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Research Article

A study on prevalence of pre-hypertension in relation to various obesity indicators in tenth standard healthy school children aged 14 to 16 years

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ABSTRACT

Background: This study was carried out to know the correlation and percentage prevalance of pre-hypertension among healthy 14 to 16 year 10th standard adolescent school children and its relation to obesity indicators BMI, waist circumference, waist/height ratio.
Methods: A cross sectional study done in schools of Madikeri taluka. 155 healthy adolescent school children of 10th standard aged 14-16 years were examined, Height, weight, waist circumference, blood pressure were measured using standard protocols. Children were categorized according to sex, government/private school and three obesity indicators separately using Indian standard percentile charts. Percentage prevalence of pre-hypertension (BP >90th percentile) varying with all variables noted. Data obtained analysed by descriptive and analytic statistics by using R statistical software and SSPS-16. P value <0.05 considered significant.
Results: Total prevalence of pre-hypertension was 16.13%, 68% boys and 32% girls. As the BMI percentile increases the percentage prevalence of pre-hypertension increases 10.8% at 50th, 25% at 50th to 23 Eq, 57.14% at 23Eq to 27Eq and 83% at >27 Eq. As per waist circumference percentage prevalence of high BP was 11.36% at <75th, 36.3% at 75th to 90th, and 50% at >95th percentile. As per waist/height ratio percentage prevalence was 11.9% at <75th, 41.66 % at 75th to 95th and 55.56% at >95th percentile. Prevalance of overweight according to BMI (>23 Eq) is 8.48%, WC (>90th p) is 7.77%, WHtR (>95th p) is 5.81%. Correlation between all obesity indicators and pre-hypertension were highly significant (p value >0.001).
Conclusions: Percentage prevalence of pre-hypertension increases as the Percentile value of all three obesity indicators increases. Correlation between pre-hypertension and all three obesity indicators was highly significant with BMI the strongest.

Keywords: Correlation Pre-hypertension, Prevalance, Obesity

INTRODUCTION

Obesity is New world syndrome that is accounting for enormous public and socioeconomic health burden.[1] At puberty central fat distribution is more important in boys i.e. nape of neck, shoulder and epigastrium whereas in girls peripheral fat accumulation in lower body predominates.[2] BMI is the simplest measure of obesity, but it cannot distinguish between fat free mass and distribution of fat. WC and WHtR are better predictors of central adiposity and obesity related metabolic risks. Each anthropometric index is to be considered with equal importance and as simple non-invasive measure of screening obesity. Indian children are more susceptible for obesity mediated hypertension. Childhood high blood pressure is risk for adult hypertension.[3,4] Obesity is the strongest modifiable risk factor for childhood hypertension.[5] Unlike recommendations for the diagnosis of hypertension in children that require elevation of BP on 3 separate occasions, repeated measures are not necessary to classify an adolescent as pre-hypertensive. Single high blood pressure reading defines pre-

hypertension in adolescents and qualifies for life style modification. The reported prevalence of pre-hypertension based on BP measurements at a single point in time as currently defined in the Working Group report ranges from 12–17%.[6,7] As observed the prevalence of hypertension increases with age, among girls prevalence increases after 10 years and in boys prevalence increases after 13 years. By the age 16 both genders have similar systolic BP value and minimal difference in diastolic BP values.[8] This study was carried out to know 1.The Percentage prevalence of obesity based on all three obesity indicators. 2. The Correlation and percentage prevalance of pre-hypertension among 14 to 16 year healthy adolescent 10th standard school children and its relation to obesity indicators i.e. BMI, WC and WHtR.

METHODS

This is an investigator initiated non interventional cross-section study carried out in school children of Madikeri Taluk, South Karnataka .Informed consent from the Parents/guardians and the principals of the school were obtained.

