Original article

STUDY OF CORRELATION OF BODY MASS INDEX(BMI) WITH BLOOD PRESSURE IN ADOLESCENTS.

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Key Words: Body Mass Index, Blood Pressure (Systolic Blood Pressure, Diastolic Blood Pressure), Overweight, Obese , Pre-hypertension, Hypertension.

Introduction: Obesity is a state of excess adipose tissue mass. The most widely used method to gauge obesity is the body mass index, which is equal to weight/height^2(in kg/m^2). BMI changes throughout the growth and development of adolescent. It can be used as an indicator for tracking body size throughout the cycle. As BMI increases throughout the range of moderate and severe overweight, so also does the risk increase for cardiovascular complications including hypertension. **Material and Method:** The present study was conducted to study correlation of Body Mass Index (BMI) with blood pressure in Adolescents. Study Population consisted of 100 subjects including both male and femalebetween age group of 15-17 yrs.All the subjects were divided in groups A and group B according to BMI.Group A Subject BMI $\leq$ 24.9.Group B Subject BMI $\geq$ 25. Height is measured by Measure Tape, Weight is recorded by standard weighing scale machine and Blood Pressure recording by clinical Sphygmomanometer and stethoscope. **Results:** The statistical analysis was done using correlation unpaired t-test. There was significant positive correlation between BMI with systolic as well as diastolic blood pressure of male and femalein adolescents age group. **Conclusion:** In present study, Group A Body Mass Index of Male With Systolic Blood Pressure and Diastolic Blood Pressure, the p value are 0.0139 and 0.0280 respectively ($P<0.05$) showing significant positive correlation between body mass index and blood pressures.Group B, Body Mass Index of Female With Systolic Blood Pressure and Diastolic Blood Pressure, the p value are 0.0099 and 0.0025 respectively ($P<0.05$) showing significant positive correlation between body mass index and blood pressures. The mechanism by which excess fat deposition (obesity) influences BP in adolescents appears to be through increased sympathetic activity, renin angiotensin -aldosterone system activation, and compression of kidneys. Changes in insulin sensitivity and its compensatory hyperinsulinemia lead to sodium and water retention and stimulation of sympathetic activity, which may in turn lead to hypertension. The recognition of elevated BMI in the present study as important factors associated with increased risk of developing elevated BP among adolescents may help target prevention towards high-risk individuals in this age group. This is especially important because of evidence linking adolescent obesity with metabolic abnormalities and risk of cardiovascular disease in adulthood.

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Introduction:

Obesity is a state of excess adipose tissue mass. The most widely used method to gauge obesity is the body mass index, which is equal to weight/height^2 (in kg/m^2). BMI changes throughout the growth and development of adolescent. It can be used as an indicator for tracking body size throughout the cycle. As BMI increases throughout the range of moderate and severe overweight, so also does the risk increase for cardiovascular complications including hypertension.

The origin of adult obesity and its adverse health consequences often begins in childhood. It has been estimated that hypertension accounts for 6% of deaths worldwide. In industrialized societies, blood pressure increases steadily during the first two decades. In adolescents, changes in blood pressure are associated with growth and maturation.

Hence in view of above, this study, "study of correlation of body mass index (BMI) with blood pressure in adolescents." is undertaken which will scientifically contribute to identify at risk population well in advance and will also help to implement necessary action to obtain desired physical fitness in the form of optimum body composition and thereby to prevent/delay future health hazards.

Aims and Objectives:

1. To determine BMI of Adolescent.
2. To determine Blood pressure of Adolescents.
3. To find out correlation if any, between body mass index and blood pressure.
4. To advice if necessary, about diet and exercise to obtain desired physical fitness in the form of optimum body mass index of adolescents.

Material and Method:

The present study was conducted in 100 Adolescent 15-17 Yrs. age group.

All the subjects were divided in groups A and group B according to BMI.

Group A Subject BMI $\leq$ 24.9.

Group B Subject BMI $\geq$ 25.

GROUP	MALE	FEMALE
A: BMI $\leq$ 24.9	39	41
B: BMI $\geq$ 25	09	11

Students belonging to same socioeconomic strata were selected from school by simple random technique.

After getting permission from school authority the study was conducted. School authority had taken permission from students and parents. The Pro-forma was filled by students with the help of their parents. Age and date of birth reported by students were verified against the school records, which in turn were based on the student's birth certificate.

Exclusion Criteria:

1. Adolescents above 17 Yrs.
2. Underweight Adolescents.
3. Adolescents having any acute illness.
4. Present or Past History suggestive of cardiovascular, respiratory or any other systemic illness.
5. Family history of hypertension, asthma, diabetes.

