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Correlation of body mass index and waist hip ratio on blood pressure in adolescents according to age groups

Virti Kirit Shah[1], Dr. Keerthi Rao[2]
[1] BPT, Department of Paediatric Physiotherapy, Dr. A.P.J. Abdul Kalam College of Physiotherapy, PIMS (DU), Loni, Maharashtra, India
[2] Professor, Dr, A.P.J. Abdul Kalam College of Physiotherapy, Loni, Maharashtra, India

Abstract
Title: Correlation of Body Mass Index and Waist Hip Ratio on Blood Pressure in Adolescents according to age groups.
Background: Obesity is increasing dramatically nowadays in adolescents due to unhealthy diet and sedentary lifestyle. This may lead to various disorders such as hypertension, diabetes mellitus, etc. in their future life. So it is important to prevent them since early age. So this research will help to know the risk factor and also a suitable method to know that.
Aim: This study was conducted to examine the correlation of the body mass index and waist hip ratio on blood pressure in adolescents according to age categories.
Method: Study involved 100 participants (adolescents). Data was obtained by measuring body mass index, waist hip ratio and blood pressure. Data analysis was done according to Karl Pearson co-efficient.
Outcome Measure: Body Mass Index and Waist Hip Circumference.
Result: The average waist-hip ratio was 0.81 in female adolescents and 0.78 in male's adolescents. A total of 71% of the sampling had normal weight, and 82% had normal blood pressure. Both body mass index and waist-hip ratio had an effect on blood pressure, but body mass index in particular had a greater effect**.**
Conclusion: To determine chronic health problems at an early age, it is necessary to follow up with adolescents at health centres and train them at school about healthy lifestyles.

Keywords: adolescents, blood pressure, body mass index, waist hip ratio

1. Introduction

Adolescence is a transitional phase of growth and development between childhood and adulthood involving physical, mental and social changes [1]. According to World Health Organization (WHO) the period between 10-19 years of age is defined as the adolescent period [2]. According to 2014 data from the WHO there are approximately 1.2 billion adolescents in the world.

After the neonatal period, adolescence is the 2nd fastest growth period in which changes occur in height, body weight, bone growth and maturation, muscle tissue and fat tissue and the circulatory and respiratory systems [1]. During this period of changes, emerging patterns of behavior also affect the adolescent's diet and habits [3].

Obesity is known as abnormal or excessive fat accumulation. Anthropometric indices such as Body Mass Index, Waist circumference, Waist Hip Ratio are the most commonly used and important criteria in the clinical determination of obesity [1, 4]. BMI and Waist hip ratio identify subjects as being above or below a certain cut off that denotes obesity risk as well as risk of Blood Pressure [4]. BMI is a valuable expression of the body fat percentile and also a measurement which compares weight and height and defines people as underweight, healthy, overweight and obese [5]. Mathematical formula of BMI is measured by dividing the body weight in kilograms to height square in m.

$$BMI = weight/(height)^2 = kg/m^2$$

BMI categories the standard weight status categories associated with BMI ranges are shown in following table.

Table 1

Weight status	Asian values	WHO values
Underweight	Less than 17.5	Below 18.5
Healthy	17.5-22.9	18.5-24.9
Overweight	23.0-27.9	25.0-29.9
Obese	28 and above	30 and above

Waist hip ratio (WHR) is fat distribution that is associated with metabolic diseases and is used to assess a person's nutritional habits [1]. It is the circumference of the waist divided by the circumference of the hips [6]. The WHO advise that a healthy Waist Hip ratio is 0.85 or less for women and 0.9 or less for men.

The following chart shows how the WHO classify the risk of being affected by weight related health conditions according to Waist Hip ratio.

Table 2

Health risk	Men	Women
Low	0.95 or less	0.8 or lower
Moderate	0.96-1.0	0.81-0.85
High	1.0 or higher	0.85 or higher

The prevalence of Hypertension increases progressively with increasing values of BMI and both the aging process and obesity are known to contribute to Blood Pressure changes during adolescence [7]. Prehypertension children are

at higher risk of developing hypertension in adulthood than normotensive child [8, 9].