The study cohort included tenth standard healthy students aged 14-16 years from 2 schools one government and one private school of Madikeri Taluk. Students having chronic disease, on medication for any on-going illness acute or chronic, physically handicapped, age >16 years were excluded by initial questionnaire and school register.155 students selected after questionnaire 85 boys 70 girls in total, Government school with strength of 81 students (M-43, F-38) with low income group cohort and annual fee of rupees 500 and private school with 74 students (M-42,F-32) with middle and high income cohort and annual fees of rupees 25000/year. All anthropometric measurements were taken according to standard methods by qualified persons using calibrated apparatus. Weight was measured to the nearest 0.1kg on a calibrated electronic scale and height was measured to the nearest 0.1 cm with a stadiometer calibrated with vertical background and adjustable head piece. Waist circumference (WC) was measured to the nearest 0.1 cm, half way between the superior ridge of the ilium and the lower border of the lowest floating rib, with a flexible steel tape. Blood pressure (BP) measurements were taken using a mercury sphygmomanometer as per the recommendations of American Heart Association. [9] The child was made to rest in a quiet room for half an hour; later measurements were taken in **a** quiet room in the sitting posture with the arm resting on the table. The average of three consecutive readings was taken as blood pressure of the child. IAP blood pressure percentile chart by Raj et al [10] were used. Pre-hypertension was diagnosed if systolic blood pressure or diastolic blood pressure or both >90th to <95th percentile for age, sex and height and hypertension if SBP/DBP/both more than the 95th percentile for the age. BMI was calculated by weight divided by height in meters square and WHtR was derived by dividing WC (cm) by height (cm). Indian percentile charts for all three obesity indicators were used. WC categorised as <75th ,75-90th ,>90th percentile and WHtR as <75th, 75-95th and >95th percentile according to IAP charts by Kuriyan et a.[11] BMI categorised into <50th ,50th to 23 Eq, >23 to 27 Eq,>27 Eq according to IAP chart by Khadilkar et al.[12] BMI >23Eq to <27 Eq was taken as overweight and >27Eq as obese, WC >90th percentile and WHtR >95th percentile was taken as cut off to represent obesity. Data plotted in excel sheet. Percentage prevalence of pre-hypertension and obesity calculated under above percentile categories of obesity indicators. Data analysed using descriptive and analytical statistics using R statistical software and SSPS-16. Chi square value calculated for deriving correlation between variables and pre-hypertension. A p value of <0.05 was taken as significant.

RESULTS

As in Table 1 and 2, The mean weight, height, WC, WC/HT ratio and BMI of girls and boys in private school was higher when compared to government school children.

Table 1: Descriptive data for measured variables in boys aged 14-16 years.

Variables	Government school boys (N=43)				Private school boys (N=42)			
	Mean	SE of Mean	SD	Range	Mean	SE of Mean	SD	Range
Weight	43.37	1.18	7.74	25-65	53.19	1.88	12.18	33-85
Height	161.93	1.42	9.29	137-182	169.29	1.06	6.86	155-189
Waist circumference	62.93	1.09	7.17	43-82	70.71	1.77	11.49	55-103
WHtR	0.39093	0.00609	0.04	0.33-0.50	0.4167	0.0103	0.067	0.32-0.59
BMI	16	0	2	12-23	18	1	4	14-28
Systolic Blood pressure	103.16	1.43	9.40	90-120	106.43	1.54	10.01	86-126
Diastolic BP	63.26	1.18	7.71	50-86	66.86	1.46	9.48	50-86
Scholastic performance	64.65	2.13	13.96	40-88	79.67	1.08	6.99	59-90

The mean WHtR in girls (Gov. -0.41, Pvt-0.44) was higher than boys (Gov. -0.39, Pvt-0.41). Mean WC in girls (Gov. - 63, Pvt- 71.38) in boys (Gov. - 62.93,Pvt-70.71)and Mean BMI in girls (Gov. -17, Pvt-18) and in boys (Gov. -16,Pvt-18).When comparing boys and girls in total, girls had shorter height than boys. WHtR was higher in girls than in boys. The scholastic performance of Government school was (66% in girls, 64.65% in boys) and Private schools (79.67% in boys, and 84.41% in girls).

Table 2: Descriptive data for measured variables in girls aged 14-16 years.

Variables	Government school girls (N=38)				Private school girls (N=32)			
	Mean	SE of Mean	SD	Range	Mean	SE of Mean	SD	Range
Weight	42.737	0.958	5.903	31-59	46.31	1.91	10.80	33-79
Height	156.34	0.945	5.82	142-172	158.25	0.824	4.66	150-167
Waist circumference	63.829	0.741	4.570	56-75	71.38	1.96	11.07	56-96
WHtR	0.40842	0.0041	0.025	0.37-0.46	0.4475	0.0109	0.062	0.35-0.61
BMI	17	0	2	14-23	18	1	4	14-33
Systolic Blood Pressure	99.42	1.94	11.95	86-140	102.69	2.20	12.45	82-140
Diastolic Blood Pressure	63.32	1.41	8.72	50-86	64.38	1.42	8.01	50-80
Scholastic performance	66.03	2.13	14.26	42-88	84.41	1.60	9.06	52-94

Table 3: Percentage prevalence of pre-hypertension among 14 to 16 year old healthy school children and its relation to various obesity indicators.

