PREVALENCE OF HYPERTENSION IN URBAN SCHOOL CHILDREN

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Abstract:

Background: Seventh Joint National Committee on prevention, detection, evaluation & treatment of high BP report that each increment of 20mmHg in systolic or 10mm Hg diastolic pressure doubles the risk of cardiovascular disease[1]. There are no similar data in children, where age, gender & height need to be taken into account while interpreting BP values. There are a few published studies in India on prevalence of pediatric HT undertaken in Southern & Northern parts of India. With this view in mind, the study was conducted in school children to evaluate the prevalence of Pediatric HT in Mumbai.

Aims & Objectives: To determine the prevalence of hypertension in school children. To determine the commonest age group of HT in children. To correlate variables like age, height, gender with HT.

Method: Prospective school based, cross sectional study was performed in 2000 students aged 8-16 yr in a public school in Mumbai between August 2006 to April 2007 with the aim of screening for hypertension. Auxologic data, age, gender, BP measurements were recorded in a pre-designed study format. BP was measured using standard auscultatory method with a mercury sphygmomanometer on regular school days with normal activities in sitting position. At each school screening, 3-seated BP measurements were made at least 1 minute apart after 3 minutes of rest using standard mercury sphygmomanometer. Students found to have Systolic BP or Diastolic BP greater than the age & height specific 95^{th}% BP value underwent 2^{nd} & 3^{rd} screening 1 week apart. Hypertension was defined in accordance with the 4^{th} report on diagnosis, evaluation & treatment of hypertension.

Results: We detected a prevalence of 6.6% of HT in children 8–16 yr age with no sex predilection and a strong correlation of HT with height, weight & not age or gender. Interestingly, we also determined 3.9% prevalence of Diastolic HT & 5.5% of Systolic HT, which is in excess of what is reported. We detected prevalence of Pre- HT in 13.7% cases (n=274) with male preponderance (13.8% males vs. 8.2% females). The peak age of Pre - HT was 14yr (30.2%).

Conclusions: These results confirm the evolving epidemic of cardiovascular risk in youth. This increase reflects an epidemoiologic shift from secondary HT (most often caused by renal diseases) to primary (essential) HT as the main cause of HT in the pediatric age range. Once considered relatively rare, primary HT in children has become increasingly common in association with other cardiovascular risk factors that include overweight, insulin resistance, and dyslipidemia.

Keywords: Prevalence of Hypertension, Urban School Children, Loni area

Introduction

Truly said that "*You cannot direct the winds, you can only adjust the sails*", though HT can't be avoided, it can well be controlled by early detection and appropriate pharmacological & non-pharmacological measures. Data from 3rd National Health & Nutrition Assessment Survey (NHANES III) reveals that in US 1/3rd of people were unaware of this problem & another 1/3rd had BP control below established goals. 7th Joint National Committee on prevention, detection, evaluation & treatment of high BP report that each increment of 20mmHg in systolic or 10mm Hg diastolic pressure doubles the risk of cardiovascular disease.[1] There are no similar data in children, where age, gender & height need to be taken into account while interpreting BP values.

Essential hypertension (HT) - A major risk factor for cardiovascular disease is prevalent in adult population. A prevalence of 25% is reported in Iran & in United States[2]. Blood Pressure (BP) in children is a reliable predictor of adult BP level. Therefore it is important to identify the children & adolescents who are at increased risk of developing essential HT as adults.

The incorporation of BP measurement in routine pediatric examination has enabled both, the discovery of significant asymptomatic HT, secondary to a previously undetected disorder & conformation that mild elevations in the BP in childhood are more common than previously recognized, particularly in adolescents[3].Although HT may be a sign of underlying cardiac, endocrine or more commonly renovascular or renal parenchymal disease, elevated BP may also represent an early onset of essential HT. However, despite the fact of increasing prevalence of pediatric hypertension world over & its strong association with obesity & metabolic syndrome, BP is rarely documented in office practice. Cook et al found that 30% of overweight children in USA meet the criteria for metabolic syndrome[4]. There are a few published studies in India on prevalence of pediatric HT undertaken in Southern & Northern parts of India[5-8].

