

Original Research Article

Body mass index and blood pressure: a study among high school students

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ABSTRACT

Background: Hypertension and its associated risk factors like overweight and obesity begins in childhood but it goes undetected. Revealing any relation between overweight/obesity and high blood pressure and its magnitude will help the policy makers in planning and implementation of necessary interventions. Objectives were to find a relation between Blood pressure and body mass index among high school children, to estimate the prevalence of high blood pressure in the study population and to estimate the prevalence of overweight and obesity in the study population.

Methods: A cross sectional study among students of 8th, 9th, 10th standards (n=697) of two randomly selected Government High School was conducted. Data was collected using a semi-structured questionnaire. Anthropometric measurements and Blood pressure were measured. Data was analyzed using SPSS software version 16.

Results: Elevated Blood pressure was detected in 4.7% and none of the participants had hypertension. The prevalence of obesity and overweight were 7% and 19.8% respectively. A positive significant correlation was seen between BMI and systolic blood pressure ($r = 0.171$, $p=0.001$) as well as between BMI and diastolic blood pressure ($r= 0.094$, $p 0.013$). Both elevated BP and overweight/obesity were significantly higher in students who had previous COVID infection, Junk food consumption and less physical activity.

Conclusions: Prevalence of Obesity and elevated BP were found to be high among male children. Systolic Blood pressure showed significant positive correlation with Body Mass Index irrespective of gender. Positive correlation was seen between BMI and Diastolic blood pressure but found to be significant in males only.

Keywords: Body Mass Index, Blood pressure, Overweight, Obesity

INTRODUCTION

Hypertension is one of the most common diseases worldwide and its prevalence in school-aged children appears to be increasing. Evidence shows that hypertension begins in childhood and its associated risk factors like overweight & obesity also emerge in children of school going age.¹ Trajectory data on BP including repeat measurements from early childhood into mid adulthood confirm the association of high BP in adolescence with hypertension in

early adulthood and that normal BP in childhood is associated with absence of hypertension in mid adulthood.² Tracking of Blood pressure helps identify adolescents at risk of developing Hypertension in future.³ The strength of the tracking relationship is stronger in older children and adolescents.⁴ Obesity is defined as a condition of abnormal or excessive fat accumulation in adipose tissue, to the extent that health may be impaired.⁵ The imbalance between energy intake from food and energy expenditure through physical activity is the

primary etiology behind development of obesity.⁶ The disease is chronic in nature and also results in wide psycho social problems.⁷ Both obesity and hypertension have common modifiable risk factors. The identification and control of either of them will have a great bearing on the future health of the society. The prevalence of hypertension and overweight/obesity can vary in various parts of the world depending on the genetic predilection of the population, food and lifestyle factors and the level of knowledge in the community. The present study assessed the prevalence of overweight, obesity and high blood pressure among adolescent children (13-16 years) from selected high schools in Alappuzha, a coastal district in southern Kerala. This study also examined the relation between blood pressure and Body Mass Index in the study population.

METHODS

A Descriptive cross-sectional study was conducted at two Government High schools (Govt. High school Kalavoor and Mannancherry, Alappuzha district) were selected randomly. The study was conducted from June 2021 to December 2021 over a period of 7 months. A parental consent form was sent through the principal office of the 2 selected schools to parents of high school students. Study included students in 8th, 9th and 10th standard. Students excluded were those taking drugs like steroids or other drugs contributing to obesity or hypertension, children with any known chronic illness which may contribute to overweight, obesity and high blood pressure and those who were not willing to participate in the study.

The Sample size was calculated using the formula for sample size calculation based on Correlation Coefficient. The Sample Correlation coefficient was taken as 0.44, based on a study to find association of obesity with hypertension amongst school-age children belonging to lower income group and middle-income group in national capital territory of Delhi and the Population Correlation coefficient was taken as 0.35.⁸ The sample size was calculated to be 691; using 80% power, Alpha error of 5% and 95% Confidence Interval. After getting parental consent and assent from the students, the study was explained to the study subjects prior to data collection. A pre-designed semi structured questionnaire was used to collect detailed on socio-demographic variables, family history of hypertension, diabetes, cardiac disease and obesity, life style factors like physical activity, junk food and fruit and vegetable consumption and history of recent COVID infection. Anthropometric measurements (height and weight) needed to calculate BMI were recorded. Height was measured using Stadiometer with the footwear removed, standing straight and looking forward, shoulder in a relaxed position to the nearest 0.1cm. Weight was measured using a digital weighing machine (OMRON-HN289) with an accuracy of ± 100 gm. The weighing scale was calibrated at the beginning of every session. Participants were weighed in their light clothing after removal of footwear, belts and other personal accessories,

