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A Study Showing Correlation between BMI and Blood Pressure amongst Male Children of Age 6 To 14 Years.

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Abstract:
Background: *Obesity and hypertension are one of the major risk factors of several life threatening diseases. The present study was conducted to study the correlation between Body Mass Index (BMI) and blood pressure in school going male children.*
Material and Methods: *We obtained data from 492 healthy school going male children and assessed the correlations between BMI and the systolic blood pressure (SBP) and diastolic blood pressure (DBP). The data of male subjects were analysed separately in view of gender differences in autonomic regulation. The relationship between BMI and blood pressure was determined by Pearson's correlation coefficient.*
Results: *A highly significant ($p<0.001$) positive correlation was found between BMI with SBP and DBP in male subjects. On estimating the prevalence of hypertension we found higher proportion of hypertension and prehypertension in obese and overweight male children for systolic as well as diastolic blood pressure.*
Conclusion: *BP and BMI is linearly related. Control of obesity is one of the important aspect of prevention of hypertension in children.*
Key Words*: Body Mass Index (BMI), Blood pressure, Male children*

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I. Introduction

Pediatric obesity is a public health problem of increasing concern in the developed world and in populations undergoing cultural transition.[1] The International Association for the Study of Obesity (IASO) and International Obesity Task Force (IOTF) estimate that 200 million school children are either overweight or obese.[2] India is also facing the epidemic of obesity and its associated diseases, especially in children and adolescents.[3] Among Indian children, the magnitude of overweight ranges from 9 to 27.5% and obesity ranges from 1 to 12.9% respectively.[4,5,6,7,8] The method used most widely for measuring obesity is the body mass index (BMI) which is equal to weight/height2 (in kg/m2).[9] Outcomes related to childhood obesity include hypertension, type 2 diabetes mellitus, dyslipidemia, left ventricular hypertrophy, nonalcoholic steatohepatitis, obstructive sleep apnea, as well as social and psychological problems.[10] Nowadays an increasing number of healthy children and adolescents across the world are being diagnosed with HTN. Hypertension is one of the most potent and universal contributor to major cardiovascular and cerebrovascular diseases worldwide and studies on hypertension in childhood have the important impact on child health with possible control and prevention of high blood pressure before its harmful sequelae can occur.

II. Material And Methods

This cross sectional school survey was conducted among primary school children of different schools of Jaipur city, Rajasthan from January 2018 to June 2019. A total of 492 school going male children aged between 6-14 years were enrolled for study.
Study design: Cross sectional study
Study Location: Various schools of Jaipur city
Study duration: January 2018 to June 2019
Sample size: 492 male students
Sample size calculation: Sample size of 492 male children was calculated by simple random sampling method.

Subjects & selection method: 492 school going male children of age 6 to 14 years were selected and the subjects were divided into two groups: Group I includes children of age 6 to 10 years and Group II includes children of age 11 to 14 years.

Inclusion criteria:

1. Male child of age between 6 to 14 years.
2. Free from any acute and chronic illness.

Exclusion criteria:

1. Present or past history suggestive of cardiovascular, respiratory or any other systemic illness.
2. Handicapped children and children with any disability.
3. Family history of hypertension, asthma, diabetes.

Procedure methodology:

After getting permission from school authority and parents the study was conducted. The proforma 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 student's birth certificate. After that height, weight, BMI and blood pressure were taken and recorded for each student.

Height:

- For measurement of height a metallic non-stretchable tape measure fixed to a plane surface wall and a set-square were used as a pointer for corresponding reading. Children were asked to remove their shoes, bulky clothing, hair ornaments and were asked to stand with feet flat, together, and against the wall, with head in the Frankfort horizontal plane and that the line of sight is parallel with the floor.
- Measurement was taken while the child stands with head, shoulders, buttocks, and heels touching the flat surface i.e. wall. For accurately recording the height, reading was taken to the nearest or 0.1 centimeter.

Weight:

- Weight was recorded using standard weighing machine (Libra India Ltd.) Children were asked to remove shoes and heavy clothing and were asked to stand with both feet in the center of the scale to have to avoid the error.
- Record the weight to the nearest decimal fraction of 0.1kg. Measurement of weight was done at the same time of the day and with the same instrument every time to avoid the error occurred by the instruments.

