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A study on relation between BMI and hypertension among adolescents in Kancheepuram district, Tamil Nadu

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Abstract

Background - Prevalence of overweight and obesity in adolescents has increased markedly in the last two decades. Hypertension among adolescents is often unrecognized, under diagnosed and hence unmanaged. But limited data is available in India regarding the prevalence of both these health problems.

Objectives – To find out the association between Body Mass Index (BMI) and hypertension among adolescent school students in Kancheepuram district, Tamil Nadu.

Methodology – A cross sectional school based study was done among 934 students aged 14-17 years studying Class IX to Class XII in selected four schools of Kancheepuram district. A pre tested questionnaire was used to collect information regarding the socio demographic details, diet pattern and physical activity. Height, weight and blood pressure were also measured.

Results - Among the study population 124 (13.28%) were found to be overweight/ obese and 67 (7.17%) were identified as hypertensives. There was a significant positive correlation between Systolic and Diastolic Blood Pressure with age, height, weight and BMI in the study population. High BMI ($P<0.001$) and family history ($P=0.03$) were found to be significant risk factors for hypertension in the study population.

Conclusion - From the study results it was seen that both obesity and hypertension were prevalent among adolescents even in rural areas. Also, high BMI has a significant association with hypertension. To conclude, both obesity and hypertension have to be identified and managed from a younger age, so as to avoid major complications at a later stage.

Keywords: BMI, hypertension, adolescents, height and weight.

1. Introduction

Globally, obesity has become a colossal epidemic causing serious public health concern and contributes to 2.6 million deaths worldwide every year.^[1] Obesity is associated with an increased risk of morbidity and mortality as well as reduced life expectancy. The last two decades of the previous century have witnessed dramatic increase in health care costs due to obesity and related issues among children and adolescents.^[2] It has been estimated that worldwide over 22 million children under the age of 5 are obese, and one in 10 children is overweight. Obesity and overweight among children have significant long term health consequences such as adult obesity, higher levels of cholesterol, the higher future incidence of coronary artery disease^[3].

Hypertension emerges from a complex interplay of genetic, environmental and behavioural factors. Owing to the hereditary component of hypertension, the disorder is considered to have its origin in the childhood. Children and adolescents with high Blood Pressure (BP) tend to maintain those levels of BP in adulthood^[4]. As the symptoms of childhood and adolescent hypertension are largely nonspecific, most children with hypertension are likely to be undiagnosed. Since there is no established standard for hypertension among adolescents in India, studies have reported a wide range in the prevalence of hypertension in children and adolescents from 1% to 11.5%^[5].

Primary hypertension in the adolescents is becoming increasingly common in association with obesity. Moore WE *et al.* in their study healthy Kids Project reported 28% of overweight among 769 students from Anadarko student population, they found that BMI more than 95th percentile was strongly associated with elevated BP (RR-3.8;95%CI:2.6-5.4).^[6] In a study conducted in China by He Q *et al.* hypertension was seen in 19.4% of obese

children and 7% in non-obese children with $P < 0.0001$. Both Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) 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. [7] Raj M *et al.* has reported a rising trend of obesity among school children in Ernakulam district of Kerala. Hypertension was found among 17.34% of overweight children vs. 10.1% among other students ($P < 0.001$). [8] Limited data was available on obesity and hypertension among adolescents in Tamil Nadu and so the present study was undertaken to find out the association between BMI and hypertension among adolescent school students in Kancheepuram district, Tamil Nadu.

2. Materials and Methods

This cross-sectional study was conducted among students in the age group of 14 to 17 years studying in Class IX – Class XII in four selected Higher Secondary Schools in rural areas of Kancheepuram district. The students who were absent during the study period and the students whose parents were not willing to allow their children to participate in the study were not included in the study. The Sample size was calculated on the basis of 9.4% prevalence rate of hypertension among school children in Aligarh in a study conducted by Anisa M. Durrani *et al.*, with allowable error of 20%, using the formula, $n = Z^2 \frac{p \times q}{d^2}$, sample size came to 865. Assuming 10% non-response, sample size is calculated as 950. The study was carried out using two stage random sampling method.

