

STUDY OF PREHYPERTENSION AND HYPERTENSION AMONG URBAN SCHOOL ADOLESCENTS AND THE DIETARY DETERMINANTS OF CHILDHOOD HYPERTENSION

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ABSTRACT

Background: Adolescent health is important as they are under a great amount of stress due to academic and peer pressures. This study aims to determine prevalence of pre-hypertension and hypertension in school adolescents and to identify diet as a risk factor in these children. **Methodology** - Cross sectional study was conducted among school adolescents (11-14 years). Anthropometric and blood pressure measurements were taken. 24 hour recall method was used to record the dietary intake and the total sodium, potassium, fat, fructose, caffeine, uric acid and fiber in the diet was estimated. **Results** - 500 adolescents were studied. Among the study population 6.4% were pre-hypertensive and 7.4% hypertensive with increased prevalence in girls. 9.8% were obese and 14.2% overweight. 14.3% obese and 11.3% overweight children had pre-hypertension. 30.6% obese and 9.9% overweight children had hypertension. Dietary analysis showed that normotensive children consumed lesser fructose (258mg), fat (12.8gm), sodium (89mg), and uric acid with more potassium (89mg), and fiber (10.2gm) per day as compared to the hypertensive children. **Conclusions:** There is high prevalence of asymptomatic hypertension among obese and over-weight school adolescents. Dietary differences were found between the hypertensive and normotensive adolescents with increased fat consumption showing statistical correlation with hypertension.

Key Words: hypertension, obese, overweight, fat intake

INTRODUCTION

Hypertension is often underestimated in children as it is usually asymptomatic among them. Childhood hypertension is an impending global burden contributing heavily to adult hypertension and is a risk factor for cardiovascular disease contributing to mortality statistics¹. The risk of hypertension is threefold more in children and adolescents with obesity², with insulin resistance being the underlying association between hypertension and obesity². Unfortunately adolescent hypertension is underestimated as there are no single clear cut values unlike in adults, as it is defined in centiles in relation to age, sex and height³. Children and adolescents in today's world have a sedentary life due to digitalization, television exposure and over emphasis on academic excellence, all of which contribute to obesity⁴. Early diagnosis of hypertension in the moldable years in childhood can help by advising non pharmacological measures like dietary modification techniques and exercise to control the blood pressure⁵. Dietary impact on hypertension is one of the major alterable factor in reducing hypertension. The dietary factors that contribute to hypertension that are well established are increased sodium, decreased potassium, increased uric acid, increased caffeine. Increased fat and decreased fibre contribute indirectly to hypertension. The effect of diet in hypertension has been studied in adults but there are very few pediatric studies that quantitatively study the effect diet plays in childhood hypertension.

This study was hence conducted to estimate the prevalence of prehypertension and hypertension among school children, 11 -14 years of age, in Mangaluru city and to identify the

dietary risk factors contributing towards pre hypertension and hypertension in these children. Numerous studies have been done upon identifying hypertension in children, however this is one of the very few studies that aims to quantify the dietary determinants of hypertension which is one of the modifiable risk factors in the same.

MATERIALS AND METHODS:

Cross sectional, school based study conducted from October 2014 to September 2016 In Private schools in Mangalore city Sample size of 500, Calculated by $n = Z\alpha^2Pq/E^2$ With 95% confidence level and 80 % power and 10% non-response .Adolescent school children between 11-14 years of age were included and Children with any known acute or chronic illness pertaining to renal disease, steroid therapy, thyroid dysfunction were excluded.

Data collection:

A cross sectional community based study was conducted from October 2015 to May 2017 for a sample size of 500 adolescents in the age group of 11-14 years studying in urban schools in Mangalore. Ethical clearance was obtained from institutional ethics committee. Permission was obtained from the block educational officer and the respective head of the institution /schools prior to the study. Written informed consent from parents and assent form from the subjects were obtained prior to the recruitment into the study.