Body Mass Index (BMI):

Body mass index (BMI) was calculated using the formula:-

$$\textbf{BMI} = \frac{\textbf{Mass (kg)}}{\textbf{[Height (m)]}^2}$$

The children were classified into BMI categories as per the IAP recommendation.
BMI cut off lines as per Revised IAP 2015 Growth Charts:[11]

- Below 23rd AE (Adult Equivalent): No overweight/No obese
- 23rd to below 27th AE (Adult Equivalent): Overweight
- 27th AE (Adult Equivalent) and above: Obese

Blood pressure:

Definition of hypertension: According to "The Fourth Report on the Diagnosis, Evaluation, and Treatment of High Blood Pressure in Children and Adolescents", definition of hypertension in children is defined as average SBP and/or DBP that is greater than or equal to 95th percentile for sex, age and height on three or more occasions. Prehypertension in children is defined as average SBP or DBP levels that are greater than or equal to the 90th percentile, but less than 95th percentile.[12]

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.

The following steps were followed while measuring the blood pressure:

1. Standard clinical sphygmomanometer and stethoscope were used to record the blood pressure of children by Auscultatory method. Appropriate size of cuff were used to measure the blood pressure, cuff of width approximately 40%, and length of at least 80% of arm circumference was used. Blood pressure was recorded using a stethoscope placed over the brachial artery pulse, proximal and medial to the cubital fossa and below the bottom edge of the cuff as shown in figure no 1.
2. Before recording the blood pressure, children were taken to a separate room away from noise to avoid disturbance in recording and also its effect on autonomic system of children, which can alter the reading values of blood pressure. The whole procedure of blood pressure recording was explained and the children were reassured that the procedure is neither painful, nor harmful and efforts were made to eliminate the 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.

3. When the child had becomes comfortable blood pressure was recorded in sitting position with his/her 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. Blood pressure recordings were expressed to the nearest 2 mmHg of standard clinical sphymomanometer. Appearance of Korotkoff sounds, K1 was noted as SBP reading and disappearance of korotkoff sounds K5 was noted as DBP reading.

4. All the blood pressure recordings were taken on the same time of day and recorded by the same person and by the same instrument to avoid bias. Systemic examination was also done to exclude cardiovascular, renal and other diseases which could affect blood pressure.

5. Height centiles were noted for each child from Revised IAP 2015 Growth Charts for height, weight and BMI for 5-18years old boys and girls. And then it was used for grading blood pressure in respective child using blood pressure table given in the Fourth Report on the Diagnosis, Evaluation, and Treatment of High Blood Pressure in children and adolescents.

Statistical analysis

Data was analyzed using SPSS version 20.0. Pearson's correlation coefficient was used to determine the relationship between BMI and blood pressure and '*p'* value <0.001 is considered as significant.

III. Results

The study was conducted in total 492 male children of age 6 to 14 years. The study subjects were divided into two groups, according to age. Group I includes 284 male children of age group 6 to 10 years and group II includes 208 male children of age group 11 to 14 years (Table no 1).

Table no 1: Distribution of male study subjects according to age group

Group	Age Group (yrs)	No. of male children
I	6 to 10	284
II	11 to 14	208
	Total	**492**

A significantly positive correlation of body Mass Index (BMI) with systolic blood pressure (SBP) in male children is seen. In group I the correlation coefficient was 0.415 with 'p' value 0.001 and in group II the correlation coefficient was 0.54 with 'p' value 0.001 (Table no 2) (Figure no 2a, b).

Table 2: Correlation of BMI with SBP in different age groups amongst males

Sr. No.	Age Group (yrs)	Correlation coefficient(r)	p value	Significance
1.	6 to 10	0.415	0.001	Significant
2.	11 to 14	0.54	0.001	Significant

