Original Article

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Paediatrics Section

The Prevalence of Elevated Blood Pressure and the Association of Obesity in Asymptomatic Female Adolescent Offsprings of Hypertensive and Normotensive Parents

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ABSTRACT

Background and objectives: The measurement of the arterial Blood Pressure (BP) is an integral part of every child's physical examination and it should be interpreted according to the age, gender and the height centiles. Hypertension runs in families and a parental history of hypertension increases the risk of developing hypertension, especially if both the parents have hypertension. The present study was conducted to test this hypothesis and also the hypothesis that hypertensive children are likely to be obese.

Methods: This case control study done on 200 adolescent girls who were aged between 12 to 17 years, who were from a higher primary school in an urban area of Mangalore and on their parents. The blood pressures in the apparently healthy children of the hypertensive and the normotensive parents were compared. The children of the hypertensive parents were defined as the cases and the children of the normotensive parents served as the controls. A calm comfortable setting was provided for the measurement of the BP. Only one researcher performed all the BP measurements and categorized them by using the 2004 fourth report on the blood pressure screening recommendations. The additional measures included the weight and the height. The obesity was determined, based on the Body Mass Index (BMI). The odds ratio (OR) was used for the evaluation of the association between the BP and the obesity, which was based on the BMI.

Results: A total of 203 adolescent girls were given proformas to be completed by their parents. Three parents did not give their consent. Two hundred children and their parents participated in this study. The prevalence rate of hypertension in this study was 11%. Among these 22 hypertensive children, 9 (40.9%) had positive family history of hypertension (the parents had high BP), while the remaining 13 (59.1%) children had normotensive parents. The mean weight and height in the cases were 45.52 ± 9.23 kg and 156.80 ± 9.19cm. The mean weight and height in the controls were 43.65 ± 8.68 kg and 155.22 ± 10.15cm. The mean systolic BP increased with the increasing body weight ($p < 0.05$). The children with hypertension and without hypertension had a mean BMI of 2.06 ± 0.44 (mean ± SD) gm/cm^2 and 1.76 ± 0.29 gm/cm^2 respectively. Obesity was associated with hypertension (50% *vs.* 8.9% , $p < 0.001$).

Interpretation and Conclusions: This study confirmed a high prevalence of hypertension in the asymptomatic, healthy, adolescent girls. The blood pressure in the apparently healthy children of the hypertensive and the normotensive parents was comparable, thus refuting our hypothesis. Obesity was a significant predictor of hypertension, based on the BMI (OR 50.882; 95% CI: 17.25-150.091). Hence, BP measurements must be a part of the routine clinical examination.

Key Words: Blood pressure, Parents , Body mass index, Obesity, School children

INTRODUCTION

Hypertension, which occurs in approximately 3-6% of the adult population, places the affected individuals at an increased risk of cerebrovascular accidents, ischaemic heart disease and renal failure [1] and these complications can be prevented by an early detection and an effective controlling of the Blood Pressure (BP). Further, the long, slow and steady course of hypertension in adults also suggests that it perhaps had its origin in childhood, but had probably gone undetected during this period, only to manifest itself during adulthood [2,3]. In the recent years, the prevalence of hypertension in the school-aged children appears to be increasing, perhaps as a result of the increased prevalence of obesity. Hypertension runs in families and a parental history of hypertension increases the risk of developing hypertension, especially if both the parents are hypertensives [2,4-6]. Therefore, it is important to identify the children and the adolescents who are at an increased risk of developing essential hypertension as adults. However, the measurement of BP is not routinely employed in our country in the various health check-up programs and the studies which pertain to the BP of the school going Indian children are limited.

AIMS

The present study was conducted to test the hypothesis that hypertensive parents are more likely to have children with hypertension; and that hypertensive children are obese.

