpose of this study was to examine the correlation between blood pressure and some anthropometric indices and to introduce the best indices among adolescents aged 14 to 17 years.

METHODS

The present study is a descriptive, analytical, and survey study that was performed to determine the correlation between BMI, BF%, WC, WHR and WSR with systolic, diastolic and mean arterial blood pressure. The statistical population of the present study included all female students aged 14-17 years old in Khoy city in the academic year of 2014-2015, of which 510 students were selected using cluster random sampling. At first, a number of secondary schools were randomly selected. Then from selected schools, classes, and subjects were randomly selected. All these steps were taken after coordination with the education organization and obtaining written permission from the organization's security. Medical records of volunteers were collected from the medical students' information form at the school. Before submitting consent to the candidates for the purpose of participating in this research, the purpose and potential risks and the points that should be followed to participate in this research are described in writing and verbally.

A briefing was held with the attendance of students' parents, and consent informed was obtained from them. All those who did not want to participate in the project were removed from the study and others were randomly replaced. In the next step, the necessary information including height, weight, waist circumference and hip circumference, measurements of subcutaneous fat thickness were collected. Also, student blood pressure measurements were measured with standard

barometer from the right arm. The predictor variables in this study included BMI, WC, WSR, WHR and BF%, which were measured and estimated using standard methods. Valid variables were systolic blood pressure, diastolic blood pressure, and mean arterial pressure. The age of the subjects was determined on the basis of the birth date and year using the School Statistics Office. A standard gauge was used to measure height and a tape measure was used to measure the waist and hip circumference. The Fat% was measured and evaluated by the Calipers Lange method using a three-point Jackson-Pollack method [13]. The weight measured by German marker SKA scale with a precision of 100 g. Systolic and diastolic blood pressure were measured by Richter mercury barometric device made in Germany.

The collected data were analyzed using SPSS software version 21 at two descriptive and inferential levels. After assuring the natural distribution of the data by the Kolmogorov-Smirnov test, in the analytical section, the correlation of each of the indices with systolic, diastolic and mean arterial blood pressure was analyzed separately using Pearson correlation formula. The significance level was considered as $P < 0.05$.

RESULTS

Table 1 contains descriptive information on anthropometric indices and information on blood pressure in the subjects. Table 2 shows the relationship between anthropometric indices and blood pressure. According to Table 2, in the present study, the strongest correlations with hypertension are BMI, BF%, WC, WSR and WHR, respectively. All three types of blood pressure (systolic, diastolic and mean arterial) showed a significant correlation with BMI, BF%, and WC in the highest values ($P < 0.05$). Furthermore, WSR showed a significant correlation with systolic and mean arterial pressure and WHR with systolic blood pressure.

Table1: Physical and physiological indices of subjects

Variables	Mean	SD
Age (year)	15.36	0.944
Height (cm)	160.18	6.28
Weight (kg)	55.73	10.35
BMI (kg.cm ⁻²)	21.62	3.61
WC (cm)	69.42	7.94
WHR	0.762	0.05
VO ₂ max (ml.kg ⁻¹ .min ⁻¹)	39.86	2.93
BF%	27.11	6.91
WSR	0.43	0.05
Systolic Blood Pressure (mmHg)	114.78	13.11
Diastolic Blood Pressure (mmHg)	66.17	11.05
Mean Blood Pressure (mmHg)	82.32	10.42

DISCUSSION

The aim of this study was to evaluate the status of blood pressure and determine the best anthropometric indices related to blood pressure in adolescent girls aged 14 to 17 years. Several studies have been conducted to determine the best anthropometric index for screening the risks of chronic diseases, including blood pressure, which often indicates a correlation between cardiovascular risk factors and anthropometric indices. Among these studies, BMI is one of the most commonly reported cases. In the present study, we also observed a high correlation between BMI and all three systolic, diastolic and mean

arterial blood pressure indicators (Table 2). In line with this study, Song (2010) states that in Korean adolescents, BMI has a positive and significant relationship with normal weight and overweight with normal blood pressure and high blood pressure, respectively [14]. Moreover, Dua (2014) studies with adults aged 18 to 50 years, stating that gender differences in blood pressure during puberty are recognizable and stabilized in adolescence; there is a positive and significant correlation between BMI and systolic and diastolic blood pressure is confirmed. Of course, in all ethnic groups studied in this study, men tended to have a lower-than-antihypertensive effect than women [15]. In confirmation of these findings, Lyngdoh (2013) in a