using the same weighing scale. Body mass index was calculated using the formula $\text{weight(kg)}/\text{height}^2(\text{m}^2)$. Body Mass Index was plotted on the revised IAP growth charts for 5-18yrs age group for Indian children based on which they were classified as undernourished/ normal/ overweight/ obese. Under and over weights were rechecked. Blood pressure was measured using the Digital Blood pressure apparatus (OMRON -HEM 7143T1A) standardized every day with the mercury sphygmomanometer and appropriate cuff size. BP was recorded in sitting position in right arm. High values of Blood pressure were rechecked 3 times after taking rest at 5 mts interval and average of second and third consecutive readings was taken^[6].

Statistical analysis

All the data were entered in Microsoft Excel Sheet and analysed using SPSS 16. Categorical and quantitative variables were expressed as frequency (percentage) and mean $\pm$ SD respectively. Chi-square test was used to find association between categorical variables. Statistical difference between the means were assessed by independent sample t test. For all statistical interpretations, $p < 0.05$ was considered the threshold for statistical significance. Relation between blood pressure and body mass index was expressed as correlation.

RESULTS

A total of 697 students were studied. The age of study subjects ranged from 13 to 16 years. Nearly three quarter (72.1%) of study subjects belonged to 14-15 year.

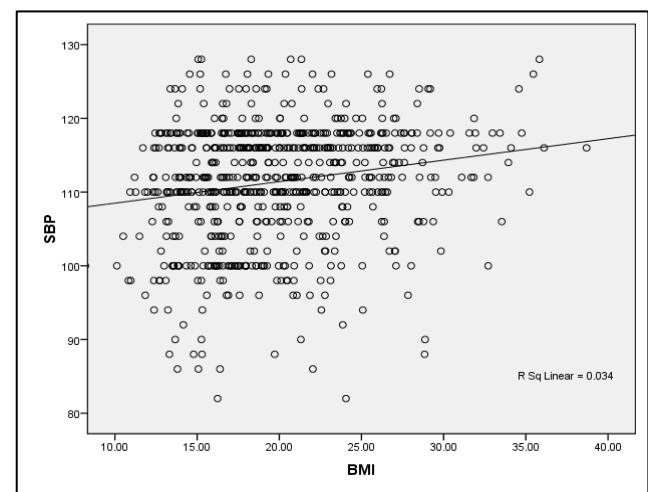


Figure 1: Correlation of BMI with systolic blood pressure.

Mean age of the study population was 14.27 ± 0.83 years. More than half (54.1%) were females which reflected the pattern in the general population. 98% children hailed from middle and upper lower class. The mean BMI of the study population was calculated to be $19.79 \pm 7.27 \text{ kg/m}^2$. The mean BMI of the girls ($20.15 \pm 9.22 \text{ kg/m}^2$) was found

to be greater than that of the boys ($19.37 \pm 3.83 \text{ kg/m}^2$), however this difference was not statistically significant

($t=1.4$, $p=0.16$). 7% (CI: 5.36-9.17%) were found to be obese while 19.8% (CI: 17.01-22.9%) were overweight.

Table 1: Socio-demographic characteristics.

Characteristics	Category	N (%)
Gender	Male/Female	320 (45.9)/377 (54.1)
Socioeconomic status	Upper class	6 (0.9)
	Upper middle	106 (15.3)
	Lower middle	273 (39.1)
	Upper lower	310 (44.5)
	Lower lower	2 (0.2)
Class /standard	8/9/10 standard	205(29.4)/169(24.2)/323(46.3)
Mode of Conveyance	Bicycle	275 (39.5)
	Walking	374 (53.6)
	Motor vehicle	48 (6.9)
Family H/O NCD	Hypertension	87 (12.5)
	Heart disease	82 (11.8)
	Obesity	27 (3.9)
	Diabetes mellitus	152 (21.8)
COVID-19 in past	Yes / No	89 (12.8)/608 (87.2)
Frequent physical exercise	Yes / No	660 (94.7)/37 (5.3)
Frequent vegetables/Fruits	Yes / No	412(59.1)/285 (40.9)
Frequent Junk food	Yes / No	167 (23.9)/530 (76.1)

*Noncommunicable disease, **Exercise ≥ 60 mts/day for ≥ 3 days per wk.***Intake for ≥ 3 days per wk

The overall prevalence of obesity and overweight was 26.8% (CI: 23.67-30.24%). 3.6% were under weight. 73.7% girls had normal BMI as against 64.7% boys. The prevalence of overweight was comparable among boys and girls (Boys :19.7%, N=63. Girls: 19.9%, N=75) while that of obesity was higher amongst boys (Boys: 10.6%, N=34. Girls: 4%, N=15) 30.3% of boys (N=97) and 23.9% girls (N=90) were overweight/obese.