The study was done using a pre tested and structured questionnaire. The questionnaire included four parts namely, socio demographic details & family history, details of diet pattern, physical activity and measurements – height, weight and blood pressure. Permission was obtained from concerned school authorities, parental consent forms were given to students. Those who gave consent were included in the study and were given questionnaires. Then, measurements were taken. Height was measured using a portable plastic stadiometer (Bioplus™) which is a wall mountable type. The student was asked to stand in an erect posture without wearing shoes/footwear. Weight was measured using a portable weighing machine (Belita®). Usual school dress can be worn but without shoes/any footwear. The scale was zeroed before weighing each student and also machine was calibrated before each visit using standard known weights. Blood pressure was measured using the mercury sphygmomanometer (Diamond Deluxe Mercury BP apparatus). Before taking Blood pressure, the subject was asked to rest for five minutes and no caffeine before an hour and BP was measured in the right arm with the subject in sitting position and with the arm at the level of the heart. Appropriate sized cuff was used which covers two thirds of the arm and the cuff was applied evenly on the bare right arm with the lower edge approximately 2.5 cm above the ante cubital fossa. WHO criteria were followed in recording BP and the average of the two readings recorded 5 minutes apart was taken as BP.

BMI percentiles were calculated for each age and sex group. Those with BMI percentile between 5th to 85th percentile were taken as normal. Those with BMI percentile between 85th percentile and 95th percentile were considered as overweight and above the 95th percentile as obese. Similarly, BP percentiles were calculated for each age and sex. Those

with SBP or DBP >95th percentile were classified as hypertensives. Data was entered into Microsoft excel spreadsheet. Analysis was done using SPSS for Windows 16.0 software. Continuous data were expressed in terms of mean and standard deviation and categorical data as proportions. The correlation was tested by Pearson's Correlation co-efficient. To test the association Chi square test was used for categorical variables and P value < 0.05 was taken as statistically significant.

3. Results and Discussion

There were 934 participants in the study among which 458 (49%) were boys and 476 (51%) were girls. According to age wise distribution 270 (28.9%) were aged 14 years, 272 (29.1%) were aged 15 years, 202 (21.6%) were aged 16 years and the remaining 190 (20.3%) were of 17 years of age. It was also seen that among the study participants, 92.9% were Hindus, 5.5% Christians and 1.6% Muslims. As per Modified BG Prasad classification 5.6% belonged to Class I, 33.5% belonged to Class II, 26.3% belonged to Class III, 25.5% belonged to Class IV and the remaining 9.1% belonged to Class V.

Table 1 shows that the mean BMI of the study population was 17.78 with a standard deviation of 3.14 and the mean BMI increases from 16.84 at 14 years to 18.52 at 17 years of age. Among the study population, 83 (8.89%) were overweight, 41 (4.4%) were obese and overall, the prevalence of overweight/ obesity was found to be 13.28%. Alice *et al.* has reported a similar prevalence among children in Kerala (13.2% for boys and 17.4% among girls) [9].

Nomograms for blood pressure were constructed for the study group (14-17 years). Table 2 shows the blood pressure percentiles for boys, girls and overall percentile. Overall out of the 934 students examined 67 (7.17%) were found to have hypertension (95% CI: 5.51%-8.82%). It was observed that the prevalence of hypertension increased with age. From 6.67% at 14 years of age to 6.98%, 7.43% and 7.89% at 15, 16 and 17 years of age respectively. The mean SBP was found to be 111.96 mmHg and the mean DBP was 69.53 mmHg (Table 3). According to the study findings, mean SBP among boys (112.48 mmHg) was higher than girls (111.48 mmHg) and mean DBP (70.16 mmHg) was higher among girls when compared to boys (68.86 mmHg). Durrani AM *et al.* [10] has reported a similar finding among school children in Aligarh. But Jaddou HY *et al.* [11] and Soudarssanane MB *et al.* [12] have reported that both mean SBP and mean DBP were higher among boys.

