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Original Research Article

Correlates of high blood pressure among the adolescent school children

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R.K. Anuradha[1], T.M. Reddy[2], P. Geetha[3], K. Surendranadha Reddy[3] and Kanala Kodanda Reddy*[3]

[1]Department of Home Science, Sri Venkateswara University, Tirupati-517 502, India
[2]Department of General Medicine, Sri Venkateswara Medical College and Hospital, Tirupati-517 507, India
[3]Department of Anthropology,Sri Venkateswara University, Tirupati-517 502, India.

*Corresponding Author
E-mail: kanalakr@yahoo.com

Tel.: +91 94904 91276

To assess the prevalence of high blood pressure and its association with overall and abdominal obesity, social & environmental conditions among the adolescent school children of Tirupati town of Andhra Pradesh, India. Data was collected from schoolchildren aged between 12 to 16 years. The sample consisted of 2258 subjects (1097 boys and 1161 girls). Overweight and obesity were defined by body mass index based on the current method recommended by the Centre for Disease Control and Prevention 2000. Abdominal obesity was classified based on age and sex specific >90th percentiles of the reference data. Hypertension was defined as raised blood pressure (average Systolic blood pressure and/or Diastolic blood pressure >95th percentile) for age and sex. Data on social and environmental factors was collected by using a pre-tested and validated questionnaire. In the present study pooled hypertension was 9.5%. Mean values of anthropometry and blood pressure showed consistent increase from 12 to 16 yrs ($p<0.05$). Body mass index, parental level of education, watching video games, leisure time physical activity and eating behavior of chocolates were the potential confounders to determine the elevated blood pressure levels. Our study reinforces the burgeoning prevalence of high blood pressure among the adolescents.

Key words: Adolescents, blood pressure, India, obesity, socioeconomic factors

List of abbreviations
BP: Blood Pressure, BMI: Body mass index, WC: Waist circumference, HC: Hip circumference , TSFT : Triceps skin fold thickness, SSFT: Sub-scapular skin fold thickness, ASFT: Abdominal skin fold thickness, ROC : Receiver operating characteristic, AUC : Area under the curve.

INTRODUCTION

High blood pressure remains a leading risk factor for heart disease and stroke and a major cause of morbidity and mortality worldwide (Go et al., 2013). Globally, prevalence of hypertension among adults was 22% in 2014 (WHO, 2015), and ischemic heart disease and stroke were the first and third leading causes of premature death (Murray et al., 2010). Hypertension is increasing rapidly in most low and middle income countries driven by diverse health transitions (Mohan et al., 2013). According to Indian Council of Medical Research, hypertension is the leading non communicable disease risk and estimated to be attributable for nearly 10 percent of all deaths in India (Patel et al., 2011). Global statistics clearly indicate that this trend is not rare in children and adolescents, which provided a base to evaluate and screen the blood pressure (BP) levels among the children and adolescents (Chukwunonso and Ejike, 2013). Several studies have provided evidence that adult hypertension has its roots in childhood (Narchi, 2011).

Confounding factors, that affect BP elevation, seem to be age, sex, body mass index (BMI), socioeconomic status and eating habits (Sorof et al., 2004; Miyaki et al., 2013).

Research reports ascertained the importance of body weight in developing high blood pressure (Anuradha et al., 2015). Since, BMI is merely a substitute for adiposity, the other indicators like circumferences of waist and hip and skin fold measures may also be preferred to understand the holistic influence on high blood pressure (Reilly et al., 2010; Chiolero et al., 2013). The effect of other risk factors like age, sex, socioeconomic conditions and eating habits varies from population to population (Stuart-Shor et al., 2012). Even though the burden of hypertension is lower in children than adults, the increasing evidence indicates that hypertension begins to develop during the first two decades of life (Sun et al., 2007). Efforts to reduce BP may have sizeable effects on hypertension related morbidity and mortality. Hence greater attention to check and understand its risk factors in early life may ultimately lead to considerable improvements in cardiovascular health (WHO, 2011). In the light of this background, an attempt has been made in the present study to assess the prevalence of high blood pressure and its correlates among the adolescent school children of Tirupati town of Andhra Pradesh. India.

