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Relationship between Blood Pressure and Body Mass Index of Children Aged 6 to 10 years

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Abstract: ***Background**: The World Health Organization (WHO) has described obesity as one of today's most neglected public health problems. Keeping in mind the lack of concrete data regarding relationship between obesity and hypertension in school going children following study was done. **Method**: Cross sectional study conducted in DY Patil School of Medical Science and Research, Navi Mumbai. Sample size being 600 children between 6 to 10 years. Exclusion criteria being children having history of chronic illness, any cardiovascular, respiratory, endocrinal or any disability. Anthropometric measures done according to standardized procedures. RESULT: Out of 600 children, 341 (56.8 %) were males and 259 (43.2 %) were females. Prevalence of hypertension and prehypertension in obese children was 10 % and 21.4 % as compared to 2.1 % and 6 % amongst lean children (p<0.01). **Conclusion**: Relationship between obesity and hypertension in school going children established.*

Keywords: Blood Pressure, Body Mass Index, BMI, Children

1. Introduction

Obesity is a condition of abnormal or excessive accumulation of fat to the amount that health may be impaired.[1] Obesity can be seen as the first wave of defined cluster of non-communicable diseases called "New World Syndrome". Such diseases create enormous socioeconomic and public health burden in poorer countries. The World Health Organization (WHO) has described obesity as one of today's most neglected public health problems.[2,3]

In recent years the prevalence of childhood obesity has risen globally. The International Association for the Study of Obesity (IASO) and International Obesity Task Force (IOTF) estimate that over 200 million school going children are either overweight or obese.[4]Obesity and overweight among children have significant long-term health consequences these include adult obesity, high cholesterol levels and higher incidence of coronary artery disease.[5]

A systematic review on epidemiology of childhood overweight and obesity in India reported prevalence data from 52 studies conducted in 16 of the 28 States in India. The pooled data after 2010 estimated a combined prevalence of 19.3 per cent of childhood overweight and obesity which was a significant upsurge from the earlier prevalence of 16.3 per cent reported in 2001-2005.[6]

A complex interplay of genetic, environmental, behavioral and dietary factors leads to hypertension. Due tothe hereditary nature of hypertension, it is considered to have its origin in the childhood. Children and adolescents with high blood pressure (BP) tend to maintain those levels in adulthood.[7]Most of the children and adolescents with hypertension are likely to be undiagnosed as the symptoms are largely nonspecific. There is no established standard for hypertension among adolescents in India. Studies have reported the prevalence of hypertension in children and adolescents ranging from 1% to 16.2%.[8,9]

Primary hypertension in the adolescents with obesity is becoming increasingly common. A recent study of central India found prehypertension in 6.9% and 6.5% and hypertension in 6.8% and 7.0% of boys and girls, respectively. Height and weight were found to be a significant predictor of systolic and diastolic BP among both gender.[10]Moore WE et al.[11] in their study reported 28% of overweight among 769 students from Anadarko student population, they found that BMI >95th percentile was strongly associated with elevated BP (RR-3.8;95%CI:2.6-5.4). In a study conducted in China by He Q et al.[12] hypertension was seen in 19.4% of obese children and 7% in non-obese children with P<0.0001. Both SystolicBP and Diastolic BP were found to be significantly associated with BMI values (p<0.05) and an increase in one unit of BMI was associated with an increase of 0.56 mmHg SBP and 0.54 mmHg DBP.

Keeping in view the seriousness of problem on one hand and lack of concrete data about the prevalence of obesity and hypertension and their correlation among school children, the present study was undertaken to find out the prevalence of obesity in school going children aged 6 to 10 years and to evaluate the correlation between anthropometric parameters like height, weight, body mass index and waist circumference with blood pressure.

2. Methodology

This cross-sectional study was conducted in the Department of Paediatrics, D Y Patil University School of Medicine, Nerul, Navi. The study protocol was approved by institutional ethical committee. A total of 600 children were included in this study between the ages of 6 to 10 years. Children having chronic illness, with present or past history suggestive of any cardiovascular, respiratory, endocrinal or any other systemic illness and children with any disability were excluded from the study. At the time of the initiating this research each parent was informed about the study protocol and written consent was obtained from them. The exact age of children was verified from birth certificate.

A semi-structured pre-tested questionnaire was administered to each parent and they were requested to fill that completely. Questionnaire included information regarding demographic details (name, age sex, address, religion) and family history of hypertension, diabetes mellitus, ischemic heart disease (IHD) in father and mother. Anthropometric and blood pressure measurements were taken by trained investigators.

