Study of Correlation of Body Mass Index (BMI) With Blood Pressure in School Going Children and Adolescents.

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Original Article

Abstract: The present study was conducted to study correlation of Body Mass Index (BMI) with blood pressure in school going children and adolescents. Study population consisted of 400 male students between the age group of 8-16 years which were grouped as Group I: 8-12 yrs and Group II: 13-16 yrs with 200 students in each. Height and weight recorded to calculate Body Mass Index (BMI). Blood pressure was recorded as recommended by the fourth report on diagnosis, evaluation and treatment of high blood pressure in children and adolescents The statistical analysis was done using correlation t-test. There was significant positive correlation between BMI with both systolic as well as diastolic blood pressure in both groups. The mechanism by which excess fat deposition (obesity) influences BP in children and adolescents appears to be through increased sympathetic activity, renin-angiotensin-aldosterone system activation, and compression of kidneys. Changes in insulin sensitivity and its compensatory hyperinsulinaemia lead to sodium and water retention and stimulation of sympathetic activity, which may in turn lead to hypertension. The recognition of obesity (as assessed by BMI) in the present study as important factors associated with increased risk of developing elevated BP among children and 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 diseases in adulthood.

Key Words: Body Mass Index (BMI), Blood pressure

Introduction: Obesity is a state of excess adipose tissue mass. Childhood obesity - now emerging as a global health problem - previously considered a problem of affluent countries. Today the problem has started appearing even in developing countries. In India, it was basically under nutrition, which attracted the focus of health workers. Childhood obesity was rarely seen. But over the past few years this entity is increasingly being observed. Globally the prevalence of childhood obesity varies from over 30% in USA to less than 2% in sub- Saharan Africa. Currently the prevalence of obese school children is 20% in UK and Australia, 15.8% in Saudi Arabia, 15.65 in Thailand, 10% in Japan and 7.8% in Iran. National representative data for childhood obesity in India is unavailable, however available studies of Chennai and Delhi has shown that prevalence of 6.2% and 7.4% respectively.[1, 2]

The most widely used method to gauge obesity is the body mass index (BMI), which is equal to weight/height^2 (in kg/m^2). BMI changes throughout the growth and development of a child. It can be used as an indicator for tracking body size throughout the life 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. Children who gain more weight than peers tend to become overweight adults with increased risk for hypertension, hypercholesterolemia, and heart disease. The alarming rise in obesity during childhood and adolescence requires immediate interventions to prevent subsequent increase in risk for diseases and deaths as these children become adult.

Group	Age group (yr)	No. of subjects
I	8-12	200
II	13-16	200

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 children and 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 school going children and 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 body mass index (BMI) of children and adolescents.
2. To determine blood pressure of children and adolescents.
3. To find out correlation if any, in between body mass index (BMI) 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 (BMI) of children and adolescents.

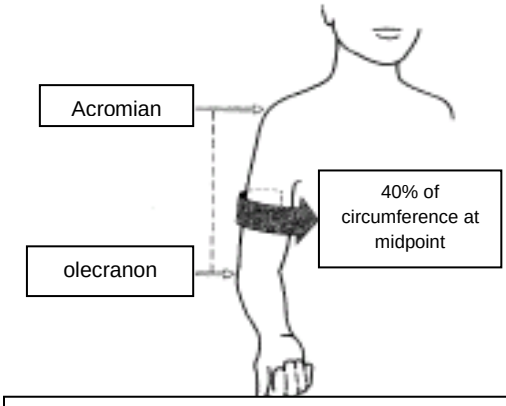

Diagram of proper placement and selection of blood pressure cuff in children.

Material and Methods:

The present study was conducted in 400 school going male children and adolescents aged between 8-16 years. All the subjects were divided into two groups as:

Students belonging to same socioeconomic strata were selected from various schools by simple random sampling technique.

After getting permission from school authority the study was conducted. School authority had taken permission from students and parents. The proforma was filled by students with the help of their parents. Age and dates 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. Children below 8 years and above 16 years.
2. Children having any acute illness.
3. Present or past history suggestive of cardiovascular, respiratory or any other systemic illness.
4. Family history of hypertension, asthma, diabetes.
5. Handicapped children and children with any disability.

