**Original article**

**Prevalence of sustained hypertension among adolescent school**

**children in Puducherry**

**Dr. Seenu Prasanth. A1, Dr.** **Kavitha. B2,** **Dr.** **K.** **Bhuvaneswari3, Dr.Vinoth.** **P3**

1. Senior Resident, Department of Cardiology, AIIMS Nagpur.
2. Professor, Department of General Medicine, Indira Gandhi Medical College & Research Institute, Puducherry.
3. Associate Professor, Department of General Medicine, Indira Gandhi Medical College & Research Institute, Puducherry.

**Corresponding** **author:** Dr. Seenu Prasanth. A (seenuprasanth.a@gmail.com)

**Abstract**

**Introduction**: Primary hypertension in adolescent children has become increasingly common in association with other cardiovascular risk factors that include obesity, insulin resistance and dyslipidemia. Hypertension in adulthood often has its origin in childhood and hence it is vital to detect it at the early stage.

**Aims**: The aim of this study is to determine the prevalence of sustained hypertension among adolescent school children and its association with obesity. It was also aimed to compare the obtained data between the children studying in public schools to those studying in schools run by private institutions.

**Method**: It is a cross-sectional, comparative study wherein a total of 1005 students (494 boys and 511 girls); 493 from private school and 512 from public schools between the ages 12-17yrs were included in the study. Height (in cm) and weight (in kg) were recorded along with blood pressure measurement using a sphygmomanometer. International Obesity Task Force classification was utilized for the estimation of overweight and obese subjects. The evaluation of hypertension was based on the Update on the 1987 Task Force Report on High Blood Pressure in Children and Adolescents.

**Results**: Overall prevalence of hypertension and pre-hypertension were 10.9% and 8.2% respectively (boys 39% and girls 61%). There was no significant difference between prevalence of hypertension among girls and boys and between students from public and private schools. There was significant correlation between hypertension and BMI.

**Conclusion**: We found that the prevalence of hypertension among the adolescents was very high, as compared to earlier studies conducted here, especially among the overweight and obese students.

**Keywords**: Hypertension; obesity; adolescent schoolchildren; prevalence

**Introduction**

Increasing trend of hypertension is a worldwide phenomenon. It is also seen in developing counties like India. Three serial epidemiological studies carried out during 1994(1), 2001(2) and 2003(3) demonstrated rising prevalence of hypertension (30%, 36%, and 51% respectively among males and 34%, 38% and 51% among females). Once considered relatively rare, primary hypertension in children has become increasingly common in association with other cardiovascular risk factors that include overweight, insulin resistance and dyslipidemia. (4, 5)  Blood pressure tracking studies suggest that hypertension in adulthood often has its origin in childhood. Indeed, bl-ood pressure in children is the best predictor of hypertension in later life. Hypertension is a major contributor to cardiovascular morbidity and mortality. The prevalence of hypertension among adolescents done in previous studies varies from 2.2% to 9.25% in India and abroad. [6- 13 ] It is also seen that from these studies, that there is a significant correlation between high blood pressure and increasing BMI in adolescents.[6-13]

**Table 1**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Authors | Place | Age group |  Year | Prevalence of hypertension | Correlation with BMI |
| Soundarssanane | Puducherry, India | 15-19yrs | 2002 | 8.5% | Yes |
| Mohan B et al. | Ludhiana, India | 11-17yrs | 2004 | 9.25% | Yes  |
| Taksande et al. | Wardha, India | 6-17yrs | 2006 | 5.75% | Yes |
| L Saha et al. | Kolkata, India | 10-19yrs | 2008 | 2.9% |  |
| Veena K G et al | Mangalore,India | 5-16yrs | 2010 | 2.2% | Yes  |
| Sharma A et al. | Shimla, India | 11-17yrs | 2010 | 5.9% | Yes  |
| Mostafa A et al. | Alexandria,Egypt | 11-17yrs | 2010 | 4% | Yes |
|  Niece KLet al. | Texas, USA | 11-17yrs | 2003-2005 | 9.4% | Yes |

Obesity is considered as the main risk factor for hypertension.[14,15] The prevalence of systolic hypertension among underweight was 1.4% and that among obese was 12.5%.[10,14] Prevalence of overweight/obesity among adolescents and young adults reported by various studies conducted in various Indian states were between 18% [16] to 26%.[17] A prevalence of 26% [18] (BMI>25) among affluent school boys aged between 10-15yrs was reported in Pune, while the prevalence was 24% [19] for overweight/obesity (BMI>23) among urban college going girls of age 17-18yrs in Ernakulam, Kerala(India).