MATERIALS AND METHODS

The present investigation was a cross sectional in nature, to collect and document information on BP, anthropometric indicators, social & environmental factors of adolescent school children of Tirupati Town of Andhra Pradesh. The study was under taken between June 2011 and April 2012. The study design was approved by the Departmental Ethics Committee of Sri Venkateswara University, Tirupati on January 21st, 2011. Tirupati is one of the biggest towns in Rayalaseema region of Andhra Pradesh State, India.

Study population and design

Study population consists of school children of both genders in the age range of 12-16 years. Child age was ascertained through their birth certificate available with the school management. According to the available statistics a total of 45,998 adolescents in the age range of 12-16 years were admitted in various schools across the town during the academic year 2011-2012 (Source: District Educational Office, Chittoor). To have the precise estimates of the sample we used multistage random sampling technique. The study area consists of 36 Municipal wards. Out of this, 8 wards were picked and 2 schools from each ward were randomly selected. The sample size was established assuming a 95% confidence interval with 3% sampling error. The required sample size was estimated to be 2200 subjects. In the current study data was captured from 2258 subjects (1097 boys and 1161 girls) and entire sample was used in the statistical analysis.

Parents of the wards were contacted over phone through school management and explained the objectives of the study prior to obtain their consent. Upon the receipt of their written consent, children were included in the study. Children with any gross abnormality were excluded from the study enrolment.

Data collection

A structured schedule was designed with prior validation through pilot study. The questionnaire consisted information on the demographics, education, occupation, socioeconomic conditions and hypertensive status of the parents. Parental education, occupation and income were recorded through their public distribution cards. Further children's self reported sleep patterns, physical activity, video watching and eating habits were procured. Parents were cross checked to ascertain the self reported information provided by the child. Information on anthropometry like height, weight, waist circumference (WC), hip circumference (HC), triceps skin fold thickness (TSFT), sub-scapular skin fold thickness (SSFT) and abdominal skin fold thickness (ASFT) was obtained as per the standard procedures (Weiner et al., 1981). Weight was measured in light clothing with no shoes nearest to 100 g using electronic scales. Height of the students was measured using stadiometer with their shoes off and measurement was taken to the nearest 1 mm. WC was measured in standing position, by a stretch resistant tape which was applied horizontally just above the uppermost lateral border of the right ileum. HC was measured at the level of the greatest protrusion of the gluteal muscles. TSFT was recorded at the right upper arm mid-point on the posterior surface. SSFT was recorded at the inferior angle of the right scapula. ASFT was recorded horizontally right side about 1 inch lateral from and 0.5 inch below the umbilicus. Lange skin fold caliper (Cambridge Scientific Industries, Cambridge, MD) was used to record the skin fold measurement. All the measurements were taken twice on the subjects with a gap of 5 min and the average was taken for the analysis. Overweight and obesity were considered as BMI above the 85th and 95th percentiles respectively as specified for age and sex by Centre for Disease Control and Prevention (CDC) 2000 (Gonzalez-Casanova et al., 2013). Age and sex specific >90th percentile values for WC, HC, TSFT, SSFT and ASFT were considered to be abdominal obesity (Kelishadi et al., 2007). BP of the subjects was measured using sphygmomanometer as per the methodology recommended by the Seventh Report on the Diagnosis, Evaluation, and Treatment of High Blood Pressure in children and adolescents (Chobanian et al., 2003). Three consecutive readings were taken and mean of these three was taken as final reading. The values were expressed as mmHg. Adolescents with raised BP (Average systolic and/or diastolic blood pressure >95th percentile for gender and age) considered as hypertension. The instruments were calibrated prior to their use.

