

Original Research Article

Prevalence of hypertension and pre-hypertension among adolescent school children in Thiruvananthapuram, Kerala, India

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ABSTRACT

Background: The foundations of hypertension in a person are laid in childhood and adolescence. The phenomenon of tracking of blood pressure is one where those children and adolescents who are in a high blood pressure category tend to fall in the same category when they become adults. Early diagnosis of hypertension and prehypertension in children and adolescents will help in reducing the prevalence of hypertension and its complications in the future adult population of any country. The objective of this study was to find out the prevalence of hypertension and pre-hypertension among school children 13-17 years in Thiruvananthapuram City Corporation, Kerala.

Methods: A two stage sampling technique was applied; in the first stage the schools were stratified as government, aided and unaided schools using probability proportionate to size. In the second stage, from the selected schools one division or class from each standard was identified at random as a cluster and all the eligible children in the selected cluster were studied. A single BP measurement was taken using a standardized digital sphygmomanometer (OMRON IA1). Hypertension and prehypertension was defined as per national high blood pressure education program (USA), working group on hypertension control in children and adolescents blood pressure tables. The data was entered in MS excel and further analysis was done using SPSS 16.0 version software and proportions of outcomes were analyzed.

Results: The total number of children studied were 2438, Boys 1274 (52.3%, 95% CI 50.28-54.32) and girls 1164 (47.7%, 95% CI 45.68-49.72). The prevalence of hypertension was found to be 21.4% (95% CI 19.64% - 22.96%). The overall prevalence of systolic hypertension is slightly high among the girls (19.4%) than the boys (18.2%), (P value>0.05). The prevalence of pre-hypertension among the study subjects was 21.3 % (19.65-22.95%). The prevalence of systolic pre-hypertension was found to be 21.4% (95% CI 19.74%- 23.06%) and diastolic pre-hypertension 5.3% (95% CI 4.4%-6.2%).

Conclusions: The overall prevalence of pre-hypertension and hypertension was 42.6%. These facts show us that preventive interventions are urgent.

Keywords: Adolescents, Children, Hypertension, Pre-hypertension, Prevalence

INTRODUCTION

Cardiovascular diseases (CVD) are the number one cause of death globally. An estimated 17.5 million people died from CVDs in 2012, representing 31% of all global deaths.¹ Of these, complications of hypertension account for 9.4 million deaths worldwide every year. Hypertension is responsible for at least 45% of deaths due to heart disease, and 51% of deaths due to stroke.² The global prevalence of raised blood pressure (defined as systolic and/or diastolic blood pressure $\geq 140/90$ mmHg) in adults aged 18 years and over was around 22% in 2014. The proportion of the world's population with high blood pressure or uncontrolled hypertension fell modestly between 1980 and 2010. However, because of population growth and ageing, the number of people with uncontrolled hypertension has risen over the years.³ If left uncontrolled, hypertension causes stroke, myocardial infarction, cardiac failure, dementia, renal failure and blindness, causing human suffering and imposing severe financial and service burden on health systems. Not only is hypertension more prevalent in low- and middle-income countries, there are also more people affected because more people live in those countries than in high-income countries.³ Further, because of weak health systems, the number of people with hypertension who are undiagnosed, untreated and uncontrolled are also higher in low and middle income countries compared to high-income countries. The foundations of hypertension in a person are laid in childhood and adolescence. There is a tendency for blood pressure to gradually increase with age as in the study by Bernard Rosner et al.⁴ There is also the phenomenon of tracking of blood pressure, where those children and adolescents who are having a higher blood pressure tend to fall in the same category as they become adults.⁵ Persistence of BP was shown by significant correlations between childhood and adulthood levels ($r = 0.36$ to 0.50 for systolic BP and $r = 0.20$ to 0.42 for diastolic BP), varying by race, sex, and age as per study conducted by Bao Wet al.⁶ 4623 school children (6 - 15 years old) from 1987 to 2005 in Hanzhong, China, whose blood pressure were re-measured 18 years later showed that follow-up blood pressure was significantly higher in higher blood pressure group at baseline than that in normal blood pressure group at baseline. The risk for hypertension was 6.88 greater in higher blood pressure group at baseline than that in normal blood pressure group at baseline.⁷ Over the past two decades, studies have shown that "essential" hypertension can be found among children and adolescents and is increasing.^{8,9}