MATERIALS AND METHODS

A case control study was conducted on 203 adolescent girls who were approached through their school, who were aged between 12 to 17 years and on their parents, in an urban area of Mangalore, over a period of 2 months, in the year 2007-08. The inclusion criteria were healthy children, without any underlying disease and

their hypertensive or normotensive parents. An informed written consent was taken from the parents before involving their children in the study. Two hundred parents gave their consent for the study. This study had the prior approval of the institutional ethics committee. Every child in the study was given a predesigned questionnaire which was to be recorded by either parent, to obtain the information with reference to their last blood pressure readings and a history of hypertension, myocardial infarction and/or stroke. The following day, the proformas were collected and analyzed. The children of the hypertensive parents were taken as the cases and those of the normotensive parents were taken as the controls. A thorough physical examination was done to rule out the presence of any disease. The ages of the children were recorded in complete years. The weight (kg) was taken by using a standardized floor weighing machine to the nearest 0.5kg, with the subject being lightly dressed and barefoot. The height was measured with the subject being without footwear, by using a standard vertical calibrated bar and a sliding pointer with an accuracy of up to 0.5 cm. The obesity was defined, based on the body mass index (BMI), which was calculated by 2 methods: the Davanport index [6] and the CDC growth charts (the BMI for the age percentiles) [7].

The blood pressure measurements were done by a single researcher to avoid interobserver variability by using a mercury sphygmomanometer, as per the recommendations of the American Heart Association [8]. The measurements of the BP of the children were taken in a quiet room after each child was seated for 5 minutes with the right arm resting on the table, and with the cubital fossa at the heart level. The length of the upper arm was the distance between the acromion and the olecranon, which was measured when the arm of the child was in a relaxed position and when it was bent at 90 degrees at the elbow. The circumference of the upper arm was measured with a tape, without indenting the skin at the midpoint of the relaxed hanging upper arm. All the BP cuffs were commercially available and the sizes were chosen to select a bladder width of at least 40% of the length of the upper arm and a length which was greater than the circumference of the upper arm. The manometer readings at the first and at the onset of the fifth korotkoff phases were taken as the systolic and the diastolic BP, respectively. Three readings were taken at intervals of 5 minutes for each child and the average was taken for the final analysis. It was corrected for age and sex in the form of centile bands and compared with the US National Childhood Blood Pressure Standards [9].

For the children, hypertension was defined as the systolic blood pressure or the diastolic blood pressure above the 95th percentile for that age and gender, after adjusting for the height [10] (by using the CDC growth chart-stature for the age percentiles). A parent with an average BP of >140/90 mm Hg or who was on antihypertensive drugs at the time of the study, was classified as a hypertensive [11].

The children were divided into 2 groups; those with hypertensive parents (either or both) were taken as the cases and those with normotensive parents were taken as the controls. The prevalence rates of hypertension in both the groups were calculated and compared.

The data was analyzed by using the SPSS (version 15.0) statistical package by using the Students 't' test and linear and logistic regression analyses. The ANOVA statistical package and the Chi Square test were also applied. A 'p' value of <0.05 was considered as significant. The Odd's Ratio (OR) and the Confidence Interval (CI) calculator were used to calculate the OR and the 95% confidence interval.

RESULTS

A total of 203 adolescent girls were given the proformas to be completed by their parents. Three parents did not give their consent. Two hundred children and their parents participated in this study. 22 subjects had hypertension, with a prevalence rate of 11%. 9 (40.9%) had a positive family history of hypertension in the parents, while the remaining 13 (59.1%) children had normotensive parents. Among the nine hypertensive children, six (66.7%) had hypertensive fathers, while only one (11.1%) had hypertension in the mother and two (22.2%) children had both parents as hypertensives.

The mean systolic and the diastolic BP in the children of the hypertensive parents were 111.04 ± 13.16 (mean ± standard deviation) mm of Hg and 72.60 ± 9.60 mm of Hg respectively, while they were 111.14 ± 11.13 mm of Hg and 72.81 ± 9.98 mm of Hg respectively in the children of the normotensive parents. There was no statistically significant correlation between the BP (systolic/diastolic) of the children of the hypertensive parents and the BP of the children of the non hypertensive parents.

The mean weight and height in the cases were 45.52 ± 9.23 kg and 156.80 ± 9.19 cm and 43.65 ± 8.68 kg and 155.22 ± 10.15cm in the control group. The mean systolic BP increased with the increasing body weight and it was statistically significant. There was no relationship between the mean diastolic BP and an increase in the body weight. The systolic BP showed a gradual rise with increasing height, while the diastolic BP did not show any definitive pattern. There was no statistically significant association between the systolic or the diastolic BP and the height.