 **Aims & Objectives:**

To evaluate the prevalence of sustained hypertension based on blood pressure readings taken during three visits and To find out the association of blood pressure with BMI And further to look for possible differences in the prevalence of hypertension among students studying in the private and public schools of Puducherry.

**Method**:

This is a cross-sectional, comparative study, conducted in four randomly selected schools (2 private and 2 pub-lic) of Puducherry. A total of 1005 students, aged 12-17years, 493 boys and 512 girls, participated in the study, after obtaining consent from Institute Ethics Committee and school authorities. Sample size (N) was derived as 1076 by using the formula, N= 4PQ/L2 , where P (8.5%)is the prevalence, Q is 100-P and taking the power

of s-tudy to be 20% of prevalence (1.7) and it was approximated to 1005. Anthropometric measurements and blood pressure were measured in all the students in the four schools.

Determination of Blood pressure:

Blood pressure was measured using standard methodology as recommended by The Fourth Report on the diagnosis, evaluation and treatment of high blood pressure in children and adolescents.[15] Average systolic or diasto-lic blood pressure greater than or equal to 95th percentile for gender, age and height is considered as hypertensi-on. Pre-hypertension is defined as average systolic blood pressure or diastolic blood pressure that is greater than or equal to 90th percentile but less than 95th percentile. Children with blood pressure levels between 120- 140 mmHg systolic and 80- 90 mmHg diastolic were also considered pre-hypertensive.[15]

Assessment of Obesity:

 WHO classification was utilized for the estimation of overweight and obese subjects. Overweight is defined as children with BMI value between 85th to 95th percentile for a specific age and sex. Similarly obesity is defined as children with a BMI value above 95th percentile for a specific age and sex.[14]

Follow up:

Two more additional visits were done after a gap of 2 weeks to record blood pressure in those children who wer-e found to have an elevated blood pressure in the first visit. Hypertension or Pre-hypertension was defined as el-evated blood pressure on all three visits.

Statistical Analysis:

Data was analysed using statistical package using Microsoft excel and SPSS version 21. Descriptive statistics like mean and percentages was calculated. Chi square test was used to find the difference between the variables. P value of less than 0.05 was considered statistically significant. Unpaired t test was used to compare means of the two groups.

**Results**

Of the 1005 apparently healthy school children who participated in the study, 493(49%) were boys, [of them 253 boys were from a private school and 241 from a public school]. 512 were girls (51%), [256 each were fr-om private and a public school respectively]. Their mean age was 14.7 years. The baseline characteristics of the study population are are represented in Table 2 & 3

Table 2 Table 3

|  |  |  |  |
| --- | --- | --- | --- |
|  | Boys  | Girls  | Total |
|  Private schools | 254 | 258 | 512 |
| Public schools | 239 | 254 | 493 |
| Total | 493 | 512 | 1005 |

|  |  |  |  |
| --- | --- | --- | --- |
| Age (years) | Total | Boys | Girls |
| 12yrs | 52 | 17 | 35 |
| 13yrs | 172 | 82 | 90 |
| 14yrs | 200 | 94 | 106 |
| 15yrs | 274 | 134 | 140 |
| 16yrs | 219 | 106 | 113 |
| 17yrs | 88 | 60 | 28 |
| Total | 1005 | 493 | 512 |