Until recently, the incidence of persistent hypertension in children has been low, with a range of 1% to 3%. Over the past few decades it has been shown that the prevalence of hypertension in children has increased as reported by various studies.^{10,11} Much of the increase has been attributed to the increase in essential hypertension. This shows that an epidemiological transition is taking place from the rare secondary hypertension to the now

common primary hypertension among the children. Much of this has been linked to factors like changing lifestyle pattern, obesity etc. It has also been observed that one of the best indicators of adult hypertension is pubertal hypertension as shown in the study conducted by Liang Y in Beijing. As per his study fifty percent of children with pubertal hypertension became hypertensive adults, while pre-pubertal hypertension resulted in 34.3%. Pubertal hypertension predicted a higher risk of adult hypertension than pre-pubertal hypertension, with odds ratios (95% confidence intervals) of 10.00 (3.03-33.07) and 2.71 (0.83-8.85), respectively.¹² There is also the problem of pre hypertension which is considered as a precursor to hypertension and is equally important. Early diagnosis of hypertension and prehypertension in children and adolescents is required to reduce the prevalence of hypertension and its impact in the future adult population of our country. In spite of all these factors measurement of blood pressure (BP) in children and adolescents is often neglected in clinical practice. It is in these contexts that the study "prevalence of hypertension among school children 13-17 years in Thiruvananthapuram City Corporation", Kerala was conducted.

METHODS

The study setting is Thiruvananthapuram City Corporation of Kerala State, South India. The study subjects are Children in the age group 13-17 years attending high schools (class 8-10) or higher secondary schools (class 11-12) in Thiruvananthapuram City Corporation.

Sample size

In a study conducted by the Department of Preventive and Social Medicine in the urban field practice area of Jawaharlal Institute of Post Graduate Medical Education and Research (JIPMER), Pondicherry, in 2002, the prevalence of hypertension among the adolescent group 15, 16 and 17 years was 5.6%, 6.3% and 7.1% respectively.¹³ The lowest percentage among them, 5.6% was chosen for the estimation of the sample size in each age category using the formula $z\alpha^2pq/12$. The alpha error was set at 5%. '1' was assumed to be 20% of p.

$1.96 \times 1.96 \times 0.056 \times 0.944 / (0.0112 \times 0.0112) = 1619$. The sample size for the study was estimated to be 1619. In order to account for the influence of design effect in cluster sampling, the sample size estimated was multiplied by a factor of 1.5 giving the final sample size of 2430.

A two stage sampling technique was applied for selection of the study subjects. Schools were selected if it satisfied the criteria: Mixed schools with high school and higher secondary School (+2) or high school and vocational higher secondary school in Thiruvananthapuram City Corporation. They were stratified according to the pattern that exists in Kerala; Government, Government

aided and unaided (private) schools. According to the statement of 6th working day strength for the year 2009 - 2010 available with District Education Officer, the proportion of children in government schools, aided schools and unaided schools were 35%, 43% and 22% respectively in Thiruvananthapuram Corporation. The proportion of children to be sampled from each stratum was determined accordingly. Thus a total number of 851 students was taken from government sector, 1045 from aided sector and 535 from unaided sector were taken for the study. Each stratum was again divided into the five classes; (8th to 12th standards). These five classes represent the age groups thirteen to seventeen if pass percentage is assumed to be nearly 100% in all of the lower standards. In the first stage the schools were sampled using probability proportionate to size (PPS sampling). In the second stage, from the selected schools one division or class from each standard was identified at random as a cluster and all the eligible children in the selected cluster were included in the study.

The final sample size was divided proportionately into Government, aided and unaided sectors (category) as per the 6th working day report. The total number of schools chosen was 12; 4 from government, 5 from aided and 3 from private schools. The 4:5:3 approximately represents the strength of these sectors in the number of students.