Among the 67 hypertensives 29 (43.28%) were having Isolated Systolic Hypertension, 21 (31.34%) were having Isolated Diastolic Hypertension and the remaining 17 (25.37%) were having both Systolic and Diastolic Hypertension. Soudarssanane MB *et al.* [12] have also reported Isolated Systolic Hypertension to be the most common (38.6%). Isolated systolic Hypertension is a strong predictor of cardiovascular diseases and the higher prevalence of it among the adolescents needs special attention. There was a positive correlation observed between SBP and DBP in the study population and variables such as age, height, weight and BMI. Taksande A *et al.* [13], Durrani AM *et al.* [10] and Soudarssanane MB *et al.* [12] have all reported a similar positive correlation between SBP and DBP with the above variables. Except for the correlation between age in girls and SBP other variables were significantly correlated with both SBP and DBP at 0.01 level (Table 4).

These findings show that just like height, weight and BMI, blood pressure is also increasing with age as a part of biological maturation.

Table 5 shows the degree of association of various factors with hypertension among the study group. There was a significant association between hypertension and overweight & obesity in the study population. Prevalence of

hypertension among them was 25%, in contrast to the prevalence among those with normal BMI (4.4%). Raj M *et al.* [8] has reported 17.34% prevalence of hypertension among overweight. Similar findings were reported by Moore WE *et al.* [6], He Q *et al.* [7] and Burgos *et al.* [14] in various countries.

3.1 Tables: Mean BMI, BMI percentile, Overweight and Obesity among the study population

Age	No.	Mean BMI (SD)	BMI Percentile		Over Weight No. (%)	Obese No. (%)	Total No. (%)	95% CI
			85 th	95 th				
14	270	16.84 (3.02)	19.61	22.64	21 (7.77%)	13 (4.8%)	34 (12.59%)	8.63%-16.55%
15	272	17.61 (2.67)	20.44	22.94	26 (9.56%)	12 (4.4%)	38 (13.97%)	9.85%-18.09%
16	202	18.50 (3.34)	21.93	24.83	19 (9.41%)	7 (3.5%)	26 (12.87%)	8.25%-17.49%
17	190	18.52 (3.32)	22.17	25.25	17 (8.95%)	9 (4.7%)	26 (13.68%)	8.79%-18.56%
Total	934	17.78 (3.14)	20.82	23.81	83 (8.89%)	41 (4.4%)	124 (13.28%)	11.10%-15.46%

Table 2: Blood Pressure percentile among the study population

	Age(yrs)	Sex	Percentiles						
			5	10	25	50	75	90	95
SBP (mmHg)	14	Boys	86	90	98	104	112	128	135.6
		Girls	90	90	100	110	120	128	133.6
		Overall	90	90	100	108	118	128	134.9
	15	Boys	90	95.6	100	110	118	128	138
		Girls	96	100	102	110	120	124	131.5
		Overall	90.1	98	100	110	120	127.8	136
	16	Boys	90.6	100	110	118	123	132	138.8
		Girls	98	100	107	110	124	132.4	136.4
		Overall	94.3	100	110	114	124	132	137.7
	17	Boys	100.3	104	110	116	126	133.4	139.4
		Girls	90	95.6	100	110	120	130	135.3
		Overall	96	100	108	112	124	132	136
DBP (mmHg)	14	Boys	54.4	56.8	60	68	70	80	80
		Girls	54	56	60	70	76	80	86
		Overall	54	56	60	70	72	80	81.8
	15	Boys	50	50	60	70	76	80	80
		Girls	54	58	60	70	76	80	86
		Overall	50	56	60	70	76	80	83.9
	16	Boys	54	56	60	70	78	84	89.4
		Girls	55.6	58	65	70	79	82	88
		Overall	54	56	62	70	78	84	88
	17	Boys	56	60	66	70	78	82	84
		Girls	60	60	68	72	80	82	87.3
		Overall	58	60	68	72	80	82	86