Table 2: Nutritional status of the study population based on BMI (n=697).

Nutritional Status based on BMI	N (%)
Obesity	49 (7)
Overweight	138 (19.8)
Normal	485 (69.6)
Under weight	25 (3.6)

Table 3: Distribution of the study population according to Blood pressure.

Categories based on blood pressure	N (%)
Hypertension	0 (0)
Elevated BP	33 (4.7)
Normal	664 (95.3)
Total	697 (100)

A significant difference in nutritional status was noted between the boys and girls ($\chi^2=8.008$, $df=1$, $p=0.018$). 4.7% (CI: 3.39-6.57%) had elevated BP while none of the participants had hypertension (Table 3). 19 boys (5.9%) and 14 girls (3.7%) were detected to have elevated BP, the difference was not statistically significant ($\chi^2=1.89$, $df=$

1, $p=0.21$). The mean Systolic blood pressure of the study population was 112 ± 8 mmHg and mean Diastolic blood pressure of the study population was 70 ± 5 mm of Hg.

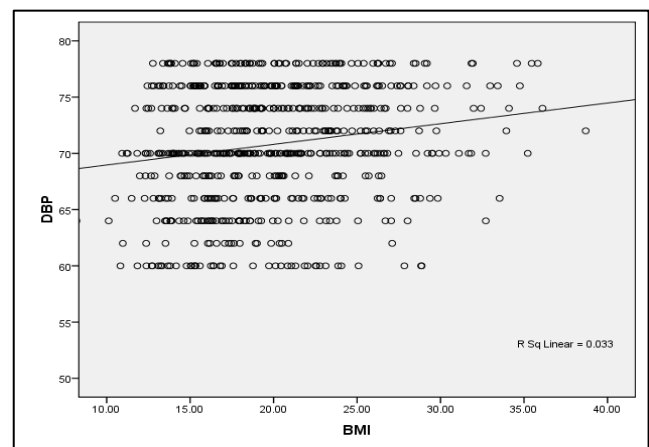


Figure 2: Correlation of BMI with diastolic blood pressure.

The difference in mean blood pressure of the boys and girls in the study population was found to be statistically not significant. A statistically significant positive correlation was seen between BMI and Systolic Blood pressure ($r=0.171$, $p=0.001$) (Figure 1) and BMI and Diastolic Blood pressure ($r=0.094$, $p=0.013$) (Figure 2). Among males a statistically significant positive correlation was seen between BMI and Systolic Blood pressure ($r=0.288$, $p=0.001$) (Figure 3) and BMI and diastolic blood pressure ($r=0.146$, $p=0.009$) (Figure 4). Among females a statistically significant positive correlation was seen

between BMI and Systolic blood pressure ($r=0.164$, $p=0.001$) (Figure 5), but not between BMI and Diastolic blood pressure ($r=0.085$, $p=0.101$) (Figure 6).

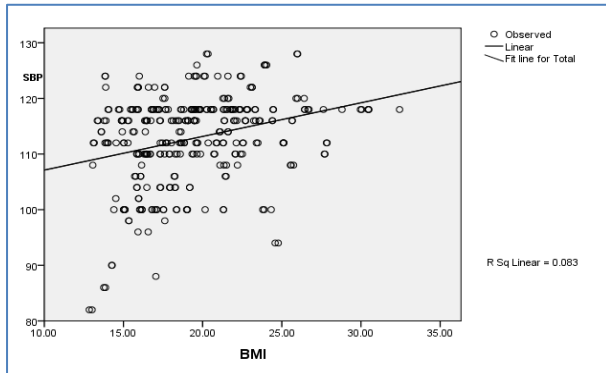


Figure 3: Correlation of BMI and systolic blood pressure based on male gender.

Of 37 students who had no physical exercise, 48.6% were found to be overweight or obese as compared to 25.6% amongst those with moderate to vigorous physical activity like walking, cycling or sports and the difference was statistically significant.