Questionnaires were distributed to the selected children through class teachers and were filled by them and their parents appropriately about the details of the child, parental history of hypertension, stroke, snoring, socio economic status and dietary practices. Anthropometric measurements like weight and height was taken using standard methods. Blood pressure was measured after child was made comfortable using mercury sphygmomanometer in right upper limb in sitting position by auscultatory method with appropriate sized cuff covering 2/3 of upper arm and encircling it completely. Systolic blood pressure was the point of appearance of Korotkoff's sounds and diastolic blood pressure was taken at the point of disappearance of the sounds. 3 measurements were taken 5 minutes apart and average of these readings was considered as the average blood pressure. This was compared to age, sex and height percentile standards given by the report of Fourth task force on hypertension control in children.

Pre hypertension was diagnosed if blood pressure was between 90th and 95th centile. Hypertension was diagnosed if blood pressure either systolic or diastolic or both was more than 95th percentile for age, sex and height percentile. WHO charts for BMI for age and sex were used as reference standards. Children with BMI above 95th centile were considered obese, those between 85th to 95th centile were considered as overweight and the rest normal.

For the dietary calculation: 24 hour dietary recall method was used to assess dietary intake. With this information the following were estimated with the help of the online calculator – DietACal: total sodium, PGIpotassium, fat, fructose, caffeine, uric acid and fibre.

Descriptive statistics was done in terms of mean, median and percentages. Association of each of the categories with pre hypertension and hypertension was assessed with Chi square test and Fischers Exact test. The determinants associated with pre hypertension and hypertension was tested using Mann Whitney test. Statistical analysis was performed using SPSS software version 17.

RESULTS AND ANALYSIS

In our study a total of 500 adolescent children, who satisfied the inclusion criteria were enrolled. The results have been tabulated in 3 sections as out lined below.

1. Demography of study population.
2. Details of Pre-Hypertension and Hypertension in the study population.
3. Dietary evaluation

Section 1 – Demography of the study population:

The study group composed of 240(48%) boys and 260(52%) girls. 44% of the children were in 14 years age group, 36% in 13 years age group, 6.8% in 12 years and 13.2 % in the 11 years group. The clinical history given by the children and their parents is tabulated in Table 1.

Section 2: Details of hypertension and Prehypertension in the study population

In our study we found that a total of 49 children showed elevated blood pressure recordings repeatedly, out of them 32 children (6.9%) had prehypertension(n=463) and 37children(7.9%) had hypertension(n=468). Within the study group isolated systolic hypertension was seen in 8.6% (43 children) of the children and isolated diastolic hypertension in 5.2%.

When the prehypertensive blood pressure values were analyzed with respect to the various age groups, 1.5% of children in the 11year age group had prehypertension and this value showed a steady increase becoming 6.9% in the 12 years age group to 8.8% in the 14 year age group. Hence in this study group, as children move into later adolescence, prevalence of prehypertension increased. (P value 0.287 by Fischers exact test.) When hypertensive blood pressure values were analyzed with respect to the age groups, 5.4 % of the children in the 11 year age group had hypertension, 13.5 % in the 12 years, 37.8 % at 13 years and 43.2 % in the 14 year age group had hypertension. Here too, similar to prehypertension, as children moved into later adolescence prevalence of hypertension increased. (P value of 0.179 by Fisher's exact test).

Upon analyzing gender as a variable with prehypertension, 4.4% of the males had prehypertension and this number had doubled in females to 9.3 %. Higher prevalence among female children was found(P value 0.039 by Chi-square test). As gender was analyzed with respect to hypertension, females had higher incidence of hypertension ie 9.3% as against 6.1 % of the males (P value 0.152 by Chi-square test).