Body Mass Index (BMI):

1. Height: For measurement of Height marking were made on the wall using measuring Tape. The students was asked to stand upright, barefoot on the ground with heels, buttocks, upper back, and back of head making firm contact with the wall (this helps the subject to stretch to his full height). The chin is tucked in slightly and the head is held erect. The cardboard was pressed firmly onto the subject's head to form a right angle to the wall and the subject was asked to bend his knees slightly when he steps away so that the cardboard is not disturbed before the height is recorded.
2. Weight: Weight was recorded using standard weighing scale machine. Measurement of weight was done at the same time of the day, with same instrument and to the same degree of accuracy to the nearest of 0.5 kg.
3. Body Mass Index: Body mass index was calculated based on the formula,
   BMI= weight in kg. /height in meter ^{2}
4. Blood Pressure: For Recording Blood Pressure here we used instrument are clinical Sphygmomanometer and Stethoscope and record the blood pressure by Auscultatory method.

Before recording the blood pressure, adolescents in group of 10 were taken to a separate room away from noise and they were explained in detailed, the procedure of blood pressure recording and they were reassured that the procedure is neither painful nor harmful.

All efforts were made to eliminate factors which might affect the blood pressure such as anxiety, fear, crying, laughing, recent activities in order to facilitate the blood pressure recording under simulated "basal" or "near basal" condition. Blood pressure was recorded only when the student had become accustomed to the observer, instrument, and surroundings.

After giving rest for 10 minutes blood pressure was recorded in sitting position with his back supported, feet on the floor and right arm supported. Right arm was used for consistency and for comparison with standard tables and because of the possibility of coarctation of the aorta, which might lead to false (low) readings in the left arm.

Blood pressure readings were expressed to the nearest 2 mmHg.

All blood pressure recordings were taken on the same time of the day, i.e. during Morning hours and recorded by the same person and by the same instrument.

Systemic examination was also done to exclude cardiovascular, renal, and other disease which could affect blood pressure.

Statistical analysis was done by using unpaired t-test.

Results: Group A

Male (48)	Blood Pressure	Mean	Standard Deviation	P Value
BMI ≤ 24.9(39)	SBP	124.87	11.6329	0.0139
BMI ≥25 (9)	SBP	135.11	14.5983	

BMI ≤ 24.9(39)	DBP	77.23	7.6449	0.028
BMI ≥25 (9)	DBP	83.11	10.0554	

Table 1*: Showing Correlation of Body Mass Index of Male with SBP and DBP in Adolescent Age Group:-*
SBP= Systolic Blood Pressure,
DBP= Diastolic Blood Pressure,
P Value< 0.05 is Significant.

GROUP: B

Female (52)	**Blood Pressure**	**Mean**	**Standard Deviation**	**P Value**
BMI ≤ 24.9 (41)	SBP	117.46	10.2471	0.0099
BMI≥ 25 (11)	SBP	126.18	12.2132	
BMI ≤ 24.9 (41)	DBP	78.19	8.0722	0.0025
BMI ≥25 (11)	DBP	86.36	8.6634	

Table 2*: Showing Correlation of Body Mass Index of Female with SBP and DBP in Adolescent Age Group:-*
SBP= Systolic Blood Pressure,
DBP= Diastolic Blood Pressure,
P Value< 0.05 is Significant.

Conclusion:

In present study, Group A Body Mass Index of Male With Systolic Blood Pressure and Diastolic Blood Pressure, the p value are 0.0139 and 0.0280 respectively (P<0.05) showing significant positive correlation between body mass index and blood pressures.

Group B, Body Mass Index of Female With Systolic Blood Pressure and Diastolic Blood Pressure, the p value are 0.0099 and 0.0025 respectively (P<0.05) showing significant positive correlation between body mass index and blood pressures.

Classification as "Pre-hypertensive" or even at risk for hypertension may cause obese subjects to take notice. As BMI is a reflection of life style, addressing it would be appropriate when subjects are in that range. An elevated BMI being associated with pre-hypertension may suggest that such individuals are at increased risk of progressing to frank hypertension. Therefore weight management programs are more important for these adolescents age group than the life style modification programs targeted at hypertension.

Prevalence of Pre-hypertension among overweight/obese suggested an early clinical detection of pre-hypertension and intervention including life style modification particularly weight management.