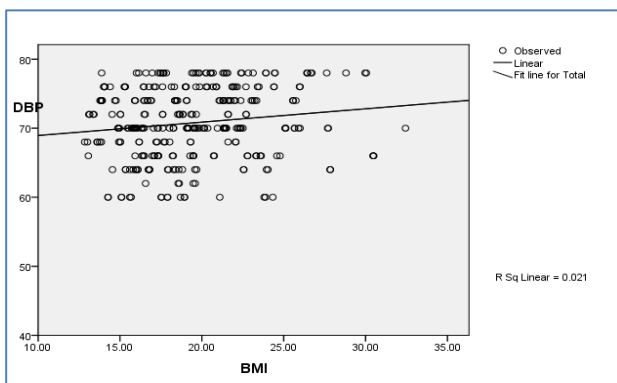


Figure 4: Correlation of BMI and diastolic blood pressure based on male gender.

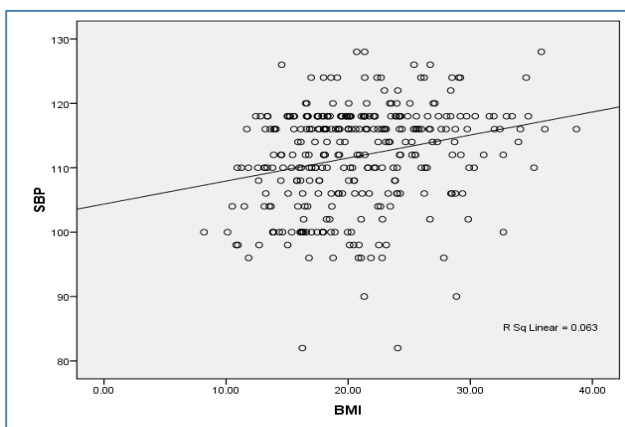


Figure 5: Correlation of BMI and Systolic blood pressure based on female gender.

Also elevated BP in this group was 13.5% against 4.2% in group with good physical activity. Of 167 students consuming junk foods thrice or more per week 28.1% was overweight or obese as compared to 26.4% among those who consume it less frequently. Also elevated BP in these groups were 9.5% and 3.2% respectively. Among students consuming fruits and vegetables thrice per week or more prevalence of overweight/obesity and elevated BP were 24.6% and 4.4% as against 28.4% and 5.3% in those taking it less frequently. Both elevated BP (5.6% vs. 4.8%) and overweight/obesity (32.6% vs. 25.9%) were higher in students who had previous COVID infection. The mean systolic (114 ± 6 mm Hg vs. 112 ± 8 mm of Hg) and diastolic (72 ± 4 mm of Hg vs. 70 ± 5 mm of Hg) pressures in students with past history of COVID 19 infection was found to be higher than the rest.

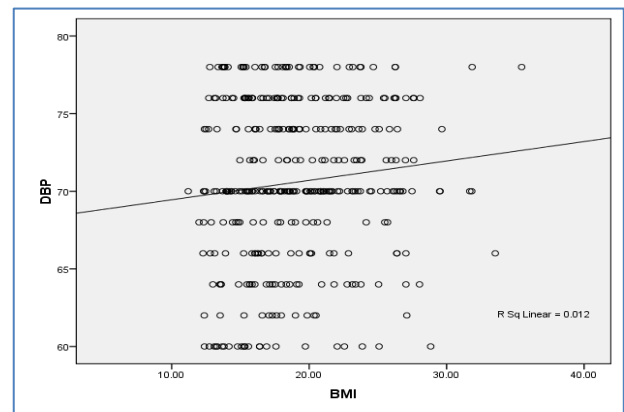


Figure 6: Correlation of BMI and Diastolic blood pressure based on female.

DISCUSSION

In our study out of 697 participants more than half (54.1%) were females. This is in accordance with the general trend in the population in this area (Sex ratio in Kerala as per NFHS 5 survey 1121 females for 1000 males.⁹ Students were aged between 13 to 16 years with most in 14-15 year group ensuring uniformity of the sample. The prevalence of overweight and obesity were 19.8% and 7% respectively. The WHO global estimate of overweight and obesity in adolescent population is 18% and 7% respectively.¹⁰ Indian studies have shown a range from 9.7%, 4.3% in a study in Pondicherry to as high as 25.8%, 12.8% in a Gujarat based study for overweight and obesity respectively.¹¹⁻¹³ Various studies conducted in Kerala by Alice et al, Little Flower et al, Babu George et al have shown a prevalence of overweight and obesity in range of 12-24% and 6-10% respectively. The prevalence in our study was roughly corresponding to the general trend at national and international levels.^{14,15} We were actually expecting a hike in overweight/obesity amongst children due to the COVID pandemic and restricted play activity but it was found the reverse. It may be because our study population was mostly class X students attending board exams who were attending classes and school more mandatorily than the rest of the children. The rigorous