The children with hypertension had a mean BMI of 2.06 ± 0.44 (mean ± SD) gm/cm^2. The children without hypertension showed a mean BMI of 1.76 ± 0.29 gm/cm^2. The mean systolic BP in the obese group was 122.0 ± 11.86 (mean ± SD) mm of Hg, while it was 110.06 ± 11.25 mm of Hg in the non-obese children, which was statistically significant. The mean diastolic BP was 76.6 ± 13.59 and 72.38 ± 9.39 in the obese and the non-obese groups respectively, which did not show any significant association with the obesity. The mean systolic BP showed an increasing trend with an increase in the BMI and it was statistically significant. ($p < 0.05$) However, for the diastolic BP, there was a trend for the mean value to increase with an increase in the BMI, but this was not statistically significant [Table/Fig-1].

The prevalence of hypertension in the obese children was 50% (as was calculated by the Davanport index) as compared to that in the non-obese children, which was 8.9% ($p < 0.001$) (95% CI: 2.67 to 38.70) [Table/Fig-2] whereas in the obese children (as was calculated by the CDC BMI charts), it was 75%, as compared to 9.7% in the non obese children ($p < 0.05$) (95% CI: 2.77-60.2) [Table/Fig-3].

DISCUSSION

Hypertension is the most potent universal contributor to the cardiovascular mortality. An elevated BP, labile or fixed, systolic or diastolic, at any age, in either sex, is a contributor to all forms of cardiovascular diseases [1,2]. BP measurements must be a part of every clinical examination in children [9].

By taking the criteria of the 95th percentile of BP for defining hypertension, for that age and sex group, after adjusting for the

BMI (gm /cm^2)	Mean systolic BP (mm Hg)	Mean diastolic BP (mm Hg)
1.00-1.50	106.11	70.11
1.51-2.00	110.16	72.52
2.01-2.50	115.60	74.40
>2.51	121.78	77.33
p value	.003 (significant)	.286 (not significant)

[Table/Fig-1]: Distribution of BP according to Body Mass Index (BMI)

Obesity	Children with hypertension	Children without hypertension	Odd's Ratio	95% CI
Obese (BMI ≥ 2.26)	5 (50 %)	5 (50%)	10.1765	2.67 to 38.70
Non-obese (BMI < 2.26)	17 (8.9%)	173 (91.1%)		
	22	178		

[Table/Fig-2]: Prevalence of Hypertension in obese and non-obese children [according to Davanport index:- weight(gm)/height(cm^2)] P< 0.001 Significant.

Obesity	Children with Hypertension	Children without Hypertension	Odd's Ratio	95% CI
Obese (BMI≥95th percentile)	3 (75 %)	1 (25%)	27.95	2.77 to 60.2
Non-obese (BMI< 95th percentile)	19 (9.7%)	177 (90.3%)		

[Table/Fig-3]: Prevalence of Hypertension in obese and non-obese children [according to CDC growth chart(BMI for age percentiles): weight(kg)/height(m^2)] P< 0.05 Significant.

Study	Age Group	Prevalence of Hypertension (%)
Present study	12-17	11
Kamath et al. [12]	5-16	2.2
Chakraborty et al. [13]	5-18	4.29
Lurbe et al. [14]	6-19	4.6
Sharma et al. [15]	11-17	5.9
Ferrara et al. [17]	11	6.5
Feng N et al. [18]	8-11	7.2
Akgun C et al. [19]	7-16	9.1
Raj et al. [20]	5-16	10.58
Matsuoka S. et al. [21]	6-25	11

[Table/Fig-4]: Prevalence of Hypertension

height; the prevalence of hypertension in our study was found to be 11%; 3% for the systolic BP, 6% for the diastolic BP and 2% for both the systolic and the diastolic BP. The prevalence of essential hypertension in children has been reported to vary from 2.2% to11% [Table/Fig-4].