When statistical analysis was done with prehypertensive and hypertensive children along with their clinical and parental history, statistical significance was found between the prevalence of hypertension and prehypertension being more in female children and the clinical history of the child suffering from headaches and their hypertension (Table 2)

Upon examining the children, their anthropometry and BMI (Table 3), 25% and 21.9% of the children who had prehypertension were overweight and obese respectively. 12.5% of overweight and 20.6% of obese children were found to be pre-hypertensive. Hypertension was identified in 4.7 % of children with normal BMI. 18.9% and 40.5% of the hypertensive children were overweight and obese respectively and vice versa, 7% of the overweight and 15% of the obese children had hypertension. This too was statistically significant with a P value 0.000 by Fisher's exact test. The prevalence of prehypertension among the children with a higher BMI also showed statistical significance as per Fischers exact test (Table 2), withp value being <0.005.

Section 3: Dietary determinants of Prehypertension and Hypertension

The dietary analysis was done by the 24 hour recall method and the detailed diet was further analysed by the dietACal online calculator to elicit the values of the dietary determinants of hypertension and prehypertension. This was done in 2 parts for the exclusively prehypertensive and hypertensive children as shown in Table 4a, 4b and 4c. Among the dietary parameters, total fructose consumption was found to be higher (294mg/day) in hypertensive children as compared to 258mg/day in normal children. (P value 0.211). Total consumption of fat was higher (20.5gm/day) in pre hypertensive children than in normal children (12.8gm/day) with a p value of 0.047. Total intake of sodium was higher (123mg/day) and potassium intake was lower (78 mg/day) in pre hypertensive children as compared to sodium intake of 89 mg/day of both sodium and potassium in in normal children, with a p value of 0.081 and 0.659 respectively. Total fibre intake was 6 gm /day in pre hypertensive children which was lower when compared to normal children with 10.2 gm/day with a p value of 0.088. Therefore upon analysis, fat consumption had a statistically significant relationship with pre hypertension but not with hypertension, sodium and fibre consumption showed a positive relationship with pre hypertension but were not statistically significant. Fructose and potassium consumption also show a positive relation with hypertension without statistical significance. When intake of uric acid in diet was analysed it was found that hypertension was seen in 7.5 % of children with high uric acid consumption and 4% in children with low uric acid consumption though not statistically significant.

DISCUSSION

In our study conducted among 11- 14 year old school going children of Mangalore, the prevalence of hypertension was found to be 7.9 % which was similar to study by Taheri F et al, where the prevalence was 7.7%⁶. Studies by Bertrand F E M et al, Vivek Singh and Mohammed Saaduddin showed a higher prevalence of around 10-11%^{7,8,9}. When we

compared the prevalence of pre hypertension, our prevalence was 6.9% which was similar to study by Mohammed Saaduddin who reported a prevalence of 5.8%⁹. Other studies as quoted above had higher prevalence rates of pre hypertension at 10-20%^{7,8,9}.

When we analyzed the hypertensive cohort and prehypertensive cohort, the prevalence of hypertension was 7.9% out of which 6.1%(n=14) were males and 9.7%(n=23) females, prevalence of pre hypertension was 6.9%(n=32) out of which males were 4.4%(n=10) and females 9.3%(n=22). We also found that the prevalence of hypertension was more among girls (9.7%) as compared to 6.1% in boys with a significant p value. This was similar to other studies done by Patil and Garg where the prevalence of hypertension was 3.2% in females and 2.8% in males¹⁰, which was lower than our study. Another similar study by Anjali Mahajan showed higher prevalence of hypertension than our study, which was 13.1 % in females and 9.5 % in males¹. Some studies like Sundar et al found the prevalence of hypertension more in males (31.75%) as compared to females (10.5%)¹¹.

When we analyzed the relationship between age and blood pressure, we found that as the age increased through adolescence, the prevalence of hypertension also increased which was in concordance with the study by James R Staley et al¹². We found a gradual increase in prevalence of hypertension as the children moved into adolescence, which can be explained due to increased anxiety, academic and psychosocial stress.

In our study 14.2% of children were overweight and 9.8% children were obese, among which 25% of the overweight children and 21.9% of obese children were pre hypertensive; 18.9% of overweight and 40.5% of obese children were hypertensive. Other studies by Baradol et al reported systolic pre hypertension in 5.1% of overweight children and 16.6% of obese children⁴.