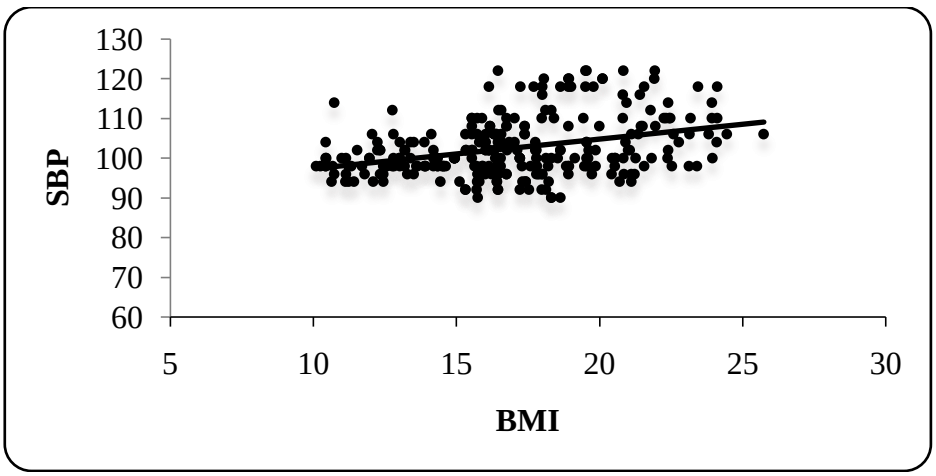

Figure 2 a: Scatter diagram showing correlation of BMI with SBP of male study subjects of group I

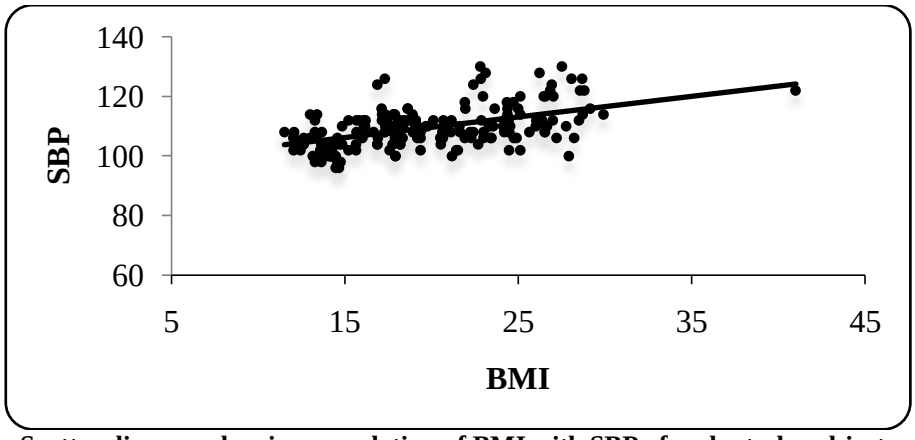

Figure 2 b: Scatter diagram showing correlation of BMI with SBP of male study subjects of group II

After that we found correlation of body mass index (BMI) with diastolic blood pressure (DBP) in two age groups of all males. In both groups there was significant positive correlation between BMI and DBP. In first group of age 6 to 10 years the correlation coefficient was 0.381 with 'p' value 0.001 and in second group of age 11 to 14 years the correlation coefficient was 0.351 with 'p' value 0.001 (Table no 3) (Figure no 3a, b).

Table 3: Correlation of BMI with DBP in different age groups amongst males

Sr. No.	Age Group (yrs)	Correlation coefficient(r)	p value	Significance
1.	6 to 10	0.381	0.001	Significant
2.	11 to 14	0.351	0.001	Significant

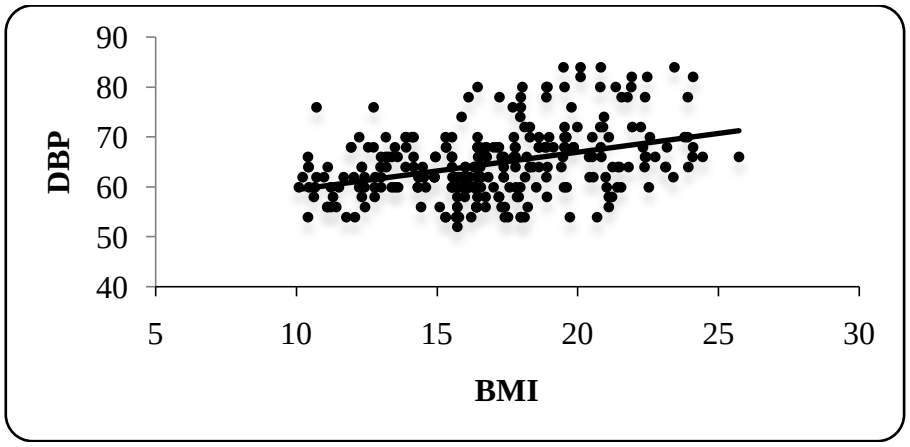

Figure 3 a: Scatter diagram showing correlation of BMI with DBP of male study subjects of group I