The increasing prevalence of obesity in adolescence is a major cause of concern based on the relationship between obesity and other cardiovascular risk factors especially hypertension [8]. It is in the light of this that this study aimed to determine the Body Mass Index and Waist Hip ratio in adolescents and examine their effects on Blood Pressure.

2. Materials and Methods

2.1 Design

The design was experimental study conducted in Pravara Public School, Loni. The study duration was one-time study. The outcome measures were Body Mass Index and Waist Hip Ratio to know the health of the adolescents and then blood pressure was measured. The study was approved (Ref. No. PIMS/CPT/IEC/2018/583) from the Institutional Ethical Committee of Dr. A.P.J. Abdul Kalam College of Physiotherapy, Pravara Rural Hospital. Written informed consent was taken for experimentation with human subjects.

2.2 Participants

Study was done using convenient sampling. 138 participants were screened out of which 100 participants were selected for the study from Pravara Public School, Loni.

3. Procedure

Students will be randomly selected from the age group between 10 and 18 years and will be informed about the research. Consent will be taken from the students who will be willing to participate in the research.

They will be taken into a classroom and will be informed about the research procedure and their questions will be answered to reduce the anxiety. After giving 5 minutes' rest the Blood Pressure will be measured using sphygmomanometer and stethoscope on the right arm and the measurements will be recorded.

Physical measurements (weight, height, waist circumference and hip circumference) are taken using weighing machine and non- elastic measuring tape.

Before performing body weight measure the students are requested to take off his/her heavy clothes like jacket, jumper and shoes. The result observed on the indicator will immediately be recorded in kilograms.

To measure the height, the student will be asked to stand erect in front of the wall. The head, back, hip and heel of student touched to back of the wall and it will be ensured that feet of adolescents are naked and united. Then length from head to the ground will be recorded after measurement.

Waist and Hip circumference are measured when balance on both legs are equal. While performing this measurement the arms are located on both sides and over the thinnest cloth. Waist circumference will be measured at the umbilicus level and hip circumference is recorded by measuring the maximum circumference passing through buttocks. Then the BMI and Waist Hip ratio will be calculated.

4. Statistical Analysis

Correlation of body mass index and waist hip ratio on blood pressure.

Table 3

	%	BMI	Systolic	Diastolic
Underweight	4	16	110	70
Healthy	71	21	120	80
Overweight	18	25.5	140	90
Obese	8	30	150	100

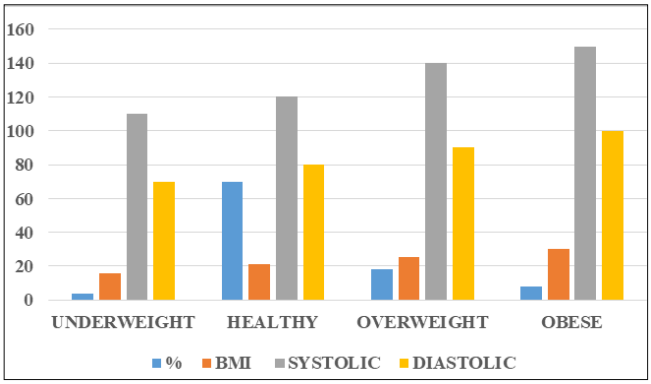

Fig 1

5. Results

In total, 17% of the adolescents were girls and 83% were boys. The average age was 13 years and the adolescents were from 6th grade to 10th grade.

In total, 70% of adolescents had normal weight, 4% were underweight, 18% were overweight and 8% were obese.

The average BMI for underweight children was 16kg/m^2, for healthy was 21kg/m^2, for overweight was 25.5kg/m^2, and for obese was 30kg/m^2.

