AN EPIDEMIOLOGICAL STUDY OF BLOOD PRESSURE AMONG SCHOOL CHILDREN

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ABSTRACT

Blood pressure was measured in 1170 school children between 5 and 15 years of age. Mean blood pressure was significantly higher in boys than girls in all age groups and a steady increase in blood pressure with age was seen in both the sexes. Mean blood pressure was significantly higher among children with positive family history of cardiovascular morbidity. Children from higher socio-economic strata and overweight children also showed higher blood pressure. Nine (0.77%) children had persistent hypertension. However, the degree of hypertension was mild and all these children were asymptomatic. Baseline investigations failed to detect any underlying pathology or target organ involvement. This study suggests that childhood could be a reasonably profitable time to look for such factors and to selectively screen children belonging to the high risk group for hypertension.

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KEY WORDS : Hypertension; Blood pressure; Epidemiology.

Introduction

Hypertension occurs in approximately 3 to 6 per cent of adult population and places such individuals at higher risk of cardiovascular, cerebrovascular and renal diseases [1]. Complications of hypertension can be prevented by early detection and effective control [2]. Epidemiological studies in different settings have confirmed that about 1 to 5 percent of children are hypertensive [3]. This insidious and steady course of hypertension in adults indicates that it may have its roots in early childhood but probably goes undetected [4]. Blood pressure (BP) studies in children are one of the ways to obtain scientific evidence on factors that contribute to BP elevation and help evolve means to control them [5]. It was therefore decided to undertake a study to determine BP among school children in the background of various epidemiological factors and suggest measures to control them.

Material and Methods

This study was conducted among school children from the Central School in one of the Air

Force Stations in south India during April 90 to February 91. One thousand one hundred and seventy children in the age group of 5 to 15 years were covered in the study. The procedure was explained to the children and clinical examination was carried out in the school premises itself between 1100 hours and 1300 hours. All the children were given a pre-tested questionnaire to be filled up by their parents to elicit history of hypertension, and coronary and cerebrovascular diseases among the first-degree relatives. In case of positive family history medical documents of the parents were screened to confirm diagnosis. Age of each child was recorded in complete years from school records. Socio-economic status was determined using Kuppuswamy's classification [6].

Clinical examination included physical and cardiovascular examination and anthropometric measurements. The normal range of body weight for children was computed (according to age, sex and height) as ideal weight $\pm$ 10 per cent by using ICMR tables [7] and thereafter children were categorized into three groups viz., normal, underweight, and overweight. Supine BP was recorded

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in both arms using a sphygmomanometer and appropriate cuff (the breadth being two-third the length of the upper arms and bladder encompassing the arm without overlapping) as advocated by the American Heart Association [8]. Three standard sizes of paediatric BP cuffs were used (4 cm, 8 cm and 12 cm) and systolic and diastolic pressures were recorded at points coinciding with the appearance and muffling respectively of Korotkoff's sounds [8]. Two readings of BP were taken by the investigator for each child and the mean was considered for data tabulation. The same sphygmomanometer was used during the entire study and it was regularly checked for precision.

Children found to have elevated BP on initial screening were subjected to repeat measurements on three different occasions and those with persistently raised BP were further investigated. Investigations included routine and microscopic examination of urine; blood urea, serum creatinine, blood cholesterol; chest (posteroanterior) and abdomen (plain) radiograms; and ECG and fundus examination. These children were followed-up once a month for six months thereafter. The data obtained was tabulated, analyzed and statistically validated. Significance of difference of mean (Z test) and analysis of variance (ANOVA) by computing 'F' ratio were used for calculating statistical significance.

Results

Out of the 1170 children, 5 to 15 years of age, 656 (56.1%) were boys and 514 (43.9%) were girls. Mean systolic and mean diastolic BP (SBP, DBP) according to age and sex are shown in Table 1. The highest mean SBP (114.2 ± 10.1 mmHg)

and DBP (72.1 ± 8.4 mmHg) were among boys in the age group of 13 to 15 years. It was obvious that a gradual and steady increase in both SBP and DBP is seen with increase of age in boys as well as girls. BP in girls was always lower when compared to boys in all age groups and this was statistically significant.

Ninety six children (8.2%) had family history of morbid cardiovascular events. Fifty six families had uncomplicated hypertension, 30 had hypertension complicated with either coronary or cerebrovascular morbid conditions and 10 had these conditions without hypertension. Children coming from families with history of cardiovascular morbidity had significantly higher levels of SBP and DBP in all age groups (Table 2).

There was an upward trend in both SBP and DBP with the rise in socio-economic status of the child's family and this was statistically significant (Table 3). The highest mean SBP (114.1 ± 7.4 mmHg) and DBP (73.8 ± 6.8 mmHg) were observed among children of 13-15 years of age belonging to families from socio-economic Class-I.