Table 3: Distribution of Blood Pressure and Hypertension among the study population

Age	Sex	No.	Mean SBP (SD)	Mean DBP (SD)	Hypertension No. (%)	95% CI for Hypertension
14	Boys	123	106.24(14.54)	67.4(9.07)	8(6.5%)	2.15% -10.85%
	Girls	147	109.96(13.92)	68.44(10.53)	10(6.8%)	2.73%-10.86%
	Overall	270	108.27(14.3)	67.96(9.88)	18(6.67%)	3.69%-9.64%
15	Boys	128	110.34(12.9)	67.9(10.32)	9(7.03%)	2.60%-11.45%
	Girls	144	111.07(10.43)	69.61(9.078)	10(6.94%)	2.78%-11.09%
	Overall	272	110.81(11.63)	68.72(9.63)	19(6.98%)	3.95%-10.00%
16	Boys	105	116.94(13.09)	69.35(10.95)	8(7.62%)	2.54%-12.69%
	Girls	97	115.16(13.29)	71.24(9.66)	7(7.22%)	2.06%-12.37%
	Overall	202	116.09(13.2)	70.26(10.37)	15(7.43%)	3.81%-11.04%
17	Boys	102	118.05(12.04)	71.49 (8.71)	8(7.84%)	2.6%-13.05%
	Girls	88	110.7(12.75)	73.16(8.41)	7 (7.95%)	2.29%-13.60%

	Overall	190	114.65(12.87)	72.26(8.59)	15(7.89%)	4.05%-11.72%
Total	Boys	458	112.48(13.97)	68.86(9.88)	33(7.2%)	4.83%-9.56%
	Girls	476	111.48(12.68)	70.16(9.65)	34(7.14%)	4.82%-9.45%
	Overall	934	111.96(13.32)	69.53(9.78)	67(7.17%)	5.51%-8.82%

Table 4: Correlation between SBP and DBP with Age, Height, Weight and BMI

Variable		SBP	DBP
Age	Boys	0.334*	0.152*
	Girls	0.067	0.173*
	Overall	0.208*	0.157*
Height	Boys	0.459*	0.146*
	Girls	0.204*	0.201*
	Overall	0.350*	0.131*
Weight	Boys	0.596*	0.266*
	Girls	0.453*	0.358*
	Overall	0.533*	0.304*
BMI	Boys	0.511*	0.268*
	Girls	0.404*	0.297*
	Overall	0.428*	0.291*

*-- Correlation coefficient significant at 0.01 level (two tailed)

Table 5: Association of Hypertension with various factors

Variable		Chi square value	df*	P value
Socio demographic factors	Age	0.286	3	0.96
	Sex	0.001	1	0.971
	Socio economic class	0.974	4	0.974
Family history of hypertension		4.614	1	0.032
Diet pattern	Vegetables intake	0.012	1	0.911
	Fruits intake	0.005	1	0.946
	Non vegetarian food intake	1.901	1	0.168
	Junk foods intake	0.074	1	0.785
	Cooking oil	0.039	1	0.844
	Salt Intake	0.002	1	0.967
Physical Activity	Mode of going to school	0.083	1	0.77
	Frequency of playing outdoor games	0.002	1	0.96
	Hours of play	0.418	1	0.52
	Hours of Television watching	0.016	1	0.9
Overweight/ obese		68.237	1	<0.001

*- degree of freedom

4. Conclusion

This study establishes the fact that both overweight/obesity and hypertension are prevalent among adolescents in rural areas also and there is a need for school based screening programme for primary and secondary prevention of these problems among adolescent school students. Standard BMI and Blood Pressure percentile charts for Indian adolescents should be prepared so as to have uniformity in classification of obesity and hypertension. The study also shows that overweight/obesity is a significant risk factor for hypertension in the study population. This requires urgent attention failing which the burden of hypertension in adolescents will result in serious consequences such as increased incidence of cardiovascular diseases when they become adults. Further larger multi centric community based studies are needed to assess the burden of obesity and hypertension among adolescents.

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