The average waist circumference was 78.47 cm for girls and 91.26 cm for boys, the average hip circumference was 95.64 cm for girls and 109.44 cm for boys, and the average WHR was 0.81 for girls and 0.78 for boys.

The systolic BP of 88% and the diastolic BP of 81% of the adolescents were determined to be normal. When systolic and diastolic BP were assessed together, 82% of the adolescents had normal BP values.

The Karl Pearson correlation co-efficient(r) for BMI and WHR is 0.1737 that means they have positive correlation with each other meaning if one quantity increases the other will also increase.

6. Discussion

Childhood obesity is one of the most important public health problems of the 21st century and is also increasing at an alarming rate. More than 10% of children and adolescents between 10-18 years of age are overweight or obese. Obesity is the prime risk factor for CVD. Obesity is also linked with hypertension [19]. If the adolescents are diagnosed with these diseases in early age their adulthood will not be that productive as it should be. So it is very important to check for the risk factors during adolescence and to prevent them so their future life is disease free and productive as it should be.

Furthermore, as a result of assessment of BMI, 4% of the adolescents in this study were underweight. Studies of blood pressure on adolescents in India have reported rates of hypertension are 4.5% and 3.5% [1, 2]. The risk factors attributed to BMI are cardiovascular risk factors such as

hypertension and metabolic disorders such as diabetes mellitus. It is due to sedentary lifestyle and unhealthy eating habits. The prevalence of hypertension in adolescence, which is one of the most important causes of mortality and morbidity is 1% -3% in adolescence and is lower than the prevalence of hypertension in adulthood, but in recent years the prevalence of hypertension in childhood has gradually increased.

In this study, the average waist circumference was 91.26cm for boys and 78.47cm for girls and the average hip circumference was 109.44 cm for boys and 95.64 cm for girls. The results we found are similar to the findings of other studies [2]. Waist circumference is an important determinant of accumulation of abdominal fat, which, particularly in the abdominal area is a risk in terms of insulin resistance and the development of cardiovascular diseases such as hypertension.

In this evaluation, WHR greater than 0.8 in female individuals and greater than 1.0 in male individuals indicates a risk of abdominal obesity and chronic illness. When the results of this study were assessed according to the above criteria, the WHR in girls is close to the risk value and the boys had values below the risk value. It may have negative health consequences such as type 2 diabetes mellitus, hypertension, insulin resistance and other cardiovascular diseases. It is due to physical inactivity and high calorie diet.

In this study, we also found that there was significant positive correlation between BMI and WHR with blood pressure. Increased BMI and WHR may be one of the reasons for increased blood pressure. It was also found that obese students were prone to develop hypertension in their adult life as the SBP & DBP within this group of subjects fall under pre hypertension category. BMI, SBP and DBP correlated significantly with each other. This correlation was also statistically significant within each categories of BMI. Rakesh Pathak., *et al* studied relationship of BMI and WHR measurement to blood pressure in medical and dental students and they also reported that increasing BMI directly affect the blood pressure [2] which supported our finding. Patients prefer this method because this method is cheap, non-invasive and reliable.

The positive correlation between BMI and WHR signify that if BMI is increasing simultaneously the WHR will also increase ultimately leading to increase in blood pressure. It is also true other way around. That is, if BMI and WHR is decreasing the blood pressure will also decrease. So these values are positively correlated. From this we can conclude that BMI and WHR both are effective tools to measure the risk factors in adolescence such as hypertension.

To prevent all the above mentioned risk factors it is important to treat the cause as soon as possible. For this we can give physical activities on daily basis and also a healthy diet. This will help adolescents to live a healthy and disease free life. So it is very necessary to know and prevent the risk factors.

7. Conclusion

As we have found a positive correlation between all the values it can be concluded that both BMI and WHR had an effect on BP, but BMI in particular had greater effect. It can also be concluded that if one value increases, simultaneously the other values will also increase and vice versa.

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