Body Mass Index (BMI):

i. Height:

- For measurement of height markings were made on the wall using measuring tape.
- The child 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.

ii. Weight :

- Weight was recorded using standard weighing machine (Libra India Ltd.)
- Measurement of weight was done at the same time of day, with same instrument and to the same degree of accuracy to the nearest of 0.5 kg.

iii. Body Mass Index (BMI):

- Body Mass Index was calculated based on the formula-

BMI = Weight in kilogram / (Height in meter) ^{2}

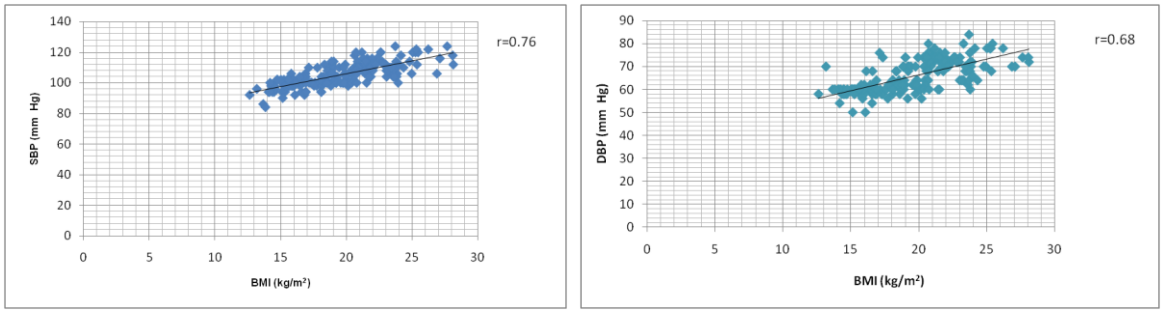

***Fig 1: SCATTER DIAGRAM I**: Showing Correlation between Body Mass Index and Blood Pressure in Group I*

Blood pressure:

- Standard methodology, as recommended by the fourth report on diagnosis, evaluation and treatment of high blood pressure in children and adolescents, was used to measure blood pressure[3].
- Before recording the blood pressure, children in groups of 10 were taken to a separate room away from noise, and they were explained in detail, 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" conditions. Blood pressure was recorded only when the child had* become accustomed to the observer, instrument and surroundings.
- After giving rest for 5-10 minutes blood pressure was recorded in sitting position with his back supported, feet on the floor and right arm supported with cubital fossa at heart level. 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 recordings were expressed to the nearest 2 mm Hg.
- All blood pressure recordings were taken on the same time of the day, i.e. during afternoon hours and recorded by the same person and by same instrument.
- Systemic examination was also done to exclude cardiovascular, renal and other

diseases which could affect blood pressure.

Stastical analysis was done by using correlation t- test.

Results:

	r	P value	S/NS
SBP	**0.76**	**<0.001**	**S**
DBP	**0.68**	**<0.001**	**S**

***Table I**: Showing Correlation of Body Mass Index with SBP and DBP in Group I*

Table I shows a significantly positive correlation of Body Mass Index with systolic as well as diastolic blood pressure.

	r	P value	S/NS
SBP	**0.81**	**<0.001**	**S**
DBP	**0.72**	**<0.001**	**S**

***Table II**: Showing Correlation of Body Mass Index with SBP and DBP in Group II:*

SBP= Systolic Blood Pressure, DBP= Diastolic Blood Pressure,
r= Correlation Coefficient, S= Significant, NS= Not Significant

Table II shows a significantly positive correlation of Body Mass Index with systolic as well as diastolic blood pressure**.**

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 schoolchildren 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 school going children and adolescents between the age group of 8 to 16 years to correlate between body mass index and blood pressure. All the subjects were divided into two groups – Group I: 8 to 12 yrs and Group II: 13 to 16 yrs. body mass index, correlated separately with systolic and diastolic blood pressure in both the groups.

In present study in group I the correlation coefficients(r) of body mass index (BMI) with systolic blood pressure and diastolic blood pressure are 0.76 and 0.68 respectively (P<0.001) and in group II the correlation coefficients(r) of body mass index with systolic blood pressure and diastolic blood pressure are 0.81 and 0.72 respectively (P<0.001) showing significant positive correlation between body mass index and blood pressures in both groups.

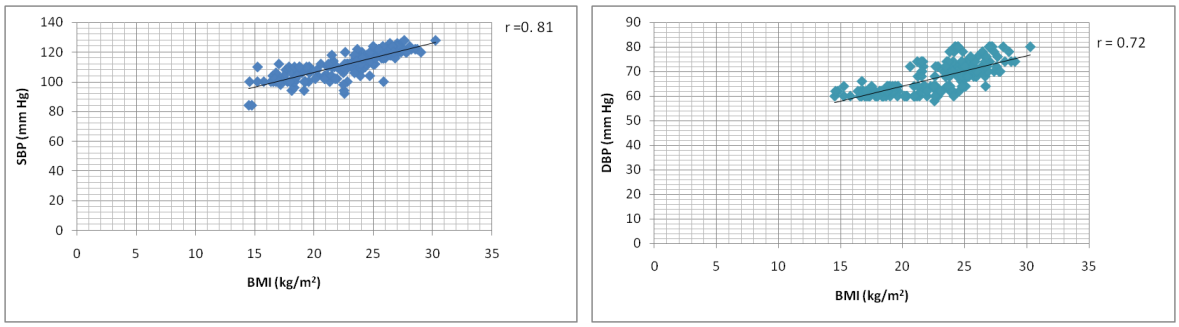

***Fig 2: SCATTER DIAGRAM II**: Showing Correlation between Body Mass Index and Blood Pressure in Group II*

Similar results were also observed by other workers.