With this view in mind, the study was conducted in school children to evaluate the prevalence of Pediatric HT in Mumbai.

We conducted the study in 2000 school children belonging to middle class socio- economic group with the following aims & objectives.

Aims & Objectives:

1. To determine the prevalence of hypertension in school children.
2. To determine the commonest age group of HT in children.
3. To correlate variables like age, height, gender with HT.

Methods:

Prospective School based, cross sectional study was performed in 2000 students aged 8-16 yr in a public school in Mumbai from August 2006 to April 2007, with the aim of screening for hypertension. Because of non- invasive nature of the protocol consisting only of measurements considered routine for school entry, sports participation examination (i.e. height, weight & BP), passive consent process was used. A letter sent from school notified parents in advance that hypertension screening would be performed at the school. Permission was sought from the Principle of the school in advance by a letter issued from Jaslok Hospital & Research Center.

Age was determined based on school records & was rounded off to the nearest completed years. Gender was self-described. Weight & Height were measured in each student. We used mercury sphygmomanometer for evaluating blood pressure[9].

Volunteers were trained to record height & weight using standardized methods. A portable weighing scale was used to measure weight of the child & was calibrated before each use. Weight was measured to the nearest 1 Kg. Height was measured to the nearest 1 cm with subject standing without shoes using a stadiometer. The standard IAP pediatric anthropometric reference data specific for gender & age were used to establish height & weight percentile[10].

BP was recorded on regular school days with normal activities. Before recording BP, the procedure was explained to children & sufficient time was given to allay anxiety & fear. BP was recorded in sitting position in right arm by auscultatory method using mercury sphygmomanometer & a stethoscope placed over the brachial artery pulse proximal

& medial to the cubital fossa & below the bottom edge of the cuff (i.e. 2 cm above cubital fossa) with a set of different sized cuffs[11]. An appropriate cuff size had an inflatable bladder that was at least 40% of the arm circumference & a point mid way between olecranon & acromion and the cuff bladder length covered 80 – 100 % of arm circumference[12]. Right arm was used for consistency & comparison with standard tables & because of the possibility of coarctation of aorta, which might lead to false low readings in left arm.

At each school screening, 3-seated BP measurements were made at least 1 minute apart after 3 minutes of rest using standard mercury sphygmomanometer. Students found to have SBP or DBP greater than the age & height specific 95th %ile BP value underwent 2nd & 3rd screening 1 week apart.

Definition & Staging Of Hypertension:

BP percentiles (50th, 90th, 95th, 99th+ 5 mmHg) based on gender, age & height were used to define HT in accordance with 4th Report on Diagnosis, Evaluation & Treatment of High BP in Children & Adolescents as follows:

- HT was defined as average Systolic and / or Diastolic BP > 95% ile for age, gender & height.
- Pre- HT was defined as average Systolic & Diastolic Pressures between 90th & 95th % ile. Tracking data suggest that this sub group is more likely to develop overt HT over time than normotensive children.
- A patient with BP> 95th% ile in a physicians office or clinic, who is normotensive outside a clinical setting has white coat HT.
- If the BP is > 95th% ile, it was staged. Stage I had BP between 95th – 99th % ile, & Stage II as > 99th%ile+5mmHg.

Statistical Analysis: Descriptive statistics are presented as percentages, mean & Standard Deviation (SD). Students't' test were performed for between group comparisons of continuous variables. Simple linear regression analysis was used to determine the pair wise association between continuous variables. Multiple linear regression was used to determine the relationship between multiple continuous variables. Multiple logistic regression on covariates was used to determine the probability of having HT based in different clinical variables. A p value < 0.05 obtained by Pearsons Chi square test was used to indicate statistical significance with 95% confidence.