The children from those schools where the authorities did not give consent for the study and those children who were absent on the day of visit or did not give consent were excluded from the study. As per the statistics of ministry of human resource and development government of India Kerala has a high gross school enrolment rates for children in the 14-16 age category 99.6% for boys and 99.4% for girls 2011-2012(14). Hence it can be assumed that this design and setting will represent the true prevalence of hypertension among children in the age group of 13-17 years in Thiruvananthapuram City Corporation.

Outcome variable

Primary outcome variable was Hypertension. Prevalence of pre-hypertension and hypertension (systolic, diastolic or both) was estimated with the reference BP tables for blood pressure levels for boys and girls aged 1-17 years established by the National High Blood Pressure Education Program (NHBPEP) Working Group on Hypertension Control in Children and Adolescents.¹⁵ The NHBPEP is a program of the United States Department of Health and Human Services. For the purpose of this study, blood pressure percentiles determined by a single measurement was used as the reference table. These tables (16 and 17) are available on the website of the Centers for Disease Control (CDC).¹⁶ These reference tables provide a reliable source for comparison when a single measurement of BP is taken. Therefore a study subject was compared with the blood pressure distribution of respective age, sex and the median height

in the BP table of NHBPEP. As per the NHBPEP, children and adolescents with BP levels at 120/80 mmHg or above, but less than the 95th percentile, should be considered prehypertensive.

Pre-hypertension in children was defined as SBP or DBP levels that are greater than or equal to the 90th percentile for their corresponding age, sex and 50th percentile for height in NHBPEP blood pressure tables or greater than 120/80, but less than the 95th percentile for BP in the corresponding tables.

Hypertension in this study was defined as SBP or DBP levels that are greater than or equal to the 95th percentile for their corresponding age, sex and 50th percentile for height in NHBPEP blood pressure tables.

Height was measured using a measuring tape calibrated to the nearest half centimeter taking precautions that the shoes are off, feet flat on the ground, back against the wall with the child looking straight ahead and using a flat ruler on top of the head to project the level on to the measuring tape fixed on the wall.

A single blood pressure measurement was taken using a digital sphygmomanometer (OMRON IA1) standardized every day with the mercury sphygmomanometer. The digital sphygmomanometer was chosen because of the advantages of ease of use and the minimization of observer bias or digit preference. It has to be noted that mercury is environmentally toxic and mercury sphygmomanometer is gradually being phased out in favor of validated electronic devices especially in low resource settings.^{17,18} Also validity of standardized digital BP monitors against mercury sphygmomanometers has been proven in many studies around the world.^{19,20} The study subjects were asked to remain seated for 5 minutes quietly. Then the blood pressure was measured on the right arm while the study subjects were sitting with the arm supported and horizontal at the level of the heart and legs uncrossed. The right arm was chosen for comparing because the BP tables of NHBPEP had used the right arm and to avoid false low BP associated with coarctation of aorta. A BP cuff with arm circumference of 17-32 cm was used to suit children in the age groups 13-17 years.

The BP apparatus used

OMRON IA1. This device has been developed specifically for use in the clinical office setting and other health care environments, and determines blood pressure by oscillometric measurement and displays systolic blood pressure, diastolic blood pressure, and pulse rate using an LCD digital monitor. The data was entered into Microsoft excel and analyzed using SPSS v.16 (Trial). Informed consent from the respective school authorities was sought for the study. The nature of the study was explained and demonstrated, and verbal consent was obtained from the students.

RESULTS

Table 1: Prevalence of pre-hypertension and hypertension in the study population

Status	Frequency	Prevalence %
Pre-hypertension	519	21.3
Hypertension	521	21.4
Normal	1398	57.3
Total	2438	100.0

The total number of children studied were n=2438, Boys n= 1274 (52.3%, 95% CI 50.28-54.32) and girls n= 1164 (47.7%, 95% CI 45.68-49.72). The number of children in the age group 13, 14,15,16,17 were 448 (18.4%), 471

(19.3%), 499 (20.5%), 532 (21.8%) and 488 (20.0%) respectively. Total number of students in the study was 851 from government sector (34.9%), 1045 from aided sector (42.8%) and 535 from unaided sector (21.9%).