Statistical analyses

The data were coded and statistical analysis was carried out through SPSS version 16.0. Alpha levels were set at 0.05

Table 1. Descriptive statistics and anthropometric measurements according to age among the adolescent boys and girls

	Sex	Age in years					
		12Yrs	13 Yrs	14 Yrs	15 Yrs	16 Yrs	P-
		(n=B: 245; G:285)	(n=B: 338; G:368)	(n=B: 272; G:311)	(n=B: 119; G:86)	(n=B: 123; G:111)	value*
Height in cm	B	143.17±7.86	146.07±7.96	151.98±8.61	155.06±8.30	154.50±8.03	0.000
	G	143.25±7.63	147.20±6.91#	150.28±6.21#	154.44±8.93	153.66±7.83	0.000
Weight in kg	B	33.79±8.37	35.29±7.95	40.82±9.31	45.18±8.28	46.20±9.20	0.000
	G	34.26±7.85	38.08±7.63#	41.83±8.35	44.56±8.95	46.04±8.83	0.000
Body mass index	B	16.35±3.16	16.43±2.79	17.56±3.16	18.85±3.60	19.52±4.34	0.000
kgm^{-2}	G	16.61±3.09	17.53±3.08#	18.47±3.26#	18.66±3.41	19.66±4.20	0.000
Waist	B	52.32±7.45	52.81±8.32	58.27±8.85	60.04±7.56	59.53±8.68	0.000
Circumference in cm	G	52.12±7.39	54.51±7.63#	56.63±7.48#	58.76±7.45	59.52±8.25	0.000
Hip Circumference	B	64.02±8.49	65.79±9.86	72.26±9.61	74.83±8.02	73.91±10.45	0.000
in cm	G	66.18±8.72#	70.56±9.26#	73.45±9.88	76.62±8.32	76.20±9.25	0.000
Triceps SFT in mm	B	5.64±2.72	5.10±2.41	5.46±2.53	5.92±2.96	6.88±3.27	0.000
	G	5.68±2.53	5.62±2.64#	6.41±2.73#	6.47±3.50	7.42±3.38	0.000
Sub scapular SFT in	B	5.05±2.48	4.80±2.42	5.84±2.43	6.21±2.65	6.92±3.07	0.000
mm	G	5.70±5.00#	5.85±2.69#	6.76±3.05#	7.05±3.04#	7.69±3.22	0.000
Abdominal SFT in	B	5.47±2.86	5.68±3.04	7.01±3.38	7.52±3.18	8.63±3.72	0.000
mm	G	6.45±2.91#	6.76±2.96#	7.48±3.01	8.14±3.04#	8.39±3.11	0.000
Systolic blood	B	111.66±9.01	112.07±8.45	115.44±9.66	118.55±11.59	119.74±12.01	0.000
pressure mmHg	G	110.70±8.56	112.19±9.08	115.20±10.64	116.45±9.70	119.14±11.54	0.000
Diastolic blood	B	68.11±10.92	67.02±10.26	68.39±11.51	69.85±9.87	69.85±11.55	0.046
pressure mmHg	G	67.27±11.26	66.96±11.22	67.67±10.25	66.36±10.43	70.41±10.74	0.041

B=Boys; G= Girls; SFT= skin fold thickness
*One way analysis of variance was applied to see the trend across the age groups and P<0.05 was considered as statistical significant
t-test was applied to see the difference between genders and P<0.05 was considered as statistical significant

as statistical significant. Continuous variables were provided with descriptive statistics and discontinuous variables with percentages. Chi square test was used to see the differences in the prevalence rates among groups. Students't' test was applied to see the difference between genders. One way analysis of variance was used to see the difference in descriptives across the age groups. In order to assess the linear relationship between variables, partial correlations have been computed after adjusting for age of the subjects. Further receiver operating characteristic (ROC) curve analysis was performed to evaluate the accuracy of each anthropometric indicator (BMI, WC, HC, TSFT, SSFT and ASFT) to distinguish between presence and absence of hypertension. The area under the curve (AUC) and 95% confidence intervals (CI) were estimated to assess the relative ability of each anthropometric indicator to identify the risk of high blood pressure. Optimal cut-off points for each anthropometric indicator were determined.