Results:

Table 1: Age group of participants

Age (yr)	No.	Percent
8	30	1.5%
9	253	12.7%
10	312	15.6%
11	311	15.6%
12	240	12.0%
13	128	6.4%
14	189	9.5%
15	324	16.2%
16	213	10.7%
Total	2000	100.0%

Maximum number of children belonged to age group 15yr (16.2%) followed by 10&11yr (15.6%). Female participants were 855(42.8%) and male participants were 1145 (57.3%). Demonstrates slight male preponderance. Male to Female ratio of 1.33

Table 2: Systolic, Diastolic BP (Percentiles) distribution among cases

	Systolic BP		Diastolic BP	
	No.	Percent	No.	Percent
Normal	1633	81.7	1819	91.0
Pre-hypertensive	259	13.0	104	5.2
Stage I HT	93	4.7	74	3.7
Stage II HT	15	0.8	3	0.2

This shows 5.5% prevalence of Systolic HT, with 4.7% in Stage I & 0.8% in Stage II HT.

Diastolic HT had a prevalence of 3.9%; out of which 3.7% was detected in stage I & 0.2% had Stage II HT.

Table 3: Hypertension status among cases

Hypertension status	No.	Percent
Normotensive	1595	79.8
Pre-hypertensive	274	13.7
Stage I HT	115	5.8
Stage II HT	16	0.8

Prevalence of HT was 6.6%, and a significant number of children (n=274) 13.7% were Pre hypertensive. Stage I HT exceeded Sate II by 5%.

Table 4: Distribution of various numerical variables among the cases

Variables	Mean ± SD	Minimum	Maximum
Age (yr)	12.26±2.4	8.00	16.00
Weight (Kg)	36.83±11.8	12.00	82.00
Weight %	20.72±24.9	-5.00	95.00
Height (cm)	146.97±14	108.00	190.00
SBP	106.49±10.9	80.00	152.00
DBP	65.53±9.3	40.00	100.00
Systolic BP (Percentiles)	56.17±15	50.00	100.00
Diastolic BP Percentiles)	58.88±17.2	50.00	100.00

It shows the variables studied with their mean & standard deviation. Age group ranged from 8-16yr, Wt. between 12-82kg, Ht. 108-190cm, SBP varied between 80-152 mmHg, DBP 50-100mmHg.

Table 5: Association between sex and Hypertension status among the cases

Sex	Hypertension status (Simple) (%)			Total
	Normotensive	Pre hypertensive	Hypertensive	
Female	729(85.3)	70 (8.2)	56 (6.5)	855
Male	866 (75.6)	204(17.8)	75(6.6)	1145
Total	1595(79.8)	274 (13.7)	131(6.6)	2000
Chi-square test	Value	df	p-value	Association
Pearson Chi-Square	38.822	2	3.71E-09	Significant
Likelihood Ratio	40.782	2	1.39E-09	Significant

Males had slight predominance of HT & Pre HT over females which was statistically significant (p value 0.0000000037)

Table 6: Association between Age (yr) and Hypertension status among the cases

Age (yr)	Hypertension status (%)				Total
	Normotensive	Pre hypertensive	Stage I HT	Stage II HT	
8	29 (96.7)	0	1 (3.3)	0	30
9	229 (90.5)	18 (7.1)	6 (2.4)	0	253
10	271 (86.9)	21 (6.7)	15 (4.8)	5 (1.6)	312
11	262 (84.2)	29 (9.3)	20 (6.4)	0	311
12	205 (85.4)	17 (7.1)	16 (6.7)	2 (0.8)	240
13	89 (69.5)	29 (22.7)	6 (4.7)	4 (3.1)	128
14	118 (62.4)	57 (30.2)	13 (6.9)	1 (0.5)	189
15	229 (70.7)	65 (20.1)	26 (8)	4 (1.2)	324
16	163 (76.5)	38 (17.8)	12 (5.6)	0	213
Total	1595 (79.8)	274 (13.7)	115 (5.8)	16 (0.8)	2000
Chi-square test	**Value**	**df**	**p-value**	**Association**	
Pearson Chi-Square	141.742	24	1.11E-18	**Significant**	
Likelihood Ratio	143.794	24	4.67E-19	**Significant**	

15 yr olds had maximum prevalence of stage I HT 8% & 13yr olds were maximally stage II hypertensive 3.1% which is statistically significant by Pearson's Chi Square test.