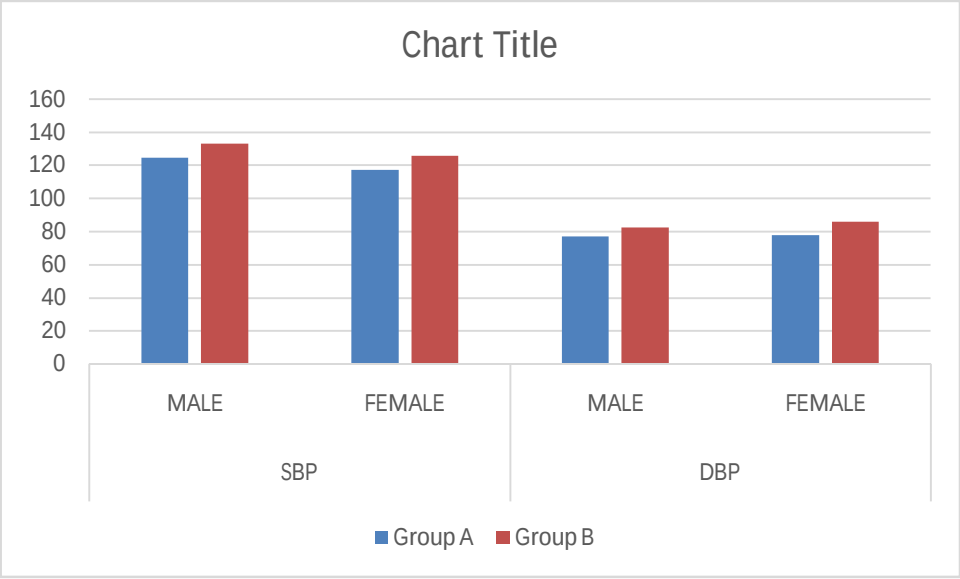

CHART: SHOWING CORRELATION BETWEEN BODY MASS INDEX AND BLOOD PRESSURE IN GROUP A AND GROUP B.

Discussion:

Hypertension is the most common, most potent universal contributor to cardiovascular mortality. Elevated blood pressure, labile or fixed, systolic or diastolic, at any age, in either sex is a contributor to all forms of cardiovascular diseases. Studies on Indian higher secondary school have demonstrated that the prevalence of hypertension in overweight children is significantly higher than that among normal children. Also Studies on urban Indian schoolchildren from selected regions report a high prevalence of obese and overweight children. Studies on hypertension in childhood have the important advantage that they may help in the control and possibly prevention of high blood pressure before its harmful sequele can occur. For any proposed value of body mass index (BMI), Indians have a higher magnitude of adiposity, abdominal obesity and a lower muscle mass than white Caucasians

7. The present study was carried out in adolescents between the age group of 15 to 17 years to correlate between body mass index and blood pressure. Body mass index correlated separately with systolic and diastolic blood pressure in the groups.

***Similar results were also observed by other workers*.** Gilles Paradis et al4 (2004) by multiple linear regression analysis found that body mass index was consistently associated with SBP and DBP in all age-gender groups. David S. Freedman et al8 found that overweight was more strongly related to elevated levels of DBP and concluded that overweight children and adolescents are at a substantially increased risk for adverse levels of several cardiovascular disease risk factors.
Berkey CS et al5(1998) confirmed that greater BMI in adolescence is associated with raised BP. Jonathan Sorof6 (2002) concluded that obesity has become an increasingly important medical problem in children and adolescents. Obese children are at approximately a 3-fold higher risk for hypertension than non-obese children. In addition, the risk of hypertension in children increases across the entire range of body mass index (BMI) values.
Aneesa M. Al -Sendi et al7 in 2003 showed that weight and height in boys and weight only in girls were significantly associated with systolic BP independent of age or percentage fat. BMI and percentage body fat were significantly and positively associated with the risk of having high BP in the boys and girls.
Schiel R et al8(2006) after investigating the associations and interactions between height, weight, body-mass index and blood pressure values in overweight / obese and normal weight children and adolescents found that overweight and obese children had significantly higher blood pressure values both systolic as well as diastolic than control subjects. Manu Raj et al9 in 2007 determined the relationship of obesity with blood pressure. Systolic or diastolic incident hypertension was found in 17.34% of overweight children versus 10.1% of the remaining students.
Survey by Neamatollah Ataei et al10 (2009) identified a high prevalence of overweight that was associated with elevated SBP among preschool-aged children in Iran and concluded that the effect of higher BMI on mean SBP is present in childhood and can be used as a predictor of high SBP even in children as young as 1–6 years.