Prevalence of prehypertension

The prevalence of pre-hypertension among the study subjects was 21.3% (19.65-22.95%). The prevalence of systolic pre-hypertension was found to be 21.4% (95%CI 19.74% - 23.06%) and diastolic pre-hypertension 5.3% (95% CI 4.4% - 6.2%). The tables 2 and 3 show the age and gender specific prevalence of systolic and diastolic pre-hypertension.

Table 2: Age and gender specific prevalence of systolic pre-hypertension in the study population.

Age (years)	Boys (frequency)	systolic pre-hypertension n (%)	Girls (frequency)	Systolic Pre-hypertension n (%)	Total n (%)	Pre hypertensive n (%)
13	213	21(9.9)	235	26 (11.1)	448	46 (10.5)
14	257	37 (14.4)	214	32 (15.0)	471	69 (14.7)
15	278	66 (23.7)	221	41 (18.6)	499	107 (21.2)
16	256	94 (36.7)	276	62 (22.5)	532	157 (29.6)
17	270	105 (38.9)	218	38 (17.4)	488	143 (28.1)
Total	1274	323 (25.3)	1164	199 (17.0)	2438	522 (21.4)

Table 3: Age and gender specific prevalence of diastolic pre-hypertension.

Age (year)	Boys n	Boys Pre hypertensive n (%)	Girls n	Girls Pre hypertensive n (%)	Total n	Total Pre hypertensive N (%)
13	213	1 (0.5)	235	4 (1.7)	448	5(1.1)
14	257	2 (0.8)	214	11 (5.1)	471	13 (2.8)
15	278	9 (3.2)	221	18 (8.1)	499	27 (5.5)
16	256	13 (5.1)	276	26 (9.4)	532	39 (7.3)
17	270	31 (11.5)	218	15 (6.9)	488	46 (9.2)
Total	1274	56 (4.3)	1164	74 (6.3)	2438	130 (5.3)

Age specific systolic pre-hypertension among both boys and girls generally shows an upward trend among the age groups. Systolic pre-hypertension was found to be highest among the 16 and 17 year old group among the boys and 15 and 16 year old group among the girls in the study (P value<0.05). Even though boys at 13years start out with a lower prevalence than girls they overtake girls from 15 to 17 years. Diastolic pre-hypertension also shows a gradual increase from 13 to 17 years. It was found to be lower among boys in the age group 13-16 years but shows a substantial increase among boys at 17 years (P value>0.05).

The increase in proportion of systolic and diastolic pre-hypertensives gradually crosses over from girls to boys as age progresses.

Table 4: Overall prevalence of hypertension.

Prevalence	n = 2438	%
Systolic	350	14.4
Diastolic	63	2.6
Systolic and diastolic	108	4.4
Total	521	21.4

Prevalence of hypertension

The prevalence of hypertension was found to be 21.4% (95% CI 19.64% - 22.96%).

The predominant form of hypertension among the children is systolic hypertension.

Age specific prevalence of systolic hypertension shows a gradual increase among both boys and girls. The overall prevalence of systolic hypertension is slightly high among the girls (19.4%) than the boys (18.2%) (P value>0.05). Among girls in the age group 14 and 16 years there is a slightly high value as compared with other age groups.

Diastolic hypertension also shows a gradual progression with age. The gender difference in the overall prevalence of diastolic hypertension is unfavorable for the girls (8.0% in girls and 6.0% in boys) just like systolic hypertension (Table 5).

Table 5: Age and gender specific prevalence of systolic hypertension

Age (year)	Boys n	Boys systolic Hypertension n (%)	Girls n	Girls systolic hypertension n (%)	Total n	Total systolic hypertension n (%)
13	213	24 (11.3)	235	32 (13.6)	448	56 (12.5)
14	257	38 (14.8)	214	48 (22.5)	471	86 (18.7)
15	278	48 (17.3)	221	33 (14.9)	499	81 (16.1)
16	256	59 (23.1)	276	71 (25.7)	532	130 (24.4)
17	270	63 (23.3)	218	42 (19.3)	488	105 (21.3)
Total	1274	232 (18.2)	1164	226 (19.4)	2438	458 (18.7)

Table 6: Age and gender specific prevalence of diastolic hypertension.