Table7: Association between sex and Hypertension status among the cases

Sex	Hypertention status(%)				Total
	Normotensive	Pre-hypertensive	Stage I HT	Stage II HT	
Female	729 (85.3)	70 (8.2)	52 (6.1)	4 (0.5)	855
Male	866 (75.6)	204 (17.8)	63 (5.5)	12 (1)	1145
Total	1595 (79.8)	274 (13.7)	115 (5.8)	16 (0.8)	2000
Chi-square test	Value	df	p-value	Association is-	
Pearson Chi-Square	41.168	3	6.02E-09	Significant	
Likelihood Ratio	43.256	3	2.17E-09	Significant	

Females outnumbered males in Stage I HT (6.1%) whereas males predominated in Stage II HT (1%) & Pre –HT (17.8%)

Table 8 : Logistic Regression with Hypertension status as Dependent variable (Enter Method)

Block 1: Method = Enter Variables in the Equation						
Step 1 (a)	B	S.E.	Wald	df	p-value	Significance
Age (yr)_A	-0.14	0.092	2.355	1	0.125	Not significant
Weight (Kg)	0.155	0.019	64.131	1	1.16E-15	Significant
Height (m)	-14.05	2.001	49.32	1	2.17E-12	Significant
SBP	0.173	0.020	71.815	1	2.36E-17	Significant
DBP	0.077	0.017	20.8	1	0.0000051	Significant
Sex (1)	0.294	0.263	1.247	1	0.264	Not significant
Constant	-11.91	2.122	31.489	1	2.01E-08	Significant

Logistic Regression Analysis shows maximum coerrelation of weight & height with HT and not with age or gender.

Table 9: Logistic Regression with Hypertension status as Dependent variable

(Forward Stepwise (Wald) Method), Block 1: Method = Forward Stepwise (Wald)							
Variables in the Equation							
		B	S.E.	Wald	Df	p-value	Significance
Step 1(a)	SBP	0.188	0.014	192.885	1	7.46E-44	Significant
	Constant	-24.247	1.623	223.219	1	1.8E-50	Significant
Step 2(b)	Height m	-6.229	1.039	35.931	1	2.04E-09	Significant
	SBP	0.228	0.016	193.707	1	4.93E-44	Significant
	Constant	-19.640	1.741	127.329	1	1.57E-29	Significant
Step 3(c)	Weight Kgs	0.141	0.018	61.757	1	3.88E-15	Significant
	Height m	-15.619	1.711	83.310	1	7.02E-20	Significant
	SBP	0.228	0.018	161.044	1	6.69E-37	Significant
	Constant	-11.466	2.003	32.754	1	1.05E-08	Significant
Step 4(d)	Weight Kgs	0.149	0.019	64.604	1	9.16E-16	Significant
	Height m	-15.799	1.765	80.118	1	3.53E-19	Significant
	SBP	0.176	0.020	74.504	1	6.05E-18	Significant
	DBP	0.078	0.017	20.990	1	0.00000462	Significant
	Constant	-11.155	2.029	30.227	1	3.84E-08	Significant

Discussion:

The extent & severity of childhood HT has been reported to be increasing. The results of current study are confirmatory of recent estimates of HT in children. In present study prevalence of 6.6% of HT in children 8 – 16 yr age with no sex predilection and a strong correlation of HT with height, weight & not age or gender. A study conducted by Boyed [4] et al detected HT prevalence of 6.8% similar to our study, while that of Pre- HT was significantly higher (27.9% as against 13.7% in our study).