Three hundred and fifty one (30%) children were under-weight and 57 (4.8%) were over-weight. Over-weight children had a higher BP when compared to the normal and under-weight counterparts and this was statistically significant (Table 4).

Various characteristics of the 9 (0.77%) children who were hypertensive are shown in Table 5. All belonged to families in the socio-economic Class-I. Only 5 children were over-weight and prevalence of hypertension was 8.8 per cent among the obese as compared to 0.36 per cent among the non-obese. Seven children had positive

TABLE 1
Mean systolic and diastolic BP according to age and sex

Age in years	No. of Children	Males			Females		
		No.	SBP (mean $\pm$ SD)	DBP (mean $\pm$ SD)	No.	SBP (mean $\pm$ SD)	DBP (mean $\pm$ SD)
5 - 7	240	140	98.2 ± 10.1	65.2 ± 8.0	100	$93.2 \pm 7.1^*$	$62.1 \pm 5.2^*$
7 - 9	240	138	98.6 ± 8.2	65.3 ± 7.6	102	$95.3 \pm 8.0^*$	$62.4 \pm 6.2^*$
9 - 11	238	134	102.4 ± 10.2	65.6 ± 8.0	104	$98.3 \pm 7.6^*$	$62.8 \pm 7.0^*$
11 - 13	236	130	106.8 ± 9.3	68.6 ± 7.6	106	$98.6 \pm 8.1^*$	$64.2 \pm 7.4^*$
13 - 15	216	114	114.2 ± 10.1	72.1 ± 8.4	102	$108.6 \pm 9.2^*$	$67.0 \pm 6.2^*$

*p < 0.01, calculated through significance of difference of means (Z test).

TABLE 2

Mean systolic and diastolic BP according to age and familial risks

Age in years	No. of Children	BP level in children without familial risk factor			BP level in children with familial risk factor		
		No.	SBP (mean $\pm$ SD)	DBP (mean $\pm$ SD)	No.	SBP (mean $\pm$ SD)	DBP (mean $\pm$ SD)
5 - 7	240	216	95.1 $\pm$ 8.1	62.9 $\pm$ 6.6	24	98.8 $\pm$ 7.2*	65.7 $\pm$ 6.2#
7 - 9	240	217	96.1 $\pm$ 8.1	64.1 $\pm$ 6.2	23	99.7 $\pm$ 7.6#	66.8 $\pm$ 5.6#
9 - 11	238	215	100.6 $\pm$ 8.6	63.3 $\pm$ 6.3	23	104.2 $\pm$ 7.2#	66.1 $\pm$ 6.1#
11 - 13	236	222	101.0 $\pm$ 8.7	63.4 $\pm$ 7.5	14	105.7 $\pm$ 7.1#	67.6 $\pm$ 6.2#
13 - 15	216	204	108.4 $\pm$ 9.6	69.2 $\pm$ 7.3	12	113.9 $\pm$ 7.3#	73.4 $\pm$ 6.7#

*p < 0.02; # p < 0.05, calculated through significance of difference of mean (Z test).

TABLE 3

Mean systolic and diastolic BP according to age and social class

Age in years		BP level in			ANOVA p values
		children of class I families (n=274)	children of class II families (n=656)	children of class III families (n=240)	
5 - 9	Systolic BP (mean $\pm$ SD)	97.2 $\pm$ 7.2	95.8 $\pm$ 7.4	95.1 $\pm$ 8.1	0.05
	Diastolic BP (mean $\pm$ SD)	64.7 $\pm$ 6.6	63.8 $\pm$ 6.2	63.0 $\pm$ 6.4	0.05
	No of children	124	250	106	
9 - 13	Systolic BP (mean $\pm$ SD)	105.2 $\pm$ 7.2	101.0 $\pm$ 8.6	98.8 $\pm$ 7.2	0.05
	Diastolic BP (mean $\pm$ SD)	67.2 $\pm$ 6.1	63.4 $\pm$ 7.5	60.1 $\pm$ 6.2	0.05
	No of children	94	266	114	
13 - 15	Systolic BP (mean $\pm$ SD)	114.1 $\pm$ 7.4	108.6 $\pm$ 8.2	105.1 $\pm$ 7.6	0.05
	Diastolic BP (mean $\pm$ SD)	73.8 $\pm$ 6.8	69.9 $\pm$ 7.1	65.8 $\pm$ 7.0	0.05
	No of children	56	140	20	

