

## Study of Association of Body Mass Index and Waist Circumference with Hypertension among School Going Children

Sangeeta Dudve<sup>1</sup>, Amrita Sinha<sup>2</sup>, Ujjwala Mavi<sup>3</sup>, Gunvant Singh Eske<sup>4</sup>

<sup>1</sup>Senior Resident, Department of Pediatrics, MGM Medical College, Indore, Madhya Pradesh, India

<sup>2</sup>Senior Resident, Department of Pediatrics, AIIMS, Patna, India

<sup>3</sup>Senior Resident, Department of Pediatrics, MGM Medical College, Indore, Madhya Pradesh, India

<sup>4</sup>Associate Professor, Department of Pediatrics, MGM Medical College, Indore, Madhya Pradesh, India

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Corresponding Author: Dr. Ujjwala Mavi

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### Abstract:

**Background:** Hypertension is on the raise among school going children. Obesity, body mass index (BMI), waist circumference (WC), and waist-to-height ratio, play an important role in the development of insulin resistance, predicting children with high blood pressure (BP).

**Objectives:** The aim is to study the relationship of WC and BMI with the BP among school-going adolescents.

**Methods:** This cross-sectional study was conducted in the department of paediatrics; Central India comprised 800 school going children between 10 and 16 years of age. Anthropometric measurements weight, height, WC was done using standard methods, and BMI was calculated. Normal BP was defined as values < 90th percentile and levels above this range were considered elevated

**Results:** The incidence of pre-hypertension and hypertension was 9% and 4.3%, respectively. Nearly 18.2% were overweight and 7.1% were obese. About 4.1% of the children had increased WC. Systolic and diastolic BP was higher in obese and central adiposity children. Prediction of pre-hypertension and hypertension among children was found to be statistically significantly associated with the high WC and high BMI.

**Conclusion:** Obesity indicators such as WC and BMI because of its ease of measurement can be used as a screening tool to identify children with high BP.

**Keywords:** School Going Children, Body Mass Index, Hypertension, and Waist Circumference.

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### Introduction

Hypertension (known as high or raised blood pressure) is one of the most common and important public health problems globally [1]. Hypertension has a multifactorial etiology with functional and morphological abnormalities of vessel walls. Genetic composition, age, dietary habits, level of physical activity, personality, and personal habits are epidemiological drivers of hypertension among adults [2].

In 2021, the World Health Organization estimated that 1.28 billion adults worldwide had hypertension [3]. "Hypertension, i.e., elevated systolic blood pressure (SBP) and/or diastolic BP (DBP) is now considered to be on the raise among school-going children in recent times [4-5]. In India, it has been noted that children are on the verge of obesity-associated elevated BP [6]. It has been known that BP tracks over time; children with increased values are now at an elevated chance of acquiring hypertension in older age group" [7]. "BP readings for children require trained doctors to identify and take out the appropriate values. Since this is

difficult to be carried out in schools, utilization of anthropometric measures which are being carried at school physical examination is found to be beneficial and early identification of those young children and adolescents who are at the verge of having elevated BP. Usually, waist-to-height ratio (WHtR), body mass index (BMI), and waist circumference (WC) which are used as obesity indicators among adults, children, and adolescents can also be utilized as an indicator of high BP" [8-10]. Waist circumference (WC) as a visceral fat indicator has already been well explored in the adult population and has more recently been identified as a risk factor in children and adolescents [11-12].

Aim of the study: To study on the relationship of Waist circumference and Body Mass Index with the hypertension among school-going adolescents.

### Materials and Methods

This was a cross-sectional observational study carried out in the department of pediatrics in a

tertiary care center, central India. A total of 800 adolescent school going children who provide consent for the study during the study period were enrolled.

#### Inclusion Criteria

- School-going children aged 10–16 years with both gender.
- Absence of any severe medical disorder or chronic illness,
- No history of hospitalization of any duration during the last year and no history of any long-term medication.
- Written informed consent provided by parents or guardians.

#### Exclusion Criteria

- Children aged <10 or >16 year.
- Children already diagnosed to have secondary hypertension.
- Children having any acute illness, cardio-respiratory or any other systemic illness.
- Children on chronic drugs such as steroids.
- Whose parents or guardian not provide consent for the study.