Interestingly, we also determined 3.9% prevalence of diastolic HT & 5.5% of Systolic HT, which is in excess of what is reported. Increased SBP correlates with increased cardiovascular morbidity & mortality & occurrence of early atherosclerosis and stroke, whereas renal diseases are more often associated with diastolic HT. It needs to be confirmed whether these children were small for gestational age (which is associated with HT & metabolic syndrome in later life), had undiagnosed anatomical renal defects & renal scarring or uncorrected heart disease which could have accounted for a surge in HT. Clearly the pubertal growth spurt at around 15- 16 yr, demonstrated peaking of prevalence of HT around 15 yr established in this study[4].

Though an attempt was made to enquire about family history of HT, sudden cardiac death in youth, recurrent strokes; a complete assessment of the same could not be done, as ours was a screening survey of pediatric HT. Children detected hypertensive on 3 subsequent screening was advised to see a local pediatrician for further diagnostic evaluation.

In the present study prevalence of Pre- HT in 13.7% cases (n=274) with male preponderance (13.8% males vs. 8.2% females). The peak age of Pre HT was again 14yr (30.2%) of whom 10.5% were obese & 13.8% were non- obese. The minimum & maximum SBP recorded in the current study for SBP is 80 to 152 & that for DBP is 40 to 100 and a mean of 107+_ 10 for SBP & 66±9.2 for DBP compared to 126± 11for SBP & 70±9 for DBP recorded by Sorof et al. The Standard Deviation for SBP in males & females in our study is 10 & for DBP is 11 correlating with that of 4th Report on Diagnosis, Evaluation & Treatment of High BP in Children & adolescents.[11]

National Institute Of Health established demographic data on height, weight & BP distribution curves in children 6-17 yr age (1896 males & 1751 females) belonging to different ethnic groups viz: Hispanic, Black, Whites, Asians, Native American & others. They had 3647 person visits for SBP & 3609 person visits for DBP. The largest sample size was that of Bogalusa Heart Study in age group 1- 17 yr olds including[11] 3751 males & 3607 females with 7358 person visits for SBP. Likewise similar studies conducted at Houston, Carolina, Iowa, Minnesota, Providence, Pittsburgh, Dallas, NHANES III, NHANES 1999-2000 followed serial person visits for SBP & DBP with a sample size ranging from 285(Pittsburgh) to a maximum of 19,000 in Minnesota. However our study did not include serial person visits for SBP & DBP, & the sample size was 2000, which was statistically appropriate to avoid skewness of data[11].

Being Asian population, we did not have different ethnic groups sub-classification & largely included children from all communities. Also, due to time constraints, only 3 BP readings were taken on separate visits to define HT in accordance with 4th report on diagnosis of HT[13].

Most American Studies have included varying ethnic groups to described relation of ethnicity and prevalence of HT while doing 3 subsequent screenings of BP. The prevalence of HT dropped from 19% to 9.5% & 4.5% in 1st, 2nd & 3rd screenings respectively demonstrating the effect of white coat HT [14] & the need for constant BP assessment before labeling as hypertensive. We documented HT only if BP readings were > 95%ile on 3 consecutive visits, thereby attempting to avoid false positives.

This study thus re- emphasizes the importance of appropriate technique of BP evaluation in ambient atmosphere with right sized cuff.

Table 10: Recommended dimensions for BP cuff bladders are as follows:

Age range	Width cm	Length cm	Max arm circumference cm
Newborn	4	8	10
Infant	6	12	15
Child	9	18	22
Small Adult	10	24	26
Adult	13	30	34
Large Adult	16	38	44
Thigh	20	42	52

Arm circumference is such calculated as to allow bladder to encircle arm by at least 80%.

It also raises question of how long a particular child should be observed before considering anti hypertensive treatment. Berensor et al showed in a pediatric anti hypertensive medication study that BP continued to fall over a 6 month observation period in a parallel, untreated control group despite confirmatory BP measurements over a 4 month observation period before study entry[14]. Similarly Sorof et al found in a recent trial[1] that 17% of subjects initially labeled as persistently hypertensive normalized BP during a 2 wk placebo-screening phase.