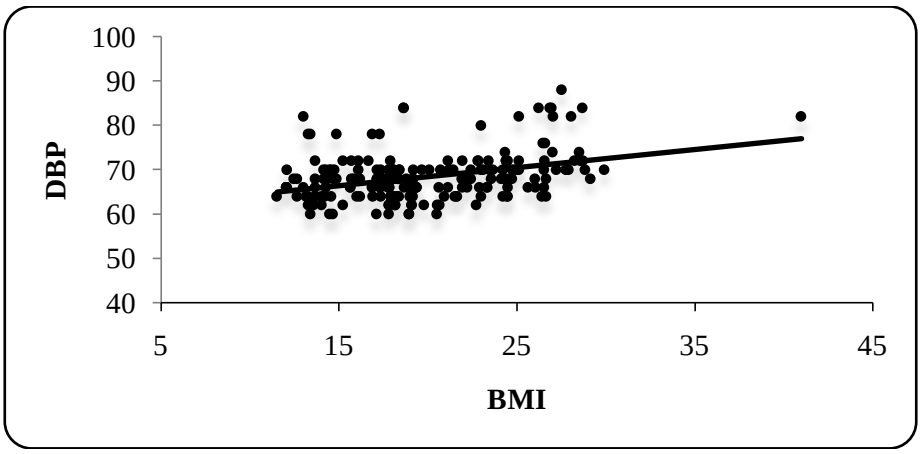

Figure 3 b: Scatter diagram showing correlation of BMI with DBP of male study subjects of group II

IV. Discussion

Hypertension is the one of the 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. It has been demonstrated by various studies on Indian school children that the prevalence of hypertension in overweight children is significantly higher than that among normal children. Studies on hypertension in childhood have an important advantage that they may help in the control and possibly prevention of high blood pressure before its harmful sequele can occur.

The present study was carried out in school going male children between the age group of 6 to 14 years to correlate between body mass index and blood pressure. All the subjects were divided into two groups – Group I: 6 to 10 yrs and Group II: 11 to 14 yrs. Body mass index, correlated separately with systolic and diastolic blood pressure in both the groups, showing significant positive correlation ($p<0.001$) between body mass index and blood pressures in both groups.

Analysing further on the basis of BMI subgroups, it was found that SBP and DBP were higher in overweight subjects as compared to normal and underweight subjects. This was possibly due to differences in sympathetic tone between underweight and overweight subjects. Similar results were also observed by other researchers[13,14] where the above correlation was more significant in overweight and obese subjects. Jain et al. (2012) found higher prevalence of overweight and obesity in girls in comparison to boys. On the contrary, De Vito E et al (1999) found higher prevalence of obesity/overweight in boys in comparison to girls.

Other studies suggested key predictors of high BP among children are BMI followed by increasing age, parental history and sedentary lifestyle.[15,16] The observed higher prevalence rates of obese children in upper class may be because of sedentary lifestyles, altered eating patterns and increased sugar and fat content of their diet.[17,18] Besides BMI there are several other factors which influence influence BP. Research shows that both genetic and environmental factors significantly influence BP and the development of hypertension during childhood.[19]

A combination of factors including over activity of the sympathetic nervous system, insulin resistance, and abnormalities in vascular structure and function may contribute to obesity-related hypertension in children.[20,21,22,23] Weight gain is almost invariably associated with an increase in BP. Thus, prevention of weight gain should be a primary target for reducing the problem of hypertension. Regular physical activity and reduced dietary fat intake could be achieved by small life style changes for prevention of obesity-associated hypertension.

V. Conclusion

A positive correlation of BMI with both SBP and DBP was found in the age group of 6 to 14 years amongst male children. There is also a positive correlation of BMI with both SBP and DBP amongst two different age groups of 6 to 10 years and 11 to 14 years. Thus control of obesity is one of the important aspect of prevention of hypertension in children and it is important to implement effective obesity control programmes and other measure to control obesity which will subsequently prevent hypertension and related cardiovascular complication in children and indirectly in adult population also.

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