Table 2: Correlation of anthropometric indices with blood pressure indices

	The Variables	The Correlation coefficient	The Significance Level
BMI relationship with:	Systolic Blood Pressure (mmHg)	0.30	0.001
	Diastolic Blood Pressure (mmHg)	0.22	0.001
	Mean Blood Pressure (mmHg)	0.26	0.001
BF% relationship with:	Systolic Blood Pressure (mmHg)	0.25	0.001
	Diastolic Blood Pressure (mmHg)	0.01	0.001
	Mean Blood Pressure (mmHg)	0.02	0.001
WC relationship with:	Systolic Blood Pressure (mmHg)	0.24	0.001
	Diastolic Blood Pressure (mmHg)	0.11	0.013
	Mean Blood Pressure (mmHg)	0.18	0.001
WSR relationship with:	Systolic Blood Pressure (mmHg)	0.16	0.001
	Diastolic Blood Pressure (mmHg)	0.04	0.236
	Mean Blood Pressure (mmHg)	0.11	0.018
WHR relationship with:	Systolic Blood Pressure (mmHg)	0.13	0.003
	Diastolic Blood Pressure (mmHg)	0.03	0.549
	Mean Blood Pressure (mmHg)	0.08	0.069

Table 2: Correlation of anthropometric indices with blood pressure indices longitudinal and cross-sectional study of 390 subjects 12 up to 15 African-Americans and BMI measurements at a specific time (cross-sectional study) and follow-up studies at the age of 19 to 20 (longitudinal study) concluded that in both models, BMI was strongly associated with cardiovascular risk factors and added that the odds of hypertension in overweight individuals are higher than those with a moderate BMI at a specific age [16]. In general, despite a small number of studies, most studies have confirmed the positive and significant correlation between BMI and hypertension.

Equivalent to the BMI, many investigators have unanimously identified the high BF as one of the most reliable and accurate indicators of obesity and overweight in different ethnicities in both sexes. Considering the relationship between obesity and cardiovascular risk factors, including high blood pressure, it can be predicted that BF% has the highest correlation between blood pressure anthropometric indices. Although a more accurate estimate of body fat may provide more information on the extent of risk factors, studies have shown that the difference between BMI and total fat subcutaneous fat mass loss is relatively low compared to subcutaneous weighing. In the hypothesis of BF% correlation with hypertension indices in the current study, there was a high correlation between this variable and all three blood pressure indices, which is the same with most studies (Table 2). Dua (2014) in a cross-sectional study on Punjabi ages 18 to 50 with the aim of examining blood pressure and body mass indices for overweight and obesity and high blood pressure in adults concluded women's BF and BMI are higher than men and there is a strong, positive, and significant correlation between BF% and systolic and diastolic blood pressure in both genders. He stated that the probability of having relatively high blood pressure in overweight and obese people is higher than those with normal BMI; it is concluded that the importance of BF% and BMI for the estimation of risk factors for cardiovascular disease, especially with regard to the relationship Positive to their high blood pressure is high [15]. Furthermore, Friedman (2009) in his studies on BF% and BMI of 6866 students aged 5 to 17 years, said that although the differences observed between BMI and BF % is not generally significant, but BMI often has a stronger correlation with BF% with cardiovascular and metabolic risk factors [17], which is in line with the results of the present study.