This diversity in the prevalence was due to the varying age groups which were taken for the study, the different criteria which were adopted for defining hypertension and the basic differences between the racial subgroups which were related to geographic, dietary and cultural factors. The familial aggregation of BP, the unidentified genetic factors and the anatomical variants of the regional circulation may also change the demographic pattern from time to time. In the recent years, the prevalence of hypertension in the school-aged children appears to be increasing, perhaps as a result of the increased prevalence of obesity and stress, a lack of physical activity and an over active sympathetic nervous system [22].

Six (66.7%) out of the 9 hypertensive children had hypertensive fathers. One (11.1%) out of the 9 hypertensive children had hypertension in the mother. Only 2 (22.2%) children had both parents as hypertensives. Although the exposure rate was higher in the cases (18%) than in the controls (8.6%), the association between the hypertension in the children and the family history of the hypertensive parents was not significant statistically (P>0.05), thus refuting our hypothesis that hypertensive parents have a higher risk of having children with hypertension. However, a family history of hypertension played an important role in the development of high BP in the children in this study [6,22]. Hypertension in both the mothers and the fathers had a strong independent association with the elevated BP levels and with the incident hypertension over the course of the adult life, in a longitudinal cohort of 1160 male former medical students with 54 years of follow-up [2]. The vagal withdrawal plays a critical role in the development of the Sympathovagal Imbalance (SVI) in the prehypertensive offsprings of the hypertensive parents. The intensity of the SVI was more in the offsprings of the two parents who were hypertensives as compared to those of a single parent who was hypertensive [5].

The body size is an important determinant of the BP in children. The BP standards depend on the age, sex, weight and height. The second Task Force Report, in 1987, stressed that the BP values must be evaluated with the height and the weight. These BP values were reanalyzed, considering the height in 1996 and the height specific systolic and diastolic BP percentiles were determined in the fourth Task Force Report [10]. The prevalence of obesity was found to be 5% by the Davanport index and to be 2% by using the CDC growth charts (the body mass index-for-age percentiles). The BP was much higher in the obese children as compared to that in the non-obese, (50% *vs.* 8.9%) and a highly significant correlation was noted, both by the Davanport index and by the CDC growth chart, as was also observed in similar studies [6,14,19,23,24]. Obesity was strongly associated with the systolic hypertension in the adolescent girls [25,26], as was also found in our study.

Some of the physiologic changes which have been proposed to explain the relationship between the excess body weight and the blood pressure, are overactivation of the sympathetic nervous and the renin–angiotensin systems, the elevated levels of the inflammatory pathways and insulin resistance [27]. A follow up study on adolescents was done for 31.5 years, where a BMI above the 95th centile in adolescence predicted increased adult mortality rates, and a 10 kg higher body weight was associated with a 3.0 mmHg higher systolic and a 2.3 mmHg higher diastolic blood pressure. These increases translate into an estimated 12% increased risk for coronary heart disease and into a 24% increased risk for stroke [28]. Hence, it would be logical to advise the families with obese children to change their lifestyles with respect to the diet, exercise and the reduced salt intake, to get their children accustomed to the life styles which are favourable for the maintenance of normal blood pressures.

LIMITATIONS OF THE STUDY

While it has been recommended to use the average of the multiple BP measurements which were taken for weeks to months to characterize an individual's BP level, limited resources and time restricted the researcher in this study from doing so. The BP is also

influenced by various other factors such as the time of the day, ambience and the fasting vs. the non-fasting state of the subject, that could not be controlled in this study. A further classification could not be done due to a lack of investigations on secondary hypertension. The small sample size and the determination of BP in a single sex were also our limitations, but the increased prevalence of hypertension emphasizes the importance of the BP monitoring in children.

CONCLUSIONS

The blood pressures in the apparently healthy children of the hypertensive and the normotensive parents were comparable; however, this study confirmed a high prevalence of hypertension in adolescent girls. 50% of the hypertensive children were obese, in comparison to the children without hypertension. Obesity was a significant predictor of hypertension, based on the BMI (OR 50.882; 95% CI: 17.25-150.091). All the paediatricians should measure and monitor the BP. The children in the high risk group should be identified and treated with an individualized approach.

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