If additional screening measurements had been performed on subsequent occasions in the current study, it is almost certain that the overall prevalence of HT would have continued to decrease. Although the current recommendations for diagnosis of HT in children is to confirm that BP is > 95th percentile on each of 3 different occasions, it should be noted that failure to confirm HT on all occasions does not necessarily translate to low risk. Because of BP variability, some children have repeat percentile just below 95th%ile, thereby removing them from the hypertensive category on that measurement. Nonetheless, many of these children will continue to have BP in high normal range, thus placing them at substantial risk for future HT. An important observation in current study is increased prevalence of Pre-HT (90th - 95th %), which is 13.7%. These children need close follow up for development of Stage I HT and/or increased cardiovascular risk from untreated HT[15-18].

What needs to be answered is that our HT prevalence was 6.6% (six fold as compared to Task Force Guidelines on HT which is 1% and 1.5 times of that reported by Sorof et al (4.5%). This could be due to unchecked renal anomalies, heart diseases, endocrine causes, lack of routine

BP evaluation in every well child visit & misconception regarding occurrence of HT in children in our country.

Conclusions:

These results confirm the evolving epidemic of cardiovascular risk in youth. The prevalence of childhood HT has increased dramatically over the last two decades. In concert with this increasing prevalence, cardiovascular disease risk & metabolic syndrome has also increased. This increase reflects an epidemoiologic shift from secondary HT (most often caused by renal diseases) to primary (essential) HT as the main cause of HT in the pediatric age range.

Once considered relatively rare, primary HT in children has become increasingly common in association with other cardiovascular risk factors that include overweight, insulin resistance, and dyslipidemia.

The economic & health consequences of this epidemic can spell a disaster for the nation unless immediate remedial measures are instituted. Unless successful interventions & preventive strategies can be instituted at local & national level, these observations suggest that the trend of decreasing cardiovascular disease in adults observed over the past 50 yrs may be reversed, as the current population of overweight hypertensive children & adolescents become adults.

Limitations: The study did not aim to track the hypertensive children & perform diagnostic tests & therapeutic interventions. Though every attempt was made to allay anxiety & fear, there could still be a few cases of white coat HT. Ambulatory BP monitoring would be needed to confirm the same

Future recommendations:

- There is a steadily increasing prevalence of HT noted in Western as well as Indian population as noted in serial studies raging from 1.1%in 1987 to 4.5% in 2006 reported in Lucknow by Gulati S. to 6.6% in our study similar to 6.8% described by Boyed et al [4].

- Elevated BP in childhood may be early expression of essential HT in adulthood. Regular measurements in young (yearly after 3 yrs) are recommended to detect elevation of BP.The new BP tables based on normative distribution of BP in healthy children include 50th & 99th percentile values of BP along with 90th & 95th %ile values [3; 11].Similar reference tables are developed in Indian Studies [2].

- It is well proven beyond doubt that adolescents with BP levels > 120/80mmHg should be considered to be pre hypertensive even if the level is <90th %ile as with adults according to JNC – 7 report on prevention, detection, evaluation & treatment of high BP.

- Height & weight are positively correlated with BP & not age or gender.

- Tracking BP every 6 – 12 monthly would be important rather than single BP measurement in office practice to define HT as BP tends to normalize with sequential monitoring as observed in many studies. Also, this helps to check the pre hypertensive group, which may become full-blown HT & pose cardiovascular risk in adolescence. It would describe the trend of HT in a given child, pubertal spurt (as shown in our study) so that these high-risk children can undergo lifestyle modifications.

- While it may be tedious to refer to BP centile charts for every child in busy practice, it should be remembered that a change by 1-3mm Hg places them in a different stage of HT; hence the use of appropriate centile charts is strongly recommended.

- Lastly, one may not hurry on investigating intensively and give pharmacologic therapy at a single office visit (unless there is hypertensive emergency or urgency). It is useful to follow a step-wise approach & level I, II III of investigation dictated by the clinical condition of the child.

- The pediatricians cannot now afford to ignore the rapidly accumulating evidence that these adult diseases are either programmed at the delicate fetal stage or have their origins in infancy or childhood.

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