Variable	Boys (n=85)				Girls (n=70)			Total (n=155)		
	Percentile	n	BP >90th percentile	%	n	BP>90th percentile	%	Total	Total BP >90th Percentile	Total %
BMI	<50th	76	11	14.6	62	4	6.45	138	15	10.87
	50th -23meq	2	1	50	2	0	0	4	1	25
	23meq - 27meq (over weight)	3	1	33.6	4	3	75	7	4	57.14
	>27 meq(obiese)	4	4	100	2	1	50	6	5	83.33
Waist circumference	<75th	72	11	15.23	60	4	6.67	132	15	11.36
	75th -90th	7	2	28.57	4	2	50	11	4	36.36
	>90th	6	4	66.67	6	2	33.33	12	6	50
Waist /height ratio	<75th	73	10	13.6	61	5	8.19	134	15	11.19
	75th -95th	6	3	50	6	2	33.33	12	5	41.66
	>95th	6	4	66.4	3	1	33.33	9	5	55.56

Table 4: Correlation of prevalence of pre-hypertension in obesity according to obesity indicators (BMI, WC, WHtR), type of school, and sex of adolescent.

Variables	Status	Prehypertensive BP>90th percentile	Normotensive	Chi-square value	P value
BMI >23 meq	Present Not present	9 16	4 126	29.52	<0.001 Highly significant
Waist circumference>90th percentile	Present Not present	6 19	6 124	11.07	<0.001 Highly significant
Waist/Height ratio >95th percentile	Present Not present	5 20	4 130	11.01	<0.001 Highly significant
Type of school	Government Private	9 16	72 58	3.15	<0.1 Not significant
Sex of child	Boys Girls	17 8	68 62	2.089	<0.5 Not significant
Total cases =155; Total Prehypertension cases (BP >90th percentile) = 25; P value < 0.05 is significant					

As in Table 3, Total prevalence of pre-hypertension was 16.13% (n=25/155), 68% boys (17/25) and 32% girls (8/25). Among these only 1.29% (n=2/155) had BP value >95th percentile. As the BMI increases the percentage prevalence of high blood pressure increases 10.8% (n=15/138) at 50th, 25% (n=1/4) at 50th to 23 Eq, 57.14% (n=4/7) at 23 Eq to 27 Eq and 83% (n=5/6) at >27 Eq. As per WC percentage prevalence of high BP was 11.36% (n=15/132) at <75th, 36.3% (n=4/11) at 75th to 90th, and 50% (n=6/12) at >90th percentile. As per WHtR percentage prevalence was 11.9% (n=15/134) at <75th, 41.66 % (n=5/12) at 75th to 95th and 55.56% (n=5/9) at >95th percentile. Prevalance of obesity according to BMI (> 23Eq) is 8.48% (n=13/155), WC (>90th) is 7.77% (n=12/155), WHtR (>95th) is 5.81% (n=9/155).

As in Table 4 Correlation between BMI and pre-hypertension showed Chi square value of 29.52, P value <0.001 was highly significant. Similarly Chi-square values for WC and WHtR correlation with pre-hypertension were 11.07 and 11.01; p values for both were <0.001. There was no significant correlation between pre-hypertension and government/ private school children (chi-square value - 3.15 P value <0.1) and between boys and girls (chi square value- 2.089, p value <0.5)

DISCUSSION

Obesity and hypertension are the only two non-invasively diagnosed parameters in metabolic syndrome. Metabolic Syndrome was diagnosed according to the National Cholesterol Education Program (ATP-III) criteria. [13] as adapted by Cruz et al.[14] who standardized the absolute value of each MS component using the percentile value by age and sex. MS was defined as having at least three of the following abnormalities: WC (≥ the 90th percentile by age and sex), high triglycerides (TG) (≥ the 90th percentile by age and sex), low high-density lipoprotein cholesterol (HDL-C) (≤ the 10th percentile by age and sex),systolic or diastolic blood pressure (≥ the 90th percentile by age, sex, and height) or undergoing antihypertensive treatments, and serum fasting glucose of at least 100 mg/dL. According to world health report 2002 cardiovascular diseases will be largest cause of death and disability by 2020 in India. In 2020 AD 2.6 million Indians are predicted to die due to coronary artery disease and nearly half of deaths are likely to occur in young and middle aged individuals.[15,16] Obesity related metabolic risks can be screened in community by three obesity indicators i.e. BMI, WC, WHtR. BMI by definition is simple index but cannot distinguish between fat and fat-free mass. It cannot be applied to children easily as it does not tell us the location of body fat distribution and may not distinguish weight of muscle and edema. [17, 18] Therefore, an elevated BMI might not necessarily reflect increased adiposity. Although Waist circumference (WC) has been internationally accepted as a reliable technique to determine deposition of fat and is used as a diagnostic criteria of metabolic complications, it does not take into consideration size of the trunk, which may differ according to sex, age and ethnicity.[19] There is no single cut-off value of WC which can be applied to the whole population - for instance, to children with metabolic syndrome risks.[20] The height of an individual influences the distribution of body fat. Men are taller than women and have larger waist circumference. This means that WHtR values are closer for both genders than average WC values because of adjustment for height and a single cut-off value can be used for indicating increased metabolic risk due to adiposity.[21,22] Obesity and hypertension are strongly correlated. Several factors important in the development of hypertension in obese children have been suggested which includes endocrine determinants, such as corticosteroids and adipokines, sympathetic nervous system activity, disturbed sodium homeostasis, as well as oxidative stress, inflammation and endothelial dysfunction.[23]