Information about age, sex, dietary habits, and residential location was recorded per the approved study format. Parental history was noted for hypertension, coronary artery disease, and stroke, as known to the study subjects.

The details of the students were collected in a prestructured pro forma. Anthropometric indices of the children such as height, weight, and WC were measured. BP was measured for all children after 5 min of rest in seated position with the right arm supported at the level of the heart. Height for each student was measured, and non-elastic measuring

tape fastened to a vertical wall was used. For weight measurement an electronic weighing scale was used to measure weight. The body mass index (BMI) was calculated as weight in kilograms (kgs) divided by height in square meters (m<sup>2</sup>). The usual range of BMI was taken between 18 and 24.9 as per World Health Organization (WHO) criteria for Asians [13].

For children whose BP was above the 90th percentile, reading was repeated twice at 5–10 min interval in the same visit and average BP was recorded. BP consistently between 90 and 95th percentile was considered to be pre-hypertensive.

For children whose BP was above the 95th percentile, BP recordings were repeated at weekly intervals twice, and BP reading that was found to be consistently above the 95th percentile was considered as hypertensive

#### Statistical Analysis:

The data were entered in MS Excel and analyzed using SPSS version 22. Qualitative data were summarized as frequencies and percentages. Association between qualitative variables was tested using Chi-square tests. Statistical significance was interpreted using an arbitrary cut-off of P<0.05.

#### Results

In this study, a total of 800 school going children were screened out of which 62% were boys and 38% were girls. Most of them (64.3%) residing at rural area and 37.3% belongs to lower socio-economic class. 18.2% were overweight and 7.1% was obese. WC was higher (>90 percentile) in 4.1% children [Tables 1].

**Table 1: Socio-demographic features of study participants**

Socio-demographic features		Frequency	Percentage
Age in year (mean ± SD)		13.52± 2.68	
Gender	Male	496	62%
	Female	304	38%
Residential area	Rural	514	64.3%
	Urban	286	35.7%
Socio-demographic status	Lower class	298	37.3%
	Middle class	286	35.7%
	Upper class	216	27%
BMI category	Normal	598	74.7%
	Overweight	145	18.2%
	Obese	57	7.1%
Waist circumference	<70 percentile	628	78.5%
	70–90 percentile	139	17.4%
	>90 percentile	33	4.1%

Weight and WC was higher in female whereas height and BMI was higher in male.

**Table 2: Anthropometry of study participants**

Anthropometry	Male	Female	Total
Weight (mean ± SD)	40.86±11.13	42.08±9.96	41.57±10.23
Height (mean ± SD)	152.9±12.36	150.34±9.5	151.65±10.32
Waist Circumference (mean ± SD)	65.89±9.65	67.5±8.65	66.47±9.11
BMI (mean ± SD)	20.26±3.21	19.47±2.72	20.74±3.08

Incidence of pre hypertension and hypertension was 9% and 4.2% respectively.

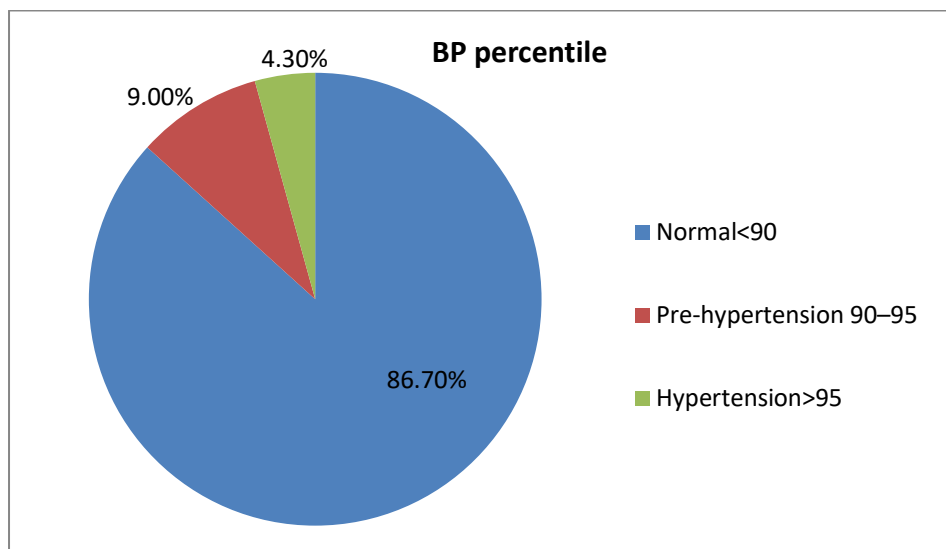


Figure 1: Blood pressure distribution among school going children

High WC and higher BMI was significantly associated with the hypertension (p<0.05).