study activity might have kept the obesity at check. Elevated blood pressure was detected in 4.7% and none of the participants had hypertension. In a study by Rafraf et al in similar age group in Iran in 2010 prevalence of elevated BP was 13.9% and hypertension was 19.4%. In Indian studies prevalence of elevated BP and hypertension varies from 6.5% and 7% in Indore study to 21.6% and 8.9% in a Bangalore study.¹⁶⁻¹⁸ In a school based study done at Ettumanoor, Kerala.¹⁹ 24.5% (males 30.5%, females 20.3%) were having elevated BP and 0.6% (males 0.98%, females 0.34%) were having hypertension. In the current study the prevalence of elevated BP was found to be much low as compared to literature. Among study subjects 5.9% males and 3.7% females had elevated BP which shows no significant change with age and gender. As compared to the other parts of Kerala, the use of cycle among school students is much more common in this part. In our study 39.5% of students were using cycle and 53.6% of them were coming by walking to school. Only 7% were using motor conveyance. 75% used junk foods less than 3 times were week. As our study was in government run school which mostly has students from middle class and lower-class backgrounds, the above observations may be due to their economic background too. Fish is a vital part of diet in majority of the people also. The rigorous physical activity and non-urban life style might have contributed to the lesser incidence of obesity and elevated BP in this study.¹⁹ The prevalence of overweight/obesity and elevated BP was found to be higher among boys. In Atlas of Obesity 2019 created by IOTF, a similar pattern has been observed in 60% countries, but mostly in higher and upper middle income groups.²⁰ Definite reason for this has not been explained but has been attributed to multiple factors like higher leptin levels in girls, socio cultural beliefs on feminine body pattern of 'thinness' in girls, high calorie intake amongst boys etc. Our study reflects that the outlook promoted by higher education levels and globalised media might be contributing to the evolution of similar patterns in such small towns in lower income countries too. A positive significant correlation was seen between BMI with systolic blood pressure as well as between BMI and diastolic blood pressure. It was in accordance with the published literature. Various cross sectional studies conducted in different parts of the country amongst urban and rural population have proved significant correlation between BMI with systolic blood pressure and diastolic blood pressure.⁸ Overweight and obesity were associated with a higher risk of high BP in both younger (prevalence ratio: 1.17, 95% CI :1.04-1.34) and older children (prevalence ratio: 1.33, 95% CI: 1.18-1.49) as per study conducted by Vadsudevan et al in New Delhi.²¹ Amongst the various lifestyle factors evaluated, junk food consumption, less physical activity were found to have increased prevalence of obesity and elevated BP. The relation between junk food and high BP have been previously reported by Payab et al in a study amongst Iranian adolescent children published in 2015.²² Intense physical activity has been found to bring down BP in adolescents in studies conducted by Gopinath et al in Australia and Wellman et al in Canada.^{23,24} However the

data in our study could not be statistically analyzed as it was not the primary outcome and hence sample size was not sufficient. In our study it was also found that the mean systolic and diastolic BP were higher in children with history of COVID-19 infection. Similar observation of higher systolic and diastolic BP was reported among COVID-19 survivors by Mahmut Apek and by Gotenda et al in hypertensive patients. As COVID-19 is reported to have serious implications on vascular health, future research may be required in this line.⁹

Limitations

The main limitation of the study is that it represents the middle and low socio-economic status adolescent population. Apart from those in whom elevated BP was detected, repeated measurements were not routinely carried out to confirm the BP recording. Sample size was insufficient to statistically confirm causal associations.

CONCLUSION

Overweight/obesity and elevated BP were prevalent among high school students in Kerala. Prevalence of Obesity and elevated BP were found to be high among male children. Underweight continues to exist in high school children and should be addressed. Those with overweight and obesity had high blood pressure. Systolic and diastolic Blood pressure showed significant positive correlation with Body mass index irrespective of gender. Higher prevalence of obesity as well as elevated BP were found among adolescents with less physical activity and frequent junk food intake. Mean systolic and diastolic BP were found to be higher in adolescents who survived COVID-19 infection.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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