In our study parental history of hypertension, history of snoring, cerebrovascular accident, family history of hypertension were not significant with childhood hypertension which was in contrast to a study by Zhai Yi et al, which stated that with family history of hypertension there will be 12% more chance of developing hypertension in children. In our study prevalence of pre hypertension was higher among children of mothers with low educational status than with children of mothers with high educational status, similar to the study by Patrick LP et al¹³.

Diet in hypertension has been identified with adult hypertension and the among all the nutrients, sodium intake has been mostly implicated with hypertension in adults with very few quantitative pediatric studies. When the diet was analyzed quantitatively, it revealed that normotensive children consumed lesser fructose (258mg), lesser fat (12.8gm), lesser sodium (89mg), more potassium (89mg) and more fiber (10.2gm) per day as compared to the hypertensive children. This was perhaps one of the main contributory factors to hypertension as the children are comparable in their age and activity levels in school. Our study also showed that normotensive children had a lower uric acid consumption as compared to the hypertensive children. These values did not show statistical significance except that of fat, but the lack of a

completely accurate food quantities may be the reason for this. Similar quantitative studies of dietary nutrient estimation in relation to hypertension were not found, hence a comparative analysis could not be done.

Pre-hypertensive children were given health education about diet and physical activity and hypertensive children were referred for further management.

CONCLUSIONS:

To conclude, the prevalence of childhood hypertension in the 11-14years age group was 7.9% and of pre-hypertension was 6.9%. The prevalence of childhood obesity and overweight being the 11-14years age group was 9.8% and 14.2% respectively. The prevalence of hypertension was found to be more in girls and in overweight/obese children. Among the dietary risk factors for hypertension, our study showed a statistical significant correlation between increased fat consumption and hypertension. Though dietary constituents of fructose, sodium, potassium, uric acid and fibre did not show statistical significance, they showed a relation between their consumption and childhood hypertension.

RECOMMENDATIONS

Blood pressure should be examined in all children above 3 years in pediatric OPD as a part of general physical examination. Blood pressure should be checked as a part of school health programmes with blood pressure percentile charts for age sex and height.

Physical activity should be encouraged in children especially outdoor games.

Sale of soft drinks, energydrinks, and tobaccoproducts should be banned along with salted foods closer to school premises

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Tables

Table 1: Clinical history

Parameter		Frequency	%
Child's history of			
(i)Headache	Yes	93	18.6%
	No	407	81.4%
(ii)Blurring of vision	Yes	16	3.2%
	No	484	96.8%
(iii)Migraine	Yes	15	3.0%
	No	485	97.0%
(iv)Snoring	Yes	4	.8%
	No	496	99.2%
Parental history of			
(i)Hypertension	Yes	37	7.4%

	No	463	92.6%
(ii)Diabetes Mellitus	Yes	36	7.2%
	No	464	92.8%
(iii)Snoring	Yes	39	7.8%
	No	461	92.2%
(iv)Heart attack	Yes	3	.6%
	No	497	99.4%
(v)Stroke	No	500	100.0%

Table 2: The statistical analysis of Hypertensive and Prehypertensive children with their clinical variables

Parameter	Hypertensive children and clinical history variables				Prehypertensive children and clinical history variables			
	Chi square test		Fishers exact test		Chi square test		Fishers exact test	
	X ² value	P value	X ² value	P value	X ² value	P value	X ² value	P value
Age			.179				.217	
Gender	1.653	.152			3.948	.039		Significant
Mother's Occupation			.781				.961	
Father's Occupation			.328				.244	
Child's symptoms								
Headache	4.595	.034		Significant	.242	.743		
Blurring of Vision	.441	.249			.001	.915		
Migraine	.373	.284			.335	.319		
Snoring		.556				.584		
Parental history:								
i)Hypertension	.024	.684			.624	.273		
(ii)Diabetes mellitus	2.046	.081			.019	.726		
(iii)Snoring	.005	.921			.118	.726		
(iv)Heart attack	.241	.678			.531	.07		
(v)Stroke								
Body mass			.000	Significant			.003	Significant