Age (year)	Boys n	Boys diastolic hypertension n (%)	Girls N	Girls diastolic hypertension n (%)	Total n	Total diastolic hypertension n (%)
13	213	7 (3.3)	235	13 (5.5)	448	20(4.4)
14	257	17 (6.6)	214	26 (12.1)	471	43 (9.4)
15	278	16 (5.8)	221	15 (6.8)	499	31 (6.3)
16	256	19 (7.5)	276	23 (8.3)	532	42 (7.9)
17	270	18 (6.7)	218	17 (7.8)	488	35 (7.2)
Total	1274	77 (6.0)	1164	94 (8.0)	2438	171 (7.0)

Table 7: Age and gender specific prevalence of pre-hypertension and hypertension combined.

Age (year)	Boys	n %	Girls	n %	Total	n %
13	213	50 (23.4)	235	64 (27.2)	448	114 (25.4)
14	257	77 (29.9)	214	89 (41.5)	471	166 (35.2)
15	278	120 (43.2)	221	83 (37.5)	499	203 (40.7)
16	256	157 (61.3)	276	142 (51.4)	532	299 (56.2)
17	270	170 (63.0)	218	88 (40.3)	488	258 (52.8)
Total	1274	573 (45.0)	1164	466 (40.0)	2438	1039 (42.6)

Prevalence of both prehypertension and hypertension combined

The prevalence of pre-hypertension and hypertension increases steadily in boys but in girls it increases till 16 years and then decreases. The overall prevalence of pre-hypertension and hypertension was 42.6%.

DISCUSSION

It can be seen from the data that all age groups from 13-17 years has been equally represented in the study sample. The sex ratio of the study sample was 52.3:47.7.

The number of students taken from the 3 different strata was strictly according to the ratio prevalent in the corporation. This could have added to the validity of the study.

Pre-hypertension

The study clearly shows that the prevalence of pre hypertension as well as hypertension is unacceptably high in the study population. The age specific prevalence of both pre hypertension and hypertension also seems to be increasing with age among both boys and girls. These findings raises lots of concern towards the health status of

future community especially in the morbidity related to cardio-vascular system. The prevalence of systolic pre-hypertension among the 16 year old (36.7%) and 17 year old (38.9%) year old children in this study have reached levels of prevalence of hypertension among the adults. This reveals that in the near future the prevalence of adult hypertension could increase dramatically if this trend would continue. The number of children at risk of developing hypertension is huge as it is more likely that pre-hypertensives tend to develop sustained hypertension in the future. It also reveals the hidden part of spectrum of hypertension, which poses a major challenge in public health. This is the crucial category of children where the primary prevention strategies for hypertension need to be implemented. The prevalence of pre-hypertension (21.3%) in this study is higher than the result obtained by Mc Niece et al who have found the prevalence of pre-hypertension as 15.7% in Houston Texas (USA) school adolescents.²¹ As described by Drukeinis JS et al in the Strong Heart Study, even pre-hypertensive adolescents and young adults also had “prognostic ally adverse preclinical cardiovascular disease, including left ventricular hypertrophy and evidence of increased arterial stiffness”.²² This should warn us of the fact that the pre-hypertensive in this study may have already developed preclinical signs of cardiovascular disease. This information is disturbing and warrants urgent measures to control its progression.

Targeting the pre-hypertensive children with effective measures may delay the onset of hypertension and possibly decrease the cardiovascular complications. The growing adolescent population in India and the increase in the risk factors make primary prevention a crucial strategy to curtail this epidemic.