The effect of social, environmental and anthropometric indicators on the prevalence of hypertension was analyzed independently for boys and girls by employing age adjusted multivariate (binary) logistic regression model with forward conditional entry. The variables that had shown significant variation in the prevalence of hypertension were entered in the model (Parental education and income, child sleeping duration, video watching, playing games, eating behavior of chocolates, parental history of hypertension, and anthropometric indicators etc). 5 g of chocolate was considered to be one unit. Local markets were supplying 5, 10, 20 g of edible chocolates. Based on the consumption pattern of chocolates per day, children were classified as nil, 1, 2, and 3 respectively. Number of children and eating behavior of ice creams, fast foods (bakery items) were dropped from the model as these variables do not show any association with hypertension. Overall the predicted correct percentage in boys and girls was 90.9 and 90.1 percent respectively. To assess the sensitivity and specificity of the independent variables those predict the high blood pressure among the children, a composite marker for AUC for high blood pressure was computed. Independent scores were calculated by using the formula: Score= log [(predicted probabilities/1-predicted probabilities)]. ROC curve statistics has been applied to calculate the AUC.

RESULTS

In the present study 2258 school children (1097 boys and 1161 girls) were screened to assess the correlates of high blood pressure. Descriptive statistics for anthropometric measurements and BP in different age groups for adolescent boys and girls were presented in Table 1. Anthropometric indicators and BP levels (systolic and diastolic) have shown an increasing trend (p<0.05) from 12 yrs to 16 yrs in both boys and girls. Girls have shown

Table 2. Prevalence of overall and abdominal obesity indicators and high blood pressure among the adolescent boys and girls

	Boys		Girls		Total		X^2 value	p-value
	N =1097	%	N=1161	%	N=2258	%		
Body mass index kgm^{-2}								
Normal weight	921	84.0	985	84.8	1906	84.4	0.455	0.797
Overweight	123	11.2	120	10.3	243	10.8		
Obese	53	4.8	56	4.8	109	4.8		
Waist circumference cm								
<90th Percentile	973	88.7	1032	88.9	2005	88.8	0.021	0.885
>90th Percentile	124	11.3	129	11.1	253	11.2		
Hip circumference cm								
<90th Percentile	981	89.4	1037	89.3	2018	89.4	0.007	0.946
>90th Percentile	116	10.6	124	10.7	240	10.6		
Triceps SFT mm								
<90th Percentile	953	86.9	1013	87.3	1966	87.1	0.072	0.788
>90th Percentile	144	13.1	148	12.7	292	12.9		
Subscapular SFT mm								
<90th Percentile	966	88.1	1018	87.7	1984	87.9	0.075	0.785
>90th Percentile	131	11.9	143	12.3	274	12.1		
Abdomen SFT mm								
<90th Percentile	961	87.6	1016	87.5	1977	87.6	0.004	0.947
>90th Percentile	136	12.4	145	12.5	281	12.4		
Blood pressure mmHg								
<95th Percentile	998	91.0	1046	90.1	2044	90.4	0.518	0.261
>95th Percentile	99	9.0	115	9.9	214	9.5		

Table 3. Age adjusted partial correlations among the blood pressure and anthropometric indicators in adolescent boys and girls

Boys → / Girls ↓	BMI	WC	HC	TSFT	SSFT	ASFT	SBP	DBP
BMI		.579**	.488**	.203**	.453**	.519**	.484**	.167**
WC	.539**		.865**	.260**	.540**	.613**	.350**	.082**
HC	.442**	.794**		.272**	.556**	.589**	.302**	.021
TSFT	.252**	.267**	.317**		.555**	.468**	.098**	.067*
SSFT	.314**	.441**	.557**	.584**		.768**	.234**	.109**
ASFT	.412**	.548**	.619**	.501**	.738**		.245**	.091**
SBP	.417**	.243**	.204**	.134**	.193**	.206**		.295**
DBP	.103**	.003	-.083**	.094**	.024	-.014	.313**	

**Significant at 0.01 level
*Significant at 0.05 level

higher BMI than boys in 13 and 14 yrs age groups (p<0.05). No sex differences were observed in BP levels across the age groups.