Overall, the prevalence of hypertension was 10.9% (n= 110) and that of prehypertension was 8.2% (n= 82 ). The mean systolic and diastolic blood pressure of hypertensive population in both public and private school students was significantly higher than systolic and diastolic blood pressure in their normotensive counterparts (public sc-hool normotensive systolic blood pressure:109 +/- 9.24mmHg, public school hypertensive systolic blood press-ure: 133.67.59+/- 20.19 mmHg. Private school normotensive systolic blood pressure: 109.41+/- 9.99 mmHg, p-rivate school hypertensive systolic blood pressure: 138.37 +/- 22.63 mmHg, public normotensive diastolic blo-od pressure: 75 +/- 9.21 mm Hg, public school hypertensive diastolic blood pressure: 85.60 +/- 9.74 mmHg , p-rivate school normotensive diastolic blood pressure:71.58 +/- 9.55 mmHg, hypertensive diastolic blood pressu-re: 83.23+/- 11.66 mmHg). Number of hypertensive boys were found maximum the 12yrs and 17yrs (12%), wh-ile for girls it was seen in the 14yrs age (22%).

Table 3:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variables |  | Hypertensive (n=110) | Prehypertensive(n= 82) | Normotensive(n= 813) | Significance (Chi Square) |
| Gender | Boys | 43 ( 39%) | 39 | 411 | P= 0.075 |
| Girls | 67 ( 61%) | 43 | 402 |
| Total | 110 | 82 | 813 |
| Schools | Public | 51 | 39 | 403 | P= 0.787 |
| Private | 59 | 43 | 410 |
| Total | 110 | 82 | 813 |
| BMI | Obese | 29 | 9 | 29 | P < 0.05 |
| Overweight  | 28 | 16 | 103 |
| Normal | 53 | 57 | 681 |
| Total | 110 | 82 | 813 |
| Exercise | Yes | 16 | 11 | 178 | P= 0.052 |
| No | 94 | 71 | 635 |
| Total | 110 | 82 | 813 |
| F/H ofHypertension | Yes | 48 | 31 | 216 | P < 0.05 |
| No | 62 | 51 | 597 |
| Total | 110 | 82 | 813 |
| Junk Food | Yes | 29 | 37 | 309 | P < 0.05 |
| No | 81 | 45 | 504 |
| Total  | 110 | 82 | 813 |

**Significant association of BMI and hypertension**

**Table 4** illustrates the correlation of blood pressure with the BMI and other variables and their significance using Chi square. The overall prevalence of obesity was 6.6% (n = 67 ) and that of overweight students was 14.6% (n = 147 ) , of them 57 (26.6%) were hypertensive and 25 (11.5%) were prehypertensive. The mean BMI of the students was 19.78 kg/m2. Of the obese subjects, boys and girls were 33 and 34 in number respectively.

Number of overweight and obese students was significantly higher among private schools with a p value of < 0.05. There was significant increase in prevalence of hypertension in public and private school children with increased body mass index (overweight & obese), [p < 0.001]. Family history of hypertension was met with in significantly higher (p < 0.05) number of children with sustained hypertension (n=48) as compared to normote-nsive students (n=216 ).

Although not statistically significant, more number of students who said that they cons-umed junk food regularly (atleast 3 times weekly) were found to be hypertensives (p of 0.019). No correlation was elicited between hypertensives who exercised regularly and those who did not do so.

**Discussion**

Hypertension is a major risk factor for cardiovascular and cerebrovascular diseases. Studies indicate that BP increases with age (12–16). Population-based epidemiological studies show that primary hypertension is more common among apparently healthy children [9]. Although the prevalence of hypertension is far less in children than in adults,[9-17] there is enough evidence to suggest that the roots of essential hypertension extend into child-hood. Obesity and weight gain are strong, independent risk factors for hypertension. It has been estimated that 60% of hypertensives are overweight. There is a well-documented association between obesity (body mass ind-ex >30 kg/m2) and hypertension. Further, cross-sectional studies indicate a direct linear correlation between bo-dy weight (or body mass index) and blood pressure. Centrally located body fat is a more important determinant of blood pressure elevation than is peripheral body fat. In longitudinal studies, a direct correlation exists betwe-en change in weight and change in blood pressure over time. It has been established that 60–70% of hyperten-sion in adults may be directly attributable to adiposity. The constellation of insulin resistance, abdominal obes-ity, hypertension, and dyslipidemia has been designated as the *metabolic syndrome*