Anthropometric measurements were done according to standardized procedures. For anthropometric measurements (weight, height, waist and hip circumference) the following equipment were used: balanced beam scale; two portable/wall mounted stadiometer with movable head piece, or measuring rod, typically mounted on balance beam scales; flexible, but non-stretchable measuring tape and Harpenden's caliper. The BMI was calculated by formula: Weight (kg) / Height $(m)^2$. The BMI was compared against the percentile for children of the same gender and age. A BMI above the 97th percentile was considered obese. Children with a BMI between the 85th and 97th percentile were considered to be overweight.[13]

The blood pressure measurement was done using simple mercury sphygmomanometer. The classification of boys and girls into normotensive, pre-hypertensives and hypertensive was done as per IAP guidelines.[14] The child is normotensive if the BP is below 90th percentile. If the BP is >90th percentile, the BP measurement should be repeated to verify an elevated BP. The average BP measurements between the 90th and 95th percentiles are high normal or prehypertension. Adolescents with BP levels >120/80 mm Hg should be considered to be prehypertensive even if the level is <90th percentile as with adults according to Seventh Report of the Joint National Committee on the Prevention, Detection, Evaluation, and Treatment of High Blood Pressure.[15] If the child's BP is >95th percentile, the child may be hypertensive and repeated measurements are indicated. Though the precise characterization of a person's BP level is an average of multiple BP measurements taken over weeks to months, it is recommended to take BP measurement on at least 2 additional separate occasions to confirm hypertension. Hypertension is defined as average SBP or DBP that is >95th percentile for age and height on at least 3 separate occasions. The 50th percentile values provide the clinician with the BP level at the midpoint of the normal range. The 99th percentile helps to determine the degree or severity of hypertension by staging of BP into stages 1 and 2.

Statistical Analysis:
Data were statistically described in terms of mean and standard deviation, frequencies and percentages whenever appropriate. For comparing categorical data, Chi square test was performed. A probability value (p-value) less than 0.05 was considered statistically significant. All statistical calculations were done using computer programs Microsoft Excel 2007 (Microsoft Corporation, NY, USA) and SPSS (Statistical Package for the Social Science; SPSS Inc., Chicago, IL, USA) version 21.

3. Results

A total of 600 children aged 6 to 10 years participated in the study. There were 341 (56.8%) male and 259 (43.2%) female children. Family history of obesity was given by 43 (7.2%) cases while that of hypertension and diabetes was given by 124 (20.2%) and 121 (20.7%) respectively. Family history of IHD was given by 59 (9.8%) of the participants.

According to the BMI, there were 101 (16.8%) underweight children, 429 (71.5%) normal and 48 (8.0%) overweight children. Twenty two (3.7%) children were obese (table 1). The mean BMI of the study population was 16.36 ± 3.20 Kg/m^2while waist to hip ratio was 8.01±0.86. Distribution of the study participants according to diagnosis of hypertension is shown in table 2. A total of 535 (89.2%) children were normotensive while prevalence of pre-hypertension and hypertension was 7.8% (47) and 3% (18) respectively.

The association of BMI with gender was analysed. It was found that no statistically significant difference (p=0.898) was present between prevalence of obesity and gender.

The association of BMI with hypertension was also analysed (table 3). A significant association was seen between obesity and hypertension among school children. Prevalence of hypertension and prehypertension among obese children was 10% and 21.4% as compared to 2.1% and 6% among lean children (p<0.01).

The correlation between anthropometry and blood pressure was checked (table 4). A significant correlation was seen between anthropometry parameters like BMI, waist circumference, hip circumference and waist hip ratio with systolic and diastolic blood pressure (p<0.05).

Table 1: Distribution of study group as per BMI category

BMI Classes	N	%
Underweight	101	16.8
Normal	429	71.5
Overweight	48	8.0
Obesity	22	3.7
Total	600	100.0

Table 2: Distribution of study group as diagnosis of hypertension

Diagnosis	N	%
Normotensive (NT)	535	89.2
Pre-hypertensive (PHT)	47	7.8
Hypertensive (HT)	18	3.0
Total	600	100.0

Table 3: Association of BMI with Hypertension

BMI Category	Diagnosis			Total
	HT	PHT	NT	
</= 85th Percentile	11	32	487	530
	2.1%	6.0%	91.9%	100.0%
> 85th Percentile	7	15	48	70
	10.0%	21.4%	68.6%	100.0%
Total	18	47	535	600
	3.0%	7.8%	89.2%	100.0%
p-value < 0.05				

Table 4: Pearson correlation between anthropometry and blood pressure

Variables	SBP	p-value	DBP	p-value
BMI	0.39	<0.05	0.38	<0.05
WC	0.44	<0.05	0.42	<0.05
HC	0.39	<0.05	0.38	<0.05
W/H Ratio	0.36	<0.05	0.36	<0.05

4. Discussion

A hospital based cross sectional study was conducted to identify the relationship between Body Mass Index and

Blood Pressure in 6 to 10 years old children so as to provide scientific basis for early prevention of hypertension. A total of 600 children were included in this study between the ages of 6 to 10 years.