We have used age, sex, specific Indian standard charts in our study to derive percentile values of all the study cases for all obesity indicators WC, WHtR, BMI and BP

The total prevalence of overweight and obese adolescents according to BMI >23Eq in our study was 8.38% (4.51% overweight and 3.87% obese). This was almost similar to prevalence of overweight children seen by Kuriyan et al 7.8%.[11] Chirag B A et al 10.4% and Cherian AT et al 12.7%.[24] In our study we had children aged 14 -16 only, whereas other studies considered 10 - 16 year cohort. As the age progresses in children the BMI reduces as of pubertal spurt in height growth is greater than weight. The percentage prevalence of obesity according to WC >90th percentile in our study was 7.74% when compared to 3.4% by Kawatra et al.[26] The variation is again because of wide range age of cohort 6-16 years compared to ours. WC starts showing linear rise with age. Smaller WC measurement in early ages has reduced the percentage in study by Kawatra. 5.8% had WHtR >95th percentile in our study when compared to 20.7% in kawatra et al study again this was high because of lower value of WHtR of 0.43 and 0.44 as cut-off value. Though WHtR is said to be age independent and has a single cut-off for screening it shows a decrease with age as of growth spurt .[26, 27] Using age and gender adjusted WHtR charts is always better than a single cut off value of 0.5. WHtR cut- off of >95th percentile has under estimated obese children in our study. There may be a need to reduce the cut off of WHtR to lower values to include more at risk children as supported by Kawatra et al and Sung RY et al.[26,28]

In children and adolescents, pre-hypertension is defined by a systolic and/or diastolic BP ≥90th percentile but <95th percentile for age, sex, and height according to normative tables published in the Working Group report. It is also important to note that while recommendations for the diagnosis of hypertension in children require that BP remain elevated on three separate occasions, repeated measures are not necessary to classify an adolescent as prehypertensive. Rather, the report recommends

instituting lifestyle changes as appropriate and continue to monitor BP every 6 months to evaluate for improvement or progression to sustained hypertension. The prevalence of pre-hypertension in our study based on BP measurements at a single point in time was 16.13% as supported by working group report ranges of 12-17%.[6,7]

In our study we used IAP blood pressure percentile charts specific for age, sex and height to categorise pre-hypertensive adolescents. Study showed raise in percentage prevalence of pre-hypertension as the percentile value of all three obesity indicator increased. It showed that 83% adolescents with BMI>27Eq, 50% of adolescents with WC>90th percentile and 55.55% of adolescents with WHtR >95th percentile were screened positive for pre-hypertension. Though many studies in past suggest that hypertension increases with obesity. Percentage prevalence of pre-hypertension in relation to each obesity indicator was novel to our study.

There was no statistically significant correlation between pre-hypertension and type of school child studied government or private. There was no statistical significant correlation between boys/girls and pre-hypertension.

Correlation between BMI, WHtR, WC was positive with p value <0.001 for all three as observed by Kajale et al.[29] BMI was most strongly associated with pre-hypertension in our study as seen by Gratz et al and many other studies. Studies suggest BMI to closely associate with hypertension and Waist circumference more closely associate with dyslipidemia.[30] Our study showed similar discriminatory ability for all three obesity indicators in predicting hypertension as supported by Mishra et al.[31]

CONCLUSION

Percentage prevalence of overweight and pre-hypertension in adolescents between 14 to 16 years was 8.38% and 16.13%. Percentage prevalence of pre-hypertension increases as the Percentile value of all three obesity indicators increases. Correlation between high BP and all three obesity indicators was highly significant with BMI being the strongest.

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