In the present study among adolescents aged 12-17 years in private and public school children of urban Puduch-erry, the overall prevalence of hypertension was found to be 10.9%, which was higher in females (61%) than m-ales (39%). Elsewhere, studies on population of 13-18 years [18], 15-24 years [19] and 15-25 years [20]  had obser-ved the same findings. It was seen that the private school children had a higher number of hypertensives 11.5% as compared to those from government schools 10.3%, although not statistically significant. This could be due to increased urban, sedentary lifestyle and unhealthy food habits in the children across all groups. Previous stud-ies showed it was more in urban children due to the difference in the socio-economic status of both the groups as also reported by Gilbert et al[21]. Life style modification between the upper the lower socio-economic classes could have had an indirect bearing on blood pressure levels.

The present study is evident that increase in BMI predisposes the adolescent individual to higher blood pressure and subsequent hypertension. A similar finding was also reported elsewhere in India, [22]  Hungary [23] and Fra-nce [24]. Shah et al had reported the prevalence of overweight and obesity to be 9.25% and 5.55% respectively in an urban area of Bhavnagar city, Gujarat [25]. Obesity in children is associated with an increased incidence of hypertension, diabetes, coronary artery disease, osteoarthritis and an overall increase in morbidity and mortality d-uring adult life.[26] The various reasons found out for hypertension in obese children are increased cardiac out-put,high sodium intake, increased steroid production and alteration in the reception for various substances[23]
A statistical significance was found between overweight/obesity and hypertension in the present study. Previous studies done in India have confirmed this finding.[24,25,26] Thus the present study strengthens the fact that overwe-ight and obesity is an important association of hypertension. This study also reveals that age and family history of hypertension are significantly related to the hypertensive child. Unhealthy diet has also been found to be sign-ificantly associated with hypertension in the study population.

* **The limitation** of this study is that the certainty of the causal direction of the associations observed and the findings associated with hypertension cannot be clearly arrived at, due to the study’s cross-sectional design. A longitudinal study with repeated measures of body composition and blood pressure would be desirable in the future. Secondly, the secondary causes of hypertension were not excluded by conducting appropriate investigations.
* Waist circumference, which is an ideal indicator of central obesity, was not measured.

 **Recommendations:**

Hypertension screening and follow-up with regular blood pressure measurements should be introduced in the routine school health programs.Assessment of obesity should also be included in the above along with offering health education regarding adversities of obesity and methods to curb it at an early stage in ones life.Cardiova-scular risk factors should be detected and prevented as early as the childhood itself. Programs and policies to li-mit sedentary behaviours and promote activity and healthy nutrition among school children are recommended.

**Conclusion**

Obesity is considered as the main risk factor for hypertension. In this study the prevalence of hypertension was found to be higher as compared to the previous similar study in Puducherry adolescents which points to the alarming rate of increase in the components of metabolic syndrome. This study will also be helpful to re-emphasize the need for preventive measures to control overweight / obesity in children which is considered as the risk factor for hypertension, cardiovascular disease and diabetes. This study can focus upon the fact that hypertension is not a rare phenomenon in adolescents; hence by detecting high blood pressure measurements at a young age and taking precautionary measures and appropriate and optimal treatment can go a long way in postponing the onset of complications or even preventing the onset of hypertension at a later age.This study focuses upon the fact that hypertension is not a rare phenomenon among adolescents. They may not present with the signs and symptoms of hypertension, but detecting hypertension by means of regular school health program-mes at an early age does help in better blood pressure control which goes a long way in preventing complicati-ons. This study also re-emphasizes the need for preventive and control measures of overweight/ obesity in children which is considered as the risk factor for hypertension, coronary artery disease & Type 2 DM.