Obesity: Cause of Hypertension: One of the causes of hypertension is abnormal sodium and fluid balance. In obesity hypertension, abnormal kidney function initially is due to increased tubular sodium re-absorption, which causes sodium retention and expansion of extracellular and blood volumes. The increase in sodium re-absorption results in a rightward shift in the renal pressure-natriuresis relation and BP elevation. Thus the obese individual requires higher levels of BP to maintain sodium and fluid homeostasis. There are several potential mechanisms that could mediate the sodium retention and hypertension associated with obesity, including sympathetic nervous system activation, renin-angiotensin-aldosterone system activation, and compression of the kidney.

a. Sympathetic Nervous System Activation
The sympathetic nervous system (SNS) plays a critical role in the regulation of cardiovascular homeostasis. SNS activation plays an important role in the pathophysiology of obesity hypertension in humans. There are number of proposed mechanisms linking obesity with SNS activation including baroreflex dysfunction, hypothalamic-pituitary axis dysfunction, hyperinsulinaemia/insulin resistance, hyperleptinaemia, and elevated circulating Angiotensin II concentrations.

b. Renin-Angiotensin-Aldosterone System (RAAS) Activation
Several components of Renin-Angiotensin-Aldosterone System are elevated in obese human despite sodium retention. In addition, plasma renin activity declines with weight loss and is correlated with the reduction in BP. Adipose tissue expresses many components of RAAS, and this local system has been implicated in obesity hypertension.

c. Compression of the Kidney
Intra-abdominal pressure is directly related to the degree of abdominal adiposity, and, thus, elevated intra-abdominal fat could act to compress the kidney, increase sodium and water retention, and elevate BP. In addition, the ectopic deposition of fat within the rigid renal capsule could also elevate intra-renal pressure, result in sodium and water retention, and increase BP11.

Both non-pharmacologic and pharmacologic approaches are useful in managing children with elevated blood pressure. Treatment modalities used in obese children and adolescents can be categorized into combination of: caloric restriction, anorectic drugs, increased physical activity, therapeutic starvation, surgery, and habit pattern changes based on social learning therapy. Certainly drugs, starvation, and surgery are unacceptable treatment strategy for most children.

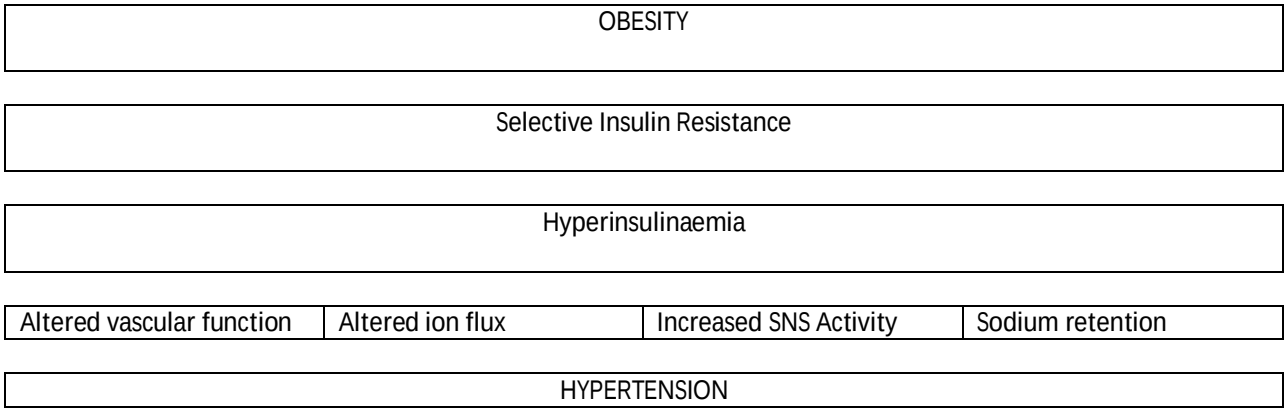

Fig 4: Showing how obesity and selective insulin resistance might result in hypertension.

Socio-Cultural Issues and Adolescent Obesity in India:
There is a general misconception in parents in India and other developing countries that an obese child is a healthy child. In an effort to keep child "healthy" he/she is fed in excess. High burden of school work and academic competitiveness have led to decreased participation in sports and any other form of physical activity. "Fast foods" fads oversee balanced nutrition. Lastly, Adolescents spend more time in front of television and computers at the expense of sports and physical activity.

Prevention of Obesity Hypertension
As indicated earlier, weight gain is almost invariably associated with an increase in BP. Thus prevention of weight gain should be a primary therapeutic target for reducing the problem of hypertension. Regular physical activity and reduced dietary fat intake reduce weight gain in normal weight subjects and weight regain after weight loss in obese individuals. This could be achieved by relatively small lifestyle changes such as adding 15 min of walking each day and reducing portion sizes by a few bites per meal. If successful, lifestyle modification such as the one proposed may have important implications for the prevention of obesity-associated hypertension.

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