Gilles Paradis et al[4] (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 al[8] 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 al[5](1998) confirmed that greater BMI in adolescence is associated with raised BP. Jonathan Sorof[6] (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 nonobese 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 al[7] 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 al[8](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 al[9] 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 al[10] (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 reabsorption, which causes sodium retention and expansion of extracellular and blood volumes. The increase in sodium reabsorption 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 a number of proposed mechanisms linking obesity with SNS activation including baroreflex dysfunction, hypothalamic-pituitary axis dysfunction, hyperinsulinemia/insulin resistance, hyperleptinemia, and elevated circulating Angiotensin II concentrations.

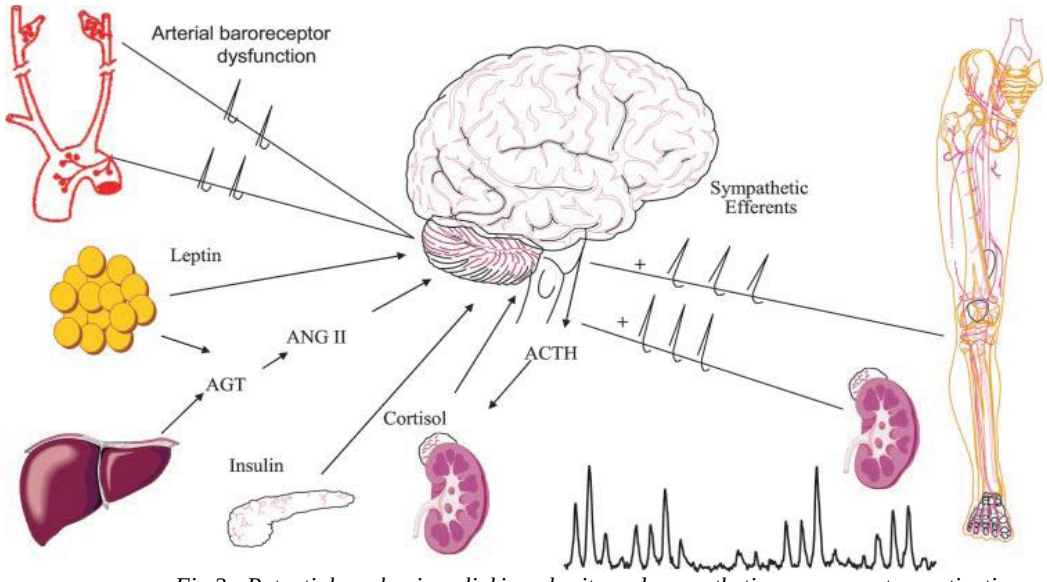

Fig 3: Potential mechanisms linking obesity and sympathetic nervous system activation.

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 intrarenal pressure, result in sodium and water retention, and increase BP[11].

Both nonpharmacologic 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.

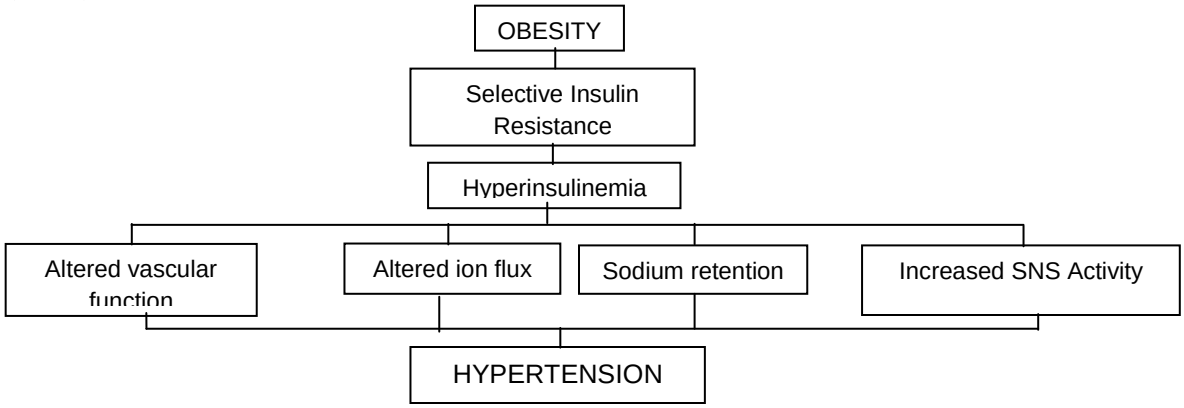

Fig 4: Showing how obesity and selective insulin resistance might result in hypertension[12]

Socio-Cultural Issues and Childhood 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, children spend more time in front of television and computers at the expense of sports and physical activity[13].

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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