**Acknowledgements**:

We thank the junior investigators who helped us in the data collection and the school authorities and students for their cooperation.

**References**:

1. Gupta R, Prakash H, Majumdar S Sharma S, Gupta VP. Prevalence of coronary heart disease and coronary risk factors in an urban population of Rajasthan.Indian Heart J. 1995 Jul-Aug;47(4):331-8.
2. Gupta R, Gupta VP, Sarna M, Bhatnagar S, Thanvi J, Sharma V, Singh AK, Gupta JB, Kaul V. Prevalence of coronary heart disease and risk factors in an urban Indian population: Jaipur Heart Watch-2. Indian Heart J. 2002 Jan-Feb;54(1):59-66.
3. Gupta R, Sarna M, Thanvi J, Rastogi P, Kaul V, Gupta VP. High prevalence of multiple coronary risk factors in Punjabi Bhatia community: Jaipur Heart Watch-3. Indian Heart J. 2004 Nov-Dec;56(6):646-52.
4. Guillaume M, Lapidus L, Beckers F, Lambert A, Bjorntorp P. Cardiovascular risk factors in children from the Belgian province of Luxembourg. The Belgian Luxembourg Child Study. Am J Epidemiol.1996; 144 :867 -80.
5. Macedo ME, Trigueiros D, de Freitas F. Prevalence of high blood pressure in children and adolescents. Influence of obesity. Rev Port Cardiol.1997; 16:27-8.
6. M.B. Soudarssanane, M. Karthigeyan, S. Stephen, A. Sahai. Key Predictors of High Blood pressure and Hypertension among Adolescents: A Simple Prescription for Prevention. Indian Journal of Community Medicine. 2006; Vol. 31 (3): 164-168.
7. [Mohan B](http://www.ncbi.nlm.nih.gov/pubmed/?term=Mohan%20B%5BAuthor%5D&cauthor=true&cauthor_uid=15586739), [Kumar N](http://www.ncbi.nlm.nih.gov/pubmed/?term=Kumar%20N%5BAuthor%5D&cauthor=true&cauthor_uid=15586739), [Aslam N](http://www.ncbi.nlm.nih.gov/pubmed/?term=Aslam%20N%5BAuthor%5D&cauthor=true&cauthor_uid=15586739), et al. Prevalence of sustained hypertension and obesity in urban and rural school going children in Ludhiana. [Indian Heart J.](http://www.ncbi.nlm.nih.gov/pubmed/15586739) 2004 Jul-Aug;56(4):310-4.
8. [Amar Taksande](http://www.ncbi.nlm.nih.gov/pubmed/?term=Taksande%20A%5Bauth%5D), [Pushpa Chaturvedi](http://www.ncbi.nlm.nih.gov/pubmed/?term=Chaturvedi%20P%5Bauth%5D), [Krishna Vilhekar](http://www.ncbi.nlm.nih.gov/pubmed/?term=Vilhekar%20K%5Bauth%5D) et al. Distribution of blood pressure in school going children in rural area of Wardha district, Maharashatra, India. Ann Pediatr Cardiol. 2008 Jul-Dec; 1(2): 101–106.
9. Saha B Paul, Dasgupta. Prevalence of hypertension and variation of blood pressure with age among adolescents in Chetla, India. TanzaniaJ of Health Resources(2008),Vol.10,No.2
10. Veena Kamath G, Prasanna Mithra Parthage ef al. Prevalence of hypertension in the paediatric population in Coastal South IndiaPublication: AMJ 2010,3,11, 695-698.
11. [Sharma A](http://www.ncbi.nlm.nih.gov/pubmed/?term=Sharma%20A%5BAuthor%5D&cauthor=true&cauthor_uid=20308762), [Grover N](http://www.ncbi.nlm.nih.gov/pubmed/?term=Grover%20N%5BAuthor%5D&cauthor=true&cauthor_uid=20308762), [Kaushik S](http://www.ncbi.nlm.nih.gov/pubmed/?term=Kaushik%20S%5BAuthor%5D&cauthor=true&cauthor_uid=20308762) et al. Prevalence of hypertension among schoolchildren in Shimla. [Indian Pediatr.](http://www.ncbi.nlm.nih.gov/pubmed/20308762) 2010 Oct;47(10):873-6.
12. Mostafa A. Abolfotouh, Sunny A. Sallam et al. Prevalence of Elevated Blood Pressure and Association with Obesity in Egyptian School Adolescents.International Journal of Hypertension, vol. 2011.