The present study highlights the increase in prevalence of obesity in school going children. In present study, prevalence of overweight and obesity was 8% and 3.7% respectively. Ahmed M et al.[16] studied overall prevalence of overweight and obesity is 5% and 1.3%. Our results are comparable to those of Bharti et al.[17] who reported prevalence of overweight and obesity as 3.1% and 1.2% in Wardha. According to Shah C et al.,[18] the prevalence of overweight and obesity was 9.25% and 5.55% in Bhavnagar. Aggarwal T et al.[19] reported 12.7% and 3.4% from Ludhiana. Kumar S et al.[20] reported prevalence of obesity as 5.74% in Davangere and Khadilkar V et al.[21] research in Pune on school going boys showed prevalence of overweight and obesity as 19.9% and 5.7% respectively.

In the present research a significant association was seen between obesity and hypertension among school children ($p<0.01$). Study in adolescents of Delhi by Akhilkant Singh et al[22] shows that BMI has got statistically significant correlation with adolescent hypertension. Mohan B et al.[23] in their study observed mean body mass index of hypertensive population in both rural and urban areas to be significantly higher than respective normotensive population. Raj B et al.[24] in their study found systolic or diastolic incident hypertension in 17.34% of overweight children versus 10.1% of the remaining students (OR: 1.87; 95% CI: 1.60–2.17; $p<0.0001$). Di GS et al.[25] observed that prevalence of hypertension was much higher in obese as compared to non-obese children (13.7% vs 0.4%). The correlation between obesity and hypertension was statistically significant ($p<0.01$). Patel U et al.[26] in their study observed prevalence of hypertension in obese as 24.07% against non-obese as 5.56% ($P <0.001$).

In present study, a significant correlation was seen between anthropometry parameters like BMI, waist circumference, hip circumference and waist hip ratio with systolic and diastolic blood pressure ($p<0.05$). Indian studies also observed strong correlation of anthropometric parameters with hypertension in adolescents. Study by Taksande et al.[27] in rural areas of Wardha shows there was a significant correlation of SBP and DBP with the weight, and body mass index (BMI). Study in adolescents of Delhi by Akhilkant Singh et al[22] shows that BMI has got statistically significant correlation with adolescent hypertension. Study by Ruchika goel et al.[28] shows that Hypertension in Asian Indian adolescents is associated with obesity, central more than peripheral as waist circumference has got stronger association with hypertension than BMI.

Similar association of various anthropometric parameters with hypertension was also observed by other authors around the world. In a study by Souza MG et al,[29] a significant association was observed between obesity (BMI, Triceps thickness, WC) with High BP. There was a moderate correlation between WC and Systolic BP, BMI and Systolic BP; a weak correlation was observed between Diastolic BP and WC and between Systolic BP and TSF thickness. One more study at Turkey by Naim Nur et al[30] shows significant correlation of systolic and diastolic blood pressures with height, weight, and BMI. Mostafa A. Abolfotouh et al[31] also showed in their study observed that high BP was significantly associated with overall obesity based on BMI and central obesity based on WC. Study concludes that both overall obesity and central obesity were significant predictors of High BP in Egyptian adolescents.

5. Conclusion

Observations made in our study confirms that there is high prevalence of overweight and obesity among school children. A significant correlation was seen between obesity and systolic and diastolic blood pressure ($p<0.05$). Obesity appears to be the best determinant of the risk of high blood pressure. The need for routine measurement of blood pressure within the school environment comes across difficulties such as having adequate equipment and mastering the measurement techniques. Therefore, the estimation of high blood pressure by anthropometric predictors in cross-sectional studies allows the stratification of this risk in a simpler andreliable way. Considering the easy technique required to obtain the measures of weight and height and the low cost they involve, the use of BMI seems to be the best option in this context.
Both together may be risk factors for later coronary disease. Modification of such a risk factor in childhood can have enormous potential pay-off. The high-risk children thus need to be identified and considered for close follow ups for modification of risk factors by advising lifestyle changes like regular physical activities and reduction in intake of salt.

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