Hypertension

The prevalence of hypertension was (21.4%) as per the current study. The current study shows that the prevalence of hypertension in this setting is comparable to various other studies conducted in different parts of the world which showed a prevalence with a range from 5.4%- 22%.^{23,24} It is higher than that was done in Ernakulam district of Kerala state, by Raj M et al which was 10.58% in the year 2005-06.²⁵ The comparatively low prevalence of hypertension in the study by Manu raj et al may have been due to the fact that the study subjects were selected from the age group 5-16 years children. The very young children are presumed to have very low prevalence of hypertension

This study is in consistence with other studies like the one conducted by Sundar JS et al in Chennai which reported a prevalence of 21.5% among 13-17 year olds. Urrutia-Rojas X et al from Texas USA, which showed a prevalence of 20.6% among 8-13 years and Sorof et al also from USA which showed a prevalence of 19% in children with a mean, age 13.5 ±1.7.^{9,26} The prevalence of hypertension in this study is much higher than the

prevalence (8.5%) found among the urban children in Pondicherry by Soudarssanane et al.¹³ Thus the prevalence of hypertension in the current study is consistent with developed countries but slightly higher compared to other studies in north India. It is well known that the prevalence of hypertension increases with age, with systolic hypertension becoming far more common than diastolic hypertension.²⁷ This can be seen from the tables 5 and 6. It has been demonstrated that SBP continues to rise with advancing age while DBP stabilizes or declines, giving rise to isolated systolic hypertension (ISH).²⁷ It has also been established that SBP is an independent cardiovascular risk factor and can provide diagnostic and prognostic information.²⁸ The multiple risk factor intervention trial (MRFIT) study has revealed that although both systolic and diastolic BP were important, systolic BP was the more precise risk indicator.²⁹ Staessen et al has found out that a “10 mm hg rise in systolic hypertension was correlated with a 10% increase in all fatal and non-fatal cardiovascular complications”.³⁰ A study by Sagie A et al has shown that borderline isolated systolic hypertension had an excess long-term risk of cardiovascular disease (hazard ratio, 1.47; 95 percent confidence interval, 1.24 to 1.74) and death from cardiovascular disease (hazard ratio, 1.57; 95 percent confidence interval, 1.24 to 2.00), as compared with normotensive participants.³¹ Concerning diastolic hypertension there is little published evidence of significant risk posed by isolated diastolic hypertension. The multiple risk factor intervention trial found that for any level of DBP, SBP was the major determinant of cardiovascular risk.³² But there are no public health strategies targeting either systolic or diastolic hypertension alone. The long term effects of hypertension in adults are real and well documented, which makes us think that the long term effects in children, perhaps could also be the same or worse! This information provides us insight into the need to prevent the development of hypertension and what can be achieved by reducing blood pressure in the population.

The high prevalence of hypertension is unacceptable. Even in the age group 13-17 years the prevalence of hypertension is nearing that of the prevalence of adults. The prevalence of pre-hypertension and hypertension combined reaches well over 40%, and at 16 years it is above 50% for both boys and girls (Table 7). It also shows the epidemiological transition in hypertension. It is genuine to assume that most of the contribution to this is by primary hypertension where there is no specific cause has been identified. This process may have started a few decades ago and perhaps rising sharply. Considering tracking of blood pressure phenomenon one can imagine the magnitude of hypertensive entering adulthood in the near future. It is estimated that a significant number of currently hypertensive track their BP into adulthood not forgetting the number of new hypertensive being added as age increases. This can increase the prevalence of hypertension in adults and its burden on the community. The long term outcomes of this hypertensive are poor,

leading to a massive surge in events associated with cardiovascular, cerebrovascular diseases etc. These facts show us that preventive interventions are urgent.

CONCLUSION

The prevalence of pre hypertension and hypertension was 21.3% and 21.4% respectively among school children in the age group 13-17yrs in Thiruvananthapuram City Corporation. The prevalence is comparable with that of developed countries but higher than in other parts of India.

The age related prevalence of hypertension and pre hypertension shows that both are increasing with age among both boys and girls. Both these findings can translate as adult hypertension in the near future and so it should warrants a public health concern.

Policy implications

Considering the magnitude of hypertension interventional strategies need to be developed for children right from their period of childhood. In order to start interventional strategies health policies for prevention and control of this condition needs to be developed. Based on these policies further programs and strategies may be developed which are comprehensive and inclusive of all levels of prevention.

Health care providers should be sensitized about the situation and made capable of providing preventive measures and other service provisions. School health programmes implemented through primary health centres should be alerted about the need.

Research needs to develop normative data for the children of Kerala for making ideal comparisons.

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