# [McNiece KL](http://www.ncbi.nlm.nih.gov/pubmed/?term=McNiece%20KL%5BAuthor%5D&cauthor=true&cauthor_uid=17517252), [Poffenbarger TS](http://www.ncbi.nlm.nih.gov/pubmed/?term=Poffenbarger%20TS%5BAuthor%5D&cauthor=true&cauthor_uid=17517252), [Turner JL](http://www.ncbi.nlm.nih.gov/pubmed/?term=Turner%20JL%5BAuthor%5D&cauthor=true&cauthor_uid=17517252) et al. Prevalence of hypertension and pre-hypertension among adolescents. [J Pediatr.](http://www.ncbi.nlm.nih.gov/pubmed/17517252) 2007 Jun;150(6):640-4, 644.e1.

1. Chiolero A,Cachat F,Burnier M et al. Prevalence of hypertension in schoolchildren based on repeated measurements and association with overweigt J.Hypertens .2007 Nov;25(11):2209-17
2. Raj M et al. Natl Med J India. Obesity in Indian children:time trends and relationship with hypertension. 2007 Nov-Dec;20(6):288-293
3. Misra A, Vikram NK, Arya S, Pandey RM, Dhingra V, Chatterjee A, Dwivedi M, Sharma R, Luthra K, Guleria R, Talwar KK. High prevalence of insulin resistance in postpubertal Asian Indian children is associated with adverse truncal body fat patterning, abdominal adiposity and excess body fat. Int J Obes Relat Metab Disord. 2004 Oct;28(10):1217-26.
4. Ramachandran A, Snehalatha C, Vinitha R, Thayyil M, Kumar CK, Sheeba L, Joseph S, Vijay V. Prevalence of overweight in urban Indian adolescent school children. Diabetes Res Clin Pract. 2002 Sep;57(3):185-90.
5. Khadilkar VV, Khadilkar AV. Prevalence of obesity in affluent school boys in Pune. Indian Pediatr. 2004 Aug;41(8):857-8.
6. Augustine LF, Poojara RH. Prevalence of obesity, weight perceptions and weight control practices among urban college going girls. Indian Journal of Community Medicine Vol. XXVIII, No.4, Oct.-Dec, 2003: 187-190.
7. Hari P, Bagga A, Srivastava RN. Sustained hypertension in children. Indian Pediatr. 2000;37:268–74.
8. Kliegman RM, Behrman RE, Jenson HB,Stanton BF, editors. Nelson text book of pediatric. 18th ed. Philadelphia: W.B. Saunders Co.; 2007. pp. 1988–96.
9. Rocchini AP. Childhood hypertension, etiology, diagnosis and treatment. Pediatr Clin North Am. 1984;31:1259–73.
10. Whyte HM. Behind the adipose curtain. Studies in Australia and New Guinea relating obesity and coronary artery disease. Am J Cardiol 1965; 15: 66-80.
11. Thakor HG, Kumar P, Desai VK. An epidemiological study of hypertension among children from various schools of surat city. Indian Journal of Community Medicine 1998; 23; 110-15.
12. Sinaiko AR, Donahue RP, Jacobs DR, Prineas RJ. Relationship of weight and rate of increase in weight during childhood and adolescence to body size, blood pressure, fasting insulin, and lipids in young adults. The Minneapolis Children’s Blood Pressure Study. Circulation 1999;99:471-76.
13. Hardy R, Wadsworth MEJ, Langenberg C, Kuh D. Birth weight, childhood growth, and blood pressure at 43 years in a British birth cohort. Int J Epidemiol 2004; 33:121-29