TABLE 4

Mean systolic and diastolic BP according to age and body weight

Age in years		BP level in			ANOVA p values
		under weight children (n=351)	normal weight children (n=762)	over weight children (n=57)	
5 - 9	Systolic BP (mean $\pm$ SD)	96.6 $\pm$ 8.2	99.4 $\pm$ 6.1	—	0.05
	Diastolic BP (mean $\pm$ SD)	63.8 $\pm$ 6.4	66.1 $\pm$ 5.9	—	0.05
	No of children	141	339	—	
9 - 13	Systolic BP (mean $\pm$ SD)	98.9 $\pm$ 8.6	103.0 $\pm$ 7.2	105.0 $\pm$ 7.4	0.05
	Diastolic BP (mean $\pm$ SD)	62.8 $\pm$ 6.9	64.4 $\pm$ 7.1	68.2 $\pm$ 6.1	0.05
	No of children	147	301	26	
13 - 15	Systolic BP (mean $\pm$ SD)	105.2 $\pm$ 7.2	108.4 $\pm$ 8.1	113.8 $\pm$ 7.2	0.05
	Diastolic BP (mean $\pm$ SD)	64.9 $\pm$ 7.1	69.0 $\pm$ 6.8	73.4 $\pm$ 6.7	0.05
	No of children	63	122	31	

family history of cardiovascular morbidity. All 9 children had sustained hypertension which was confirmed by six follow-up examinations at

monthly intervals. However, these children were asymptomatic and their biochemical, haematological and fundus examinations did not reveal any

TABLE 5

Various characteristics of hypertensive children

Serial No.	Age in years	Sex	Social class	Weight (kg)	Family history	SBP (mmHg)	DBP (mmHg)	Normal mean BP @	
								SBP	DBP
1	8	M	I	43*	+	124	86	115.0	80.5
2	9.5	M	I	33	+	128	86	122.4	81.6
3	10.5	M	I	34	+	130	86	122.4	81.6
4	11	M	I	60*	—	134	90	125.4	83.8
5	12.5	M	I	58*	+	130	86	125.4	83.8
6	13.5	M	I	60*	+	140	90	134.4	87.9
7	14	M	I	54	+	138	94	134.4	87.9
8	16	F	I	53	—	130	86	127.0	79.4
9	16	F	I	68*	+	130	86	127.0	79.4

* Obese children; @Range of normal BP = mean (for age and sex) $\pm$ 2SD

abnormality. No past history suggestive of glomerulonephritis was given by any of these hypertensive children.

Discussion

In the present study, the highest mean SBP and DBP was seen among boys in the 13 to 15 years age group. A gradual and steady increase in both SBP and DBP was observed with increase in age. BP among girls was always lower than boys in all age groups. Szklo also observed a rise in BP with age in both the sexes [9]. However during adolescence the rise is steeper in boys than girls which probably explains the difference in BP between boys and girls. He also observed an average annual increase of 2 mmHg in SBP until the age of 20 years in boys and 1 mmHg in girls; the increase in DBP was 0.5 to 1 mmHg for both the sexes.

Our study revealed that children coming from families with history of morbid cardiovascular events had significantly higher mean SBP and DBP as compared to their normal counterparts. Similar findings have been documented by authors from other countries [10]. Sigurdsson reported that adults with history of hypertension in first-degree relatives had a mean SBP that was 6 to 8 mmHg higher and diastolic hypertension (>105 mmHg) twice as frequent as compared to normal counterparts [11].

A significantly higher mean SBP and DBP was seen among the children belonging to families

from higher social class and also in the overweight children. There is a strong positive correlation between BP, height, weight and various indices of body mass [12]. Body weight is also a predictor of elevated BP in follow-up studies in children [13]. In adults there is evidence that reduction in energy intake, leading to weight loss, reduces BP [14]. Clustering of hypertension in families is a well known phenomenon [15, 16]. It is understandable that children coming from well-to-do families tend to be over-nourished and obese and when associated with familial predisposition these children manifest with higher BP as compared to their normal counterparts.

The prevalence of hypertension was 0.77 per cent which is much lower compared to prevalence in other countries [3], and this may be due to difference in socio-economic status and genetic constitution. Nine children from higher socio-economic background were hypertensive and 5 of them were obese. Prevalence of hypertension among obese (8.8%) was significantly higher as compared to non-obese ($\chi^2=39.85$, $df=1$, $p < 0.001$, $OR=26.6$). Seven children had positive family history of cardiovascular morbidity. However, in all the children the degree of hypertension was mild without any target organ involvement or biochemical abnormality. Similar findings have also been documented by other authors [2, 17-19].

The study clearly indicates that mild hypertension in asymptomatic school children is not so

uncommon. The association of positive family history and hypertension in adolescents and young adults is well established and this association also holds good for children as reported by other workers [17-20]. The risk increases when the child is male, obese and belongs to a higher socio-economic background. Therefore, it appears convincing that childhood should be a profitable time to look for these factors as well as for screening of BP among the children belonging to the high-risk group.

This is a limited descriptive study and was conducted primarily to ascertain the level of BP among school children. The association of raised BP with other factors observed is a corollary to the principal finding. Therefore, it appears pertinent to mention here that the same sample will be inadequate for studying these associations individually. However the information generated by studying this small sample can be useful for planning preventive strategies and future epidemiological research. It is prudent to conduct more such studies on similar populations in different settings to confirm the findings.

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