Prevalence of obesity and abdominal obesity indicators and high blood pressure among adolescent boys and girls were shown in Table 2. Obesity and abdominal obesity indicators (overweight/obesity, WC, HC, TSFT, SSFT, ASFT) and hypertension failed to exert significant differences across the age groups and between genders. The results clearly indicate that more than 10% of the children were exerting high blood pressure and obesity and abdominal obesity indicators.

Age adjusted partial correlation coefficients for anthropometry and BP levels for boys and girls were shown in Table 3. In boys, systolic blood pressure (SBP) has had strong correlation with BMI (P<0.01) followed by WC (P<0.01), TSFT (P<0.01) and ASFT (P<0.01), however anthropometric indicators failed to exert similar effect on diastolic blood pressure (DBP). In girls, SBP has had strong correlations with BMI (P<0.01) followed by WC (P<0.01), HC (P<0.01) and ASFT (P<0.01), while the correlations between anthropometry and DBP were weak and some were negative. The correlations among obesity and abdominal obesity indicators, shows high correlations (P<0.01) in both boys and girls except for TSFT.

Table 4 describes the gender specific ROC curves and optimal cutoff values for each of the five anthropometric indicators in detecting the high blood pressure. The AUC

Table 4. ROC Curves for hypertension in boys and girls

Variable	AUC	S.E	95% CI	P-Value	Sensitivity	Specificity	Cutoff
Boys							
BMI	0.696	0.027	0.668-0.723	0.0001	75.76	55.71	16.80
WC	0.595	0.032	0.565-0.624	0.0032	59.60	58.62	56
HC	0.565	0.033	0.535-0.594	0.0513	56.57	57.62	70
TSFT	0.606	0.029	0.576-0.635	0.0003	72.73	43.69	4
SSFT	0.547	0.033	0.517-0.577	0.1515	48.48	65.63	5
ASFT	0.568	0.030	0.538-0.597	0.0252	75.76	34.67	4
Girls							
BMI	0.672	0.026	0.644-0.699	0.0001	62.61	65.39	18
WC	0.543	0.0312	0.514 -0.572	0.1656	27.83	83.84	61
HC	0.535	0.0320	0.506-0.564	0.2707	17.39	94.74	84
TSFT	0.561	0.0280	0.531-0.589	0.0304	53.91	55.74	5
SSFT	0.505	0.0300	0.476- 0.534	0.8611	80.00	14.44	9
ASFT	0.542	0.0304	0.512-0.570	0.1721	20.87	92.35	11

was significantly higher for BMI ($P<0.0001$) for both genders indicating its ability in detecting the risk of high blood pressure in this adolescent sample. Sensitivity and specificity is greater for BMI than other anthropometric indicators.

Multivariate (binary) logistic regression analysis depicts that BMI, mother's education, video watching and playing games were the significant predictors of high blood pressure in boys (Table 5). Overweight children exhibited 4 times and obese children 6.7 times at risk towards hypertension. Boys were 2.5 times at risk in developing hypertension when their mother was with higher grade of education, indicating parental increased education level increase the risk of hypertension in children. Similarly video watching and physical inactivity were also significant risk factors in the prediction of high blood pressure. In girls, obesity, ASFT (>90th percentile) and chocolate consumption were the significant predictors of high blood pressure (Table 5). Overweight girls were 2.4 times and obese were 2.8 times at risk in developing high blood pressure. Accumulation of fat mass at abdomen exerted twice the risk in developing high blood pressure. Consumption of 3 containers of chocolates was elevating the risk of high blood pressure. The results on composite marker of AUC for the correlates of high blood pressure were as follows. The AUC was significantly high, different from 0.5 for BMI, mother's education, video watching and playing games for boys and BMI, ASFT and chocolate consumption for girls, indicating the ability of these correlates in detecting the risk of high blood pressure.

DISCUSSION

The prevalence of hypertension (SBP and/or DBP >95 percentile) in the present sample was 9.5%. The pooled prevalence of systolic and diastolic hypertension was 5.5 and 5.3% respectively. Our results are consistent with other studies indicating that BP above 95th percentiles is not rare among the adolescents (Falkner, 2010; Kaur et al., 2013). A significant portion of the children in the study was also noticed with higher abdominal obesity indicators (>90th percentiles). In the given situation if the trend is not corrected it may lead to high blood pressure and obesity related health complications. Our results strongly suggest for managerial therapies to control this epidemic situation.