Table 3: Association between blood pressure and BMI among study participants

BMI	Normal BP	Pre-hypertension	Hypertension	P" value
<b>Systolic blood pressure (SBP)</b>				
Normal	589	9	0	<0.001
Overweight	90	45	10	
Obese	15	18	24	
<b>Diastolic blood pressure (DBP)</b>				
Normal	586	10	2	<0.001
Overweight	92	38	16	
Obese	17	24	16	

Table 4: Association between blood pressure and WC among study participants

WC	Normal BP	Pre-hypertension	Hypertension	P" value
<b>Systolic blood pressure (SBP)</b>				
<70 percentile	593	26	7	<0.001
70-90 percentile	89	36	14	
>90 percentile	12	10	13	
<b>Diastolic blood pressure (DBP)</b>				
<70 percentile	595	24	9	<0.001
70-90 percentile	91	35	13	
>90 percentile	10	13	12	

Table 4: Correlation between BP, WC, and BMI among study subjects

Parameter	BP male correlation coefficient, P value	BP female correlation coefficient, P value	Total BP correlation coefficient, P value
<b>Correlation between SBP, WC and BMI</b>			
BMI	0.561, <0.001	0.548, <0.001	0.560, <0.001
WC	0.572, <0.001	0.547, <0.001	0.570, <0.001
<b>Correlation between DBP, WC and BMI</b>			

BMI	0.203, <0.001	0.125, <0.001	0.201, <0.001
WC	0.27, <0.001	0.099, <0.001	0.183, <0.001

### Discussion

An association was found between BP and anthropometric measurements such as WC and BMI. It was observed that children with more body weight had increased SBP and DBP. This association was found in all age groups, even with other factors that could influence the results. Although secondary forms of hypertension are more common in children than in adults, most cases of mild to moderate hypertension in children do not have an identifiable cause. The increased incidence of hypertension in the pediatric population in recent decades is probably directly associated with the increased incidence of obesity [14-15].

In our study, it was noted that the incidence of pre-hypertension and hypertension in school going children was 9% and 4.3% respectively, these results are comparable with the other studies done by Goel R, et al [16] and Meena J, et al [17].

Present study found majority of the participants were male children and belonging to lower socio-economic class, in agreement with the Chadha SL, et al [18].

The incidence of obesity in current study was 7.1%, concordance with the Pazin et al. [19] it was noted that 7.4% of children had high BMI.

Our results shows that 7.1% children had central adiposity (WC more than 90 percentile), consistent with the Jitendra Kumar et al [20] reported 11.1% children having increased WC. On measurement of anthropometry parameters, height and BMI were higher in male children whereas weight and WC was higher in female children, these results correlates with the Murugalatha P, et al [21].

Present study was noted that high obesity indicators were associated with elevated BP, in agreement with the Mishra et al [22].

In current study the prevalence of hypertension was higher among overweight participants (BMI > 25), accordance to the study conducted by Bahl et al.[23] In Bogalusa Heart Study, it was established that BP is correlated with height and BMI [24].

A study performed by Janssen et al [25], found that individuals with high WC are more likely to have hypertension, dyslipidemia and metabolic syndrome. The prediction of detecting hypertension was found to be higher when WC was used as an indicator when compared to BMI.

In the present study, statistically significant association was found between BP and anthropometric measurements such as WC and

BMI in adolescent children. The children with higher body weight had higher SBP and DBP, similar results reported in many other studies: Kapil, et al [26], Jain B, et al [27] and Wang, Q, et al [28].

### Conclusion

The incidence of hypertension among school-going adolescents was found to be 9 %. There was a strong correlation noted between increased WC and BMI with high BP among adolescents. Prediction for hypertension by WC was found to be higher compared to BMI in this study.

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