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Table 3: Relationship of BMI with Prehypertension and Hypertension

BMI	Exclusive Pre Hypertension	Count (%)n=46 3	% Within Pre Hypertension n = 32	Exclusive Hypertension	Count (%)n=46 8	% Within Hypertension n = 37
Under nutrition	Yes	2(4.3)	6.3	Yes	0(0)	0
	No	45 (95.7)	10.4	No	45 (100)	10.4
Normal	Yes	15 (4.7)	46.9	Yes	15 (4.7)	40.5
	No	303 (95.3)	70.3	No	303 (95.3)	70.3
Overweight	Yes	8 (12.5)	25	Yes	7 (11.1)	18.9
	No	56 (87.5)	13	No	56 (88.9)	13
Obesity	Yes	7 (20.6)	21.9	Yes	15 (35.7)	40.5
	No	27 (79.4)	6.3	No	27 (64.3)	6.3
Total number of children with elevated Bp recordings		32(6.9%)			37(7.9%)	

Table 4a: Dietary determinants of exclusively prehypertensive children

Dietary parameter	Blood pressure	Mean	Standard Deviation	Median	Percentile 25th	Percentile 75th	Z score	P value
TOTAL FRUCTOSE in mg/day	Pre Hypertension (n = 32)	283	177.4	245	168.5	325	0.46	0.645
	Normal (n = 431)	311	255.4	258	189	325		
TOTAL FAT in gm/day	Pre Hypertension (n = 32)	37.3	72.5	20.5	12	36.3	1.99	0.047*
	Normal (n = 431)	28.8	48.2	12.8	3.5	32		

TOTAL SODIUM in mg/day	Pre Hypertension (n = 32)	173	259	123	73	152	1.74	0.081
	Normal (n = 431)	152	261	89	59	132		
TOTAL POTASSIUM in mg/day	Pre Hypertension (n = 32)	179	333	89	25	128	0.09	0.927
	Normal (n = 431)	116	180	89	40	98		
TOTAL FIBRE in gm/day	Pre Hypertension (n = 32)	9.3	9.5	6	2.7	13.1	1.71	0.088
	Normal (n = 431)	24.5	91.1	10.2	3.2	23		
TOTAL CAFFEINE in mg/day	Pre Hypertension (n = 32)	42	114	0	0	0	0.35	0.73
	Normal (n = 431)	49	123	0	0	0		

Table 4b: Dietary determinants of exclusively hypertensive children

Dietary parameter	Blood pressure	Mean	Standard Deviation	Median	Percentile 25th	Percentile 75th	Z score	P value
TOTAL FRUCTOSE in mg/day	Hypertension n = 37	298	117.4	294	235	384	1.252	0.211
	Normal n = 431	311	255.4	258	189	325		
TOTAL FAT in	Hypertension n = 37	22	27.8	13.2	3.4	32	0.283	0.777

gm/day	Normal n = 431	28.8	48.2	12.8	3.5	32		
TOTAL SODIUM in mg/day	Hypertension n = 37	102	58	89	74	125	0.042	0.967
	Normal n = 431	152	261	89	59	132		
TOTAL POTASSIUM in mg/day	Hypertension n = 37	76	47	78	36	98	0.442	0.659
	Normal n = 431	116	180	89	40	98		
TOTAL FIBRE in gm/day	Hypertension n = 37	15.2	15.5	8.7	4.2	21	0.497	0.619
	Normal n = 431	24.5	91.1	10.2	3.2	23		
TOTAL CAFFEINE in mg/day	Hypertension n = 37	62	135	0	0	0	0.639	0.523
	Normal n = 431	49	123	0	0	0		

Table 4c: Uric acid consumption and hypertension/prehypertension

Uric acid	Hypertension (n=37)	Prehypertension(n=32)	Normal (n=431)	P value
Low consumption	24 (7.5%)	20 (10%)	300	0.401
High consumption	13 (4.0%)	12 (3.75%)	131	