Regarding correlation of WC with blood pressure, the results of this study indicate that WC in this age group such as BMI and BF% has high correlation with systolic, diastolic and hypertensive blood pressure

(Table 2). Many researchers have considered WC to be one of the best indicators in determining obesity and overweight [18]. Ying-xiu (2014) investigated blood pressure indices in children and adolescents with more natural WCs in a large population of 38826 with a group. The age range of 7 to 17 years of age from Shandong, China concluded that in all age groups and in both sexes, the prevalence of hypertension in individuals with high WC and normal weight was more significant than those with WC and normal weight [19]. Zhang (2013) studied 6895 subjects aged 7 to 17 years found BMI, WC and WSR had a positive correlation with systolic and diastolic blood pressure, but the strongest correlation was with WC [20]. He also pointed out in another unique study (2014) the effect of the combination of BMI and WC. He studied 38,822 people between the ages of 7 and 17, taking into account the BMI for measuring general obesity and WC for central obesity, with the goal that obesity is a major cause of elevated blood pressure in children and adolescents, by dividing people in three groups of general obesity, central obesity and combined obesity. It was concluded that in both sexes the prevalence of hypertension was relatively high in all three groups, but in the combined group, these complications were the highest in comparison to the other two groups. In other words, the WC index combined with BMI was considered as a better tool for prediction and screening of high blood pressure [21]. In sum, most researchers have found that BMI and WC with a high correlation coefficient may be in place of each other. The results of this study are very similar to this opinion, although in the present study BMI showed a higher correlation coefficient with three types of blood pressure than WC.

Regarding the WSR index, it should be noted that this index can be one of the best indicators of cardiovascular, blood pressure, and also visceral and abdominal fat index. This indicator, in view of the fact that height in adulthood is constant, can indicate changes in obesity over time with changes in WC [22]. In the present study, the correlation between WSR and systolic and mean blood pressure is positive and significant, and this relationship with pressure systolic blood was much more potent, although there was no significant relationship with diastolic blood pressure (Table 2). Zhang (2014) concluded that there is a positive and significant correlation between increased systolic and diastolic blood pressure with increasing WSR in both sexes [21], which is not consistent with the present study. Also, in another study conducted on 2895 Chinese-adult Hong Kong, the results indicate that among the 11 cardiovascular risk factors, WSR has the strongest correlation with blood pressure in both sexes [20]. This study is not

consistent with the results of the present study, because in this study, the highest correlation was found between BMI and BF%.

In relation to the WHR, the WHR's specific feature, which measures the ratio of the two waist and pelvic circumferences, and in view of the fact that these two sizes are both modifiable, in most cases, the results are not properly interpretable. For example, if the weight of someone doubles, WHR stays constant due to the increase in the waist and hip. Another point about this indicator is that most people are aware of their waist, while they are unaware of their hips or are not aware of their importance in their health. For this reason, WHR has been reported as a predictor of cardiovascular risk factors, including low blood pressure, in hypertensive society [23]. In this study, this index correlates with systolic blood pressure, but with two other indicators of hypertension. Significant correlation does not show that, in comparison with other indicators, the weakest correlation is considered (Table 2). Results of some researches contradict the results of this research. For example, in a cross-sectional study of 16 different groups of 9095 men and 11732 women aged 35-74 from different ethnic groups in Asia, it was found that hypercholesterolemia in men after BMI had the strongest correlation with WHR ($P < 0.001$), and in women, the strongest relationship was with BMI and then with other indices such as WHR ($P < 0.001$), WSR ($P < 0.01$), WC ($P < 0.05$) [24]. The differences between WHR and WSR may be attributed to differences in gender, age, genetic, ethnic, racial, cultural, geographical, and so on. Meanwhile, the difference in sample size can be a factor in the outcome.

CONCLUSION

According to the evidence provided in this study, all researchers were in some way in agreement with the correlation between anthropometric indices and the hypertension, but which of them has the stronger correlation, and the results are completely contradictory. These differences can be attributed to differences in gender, genetic, ethnic, racial, cultural, geographic, and so on. However, what is more apparent in these studies is that in most studies BMI and WC show a better relationship with blood pressure indices. However, it seems that a combination of BMI and WC indices has the best relationship with blood pressure and is probably the best predictor of hypertension.

Conflicts of interest

The authors declare no conflicts of interest.

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