This cross sectional survey clearly demonstrates that BMI was an independent risk factor in the elevation of BP than other anthropometric indicators. Recent study by Dong et al (2015) observed that BMI exhibited superior ROC (AUC) statistics to other anthropometric indicators and concluded that BMI is the best predictor of high blood pressure in adolescents. Our results are in the best agreement with the above study. Even though other anthropometric indicators like circumferences of waist and hip, skin fold thickness at triceps and abdomen in boys and TSFT in girls showed positive trend, their contribution nullified and has not added values in the regression analysis over BMI to predict high blood pressure. Similar results were published in elsewhere population groups (Reilly et al., 2010; Chiolero et al., 2013).

Adolescent boys with higher BMI were seven times (95% CI: 3.303-13.421) and girls three times (95%CI: 1.372-5.528) at risk in developing high blood pressure even after controlling for confounding factors. Several prospective studies exhibited similar association between weight gain and BP (Chobanian et al., 2003). The strong underlying association between obesity and elevated BP may corroborate that increasing prevalence of obesity may likely elevate the BP levels as supported by our data (Flynn, 2008). BP elevation may lead to increased risk of end-organ damage such as ventricular hypertrophy and increased carotid intima-media thickness and risk of hypertension in adulthood (Juonala et al., 2010; Miyaki et al., 2013).

Parental educational levels seem to be the most pertinent social problem in India for the observed escalation in high blood pressure levels. Children belonging to educated parents were 2.523 times at risk in developing

Table 5. Multivariate (binary) logistic regression model to predict the high blood pressure in boys and girls

	Boys						Girls					
	β	**S.E.**	**Sig.**	**Exp(B)**	**95 % CI Exp(B)**		**β**	**S.E.**	**Sig.**	**Exp(B)**	**95% CI Exp(B)**	
Body mass index												
Normal weight				**Ref.**						**Ref.**		
Over weight	1.422	0.271	0	4.147	2.438	7.053	0.883	0.271	0.001	2.418	1.422	4.111
Obesity	1.896	0.358	0	6.658	3.303	13.421	1.013	0.356	0.004	2.754	1.372	5.528
Abdomen Skin fold thickness												
<90th Percentile										**Ref.**		
>90th Percentile							0.631	0.265	0.017	1.879	1.118	3.158
Mothers education												
Illiterate				**Ref.**								
Primary	0.204	0.383	0.595	1.226	0.579	2.599						
Secondary	0.255	0.315	0.418	1.291	0.696	2.393						
Higher	0.925	0.354	0.009	2.523	1.26	5.053						
Video watching												
½ hour				**Ref.**								
1 hour	-0.105	0.356	0.769	0.901	0.448	1.81						
>2 hours	0.533	0.254	0.036	1.705	1.036	2.804						
Playing games												
½ hour	0.912	0.478	0.056	2.49	0.976	6.357						
1 hour	1.092	0.46	0.018	2.98	1.21	7.343						
2 hours				**Ref.**								
Quantity of chocolates												
Nil										**Ref.**		
1							0.213	0.279	0.445	1.237	0.717	2.136
2							0.133	0.299	0.657	1.142	0.636	2.05
3							0.874	0.267	0.001	2.395	1.42	4.04
Constant	-4.238	0.549	0	0.014			-2.794	0.197	0	0.061		

Boys:
a. Variable(s) entered on step 1: Body mass index
b. Variable(s) entered on step 2: Mothers education
c. Variable(s) entered on step 3: Video watching
d. Variable(s) entered on step 4: Playing games

Girls:
a.Variable(s) entered on step 1: BMI.
b.Variable(s) entered on step 2: Quantity of chocolates.
c. Variable(s) entered on step 3: Abdomen.

Composite marker for AUC

Boys AUC	S.E	95% CI	P-Value	Sensitivity	Specificity	Girls AUC	S.E	95% CI	P-Value	Sensitivity	Specificity
0.732	0.027	0.705-0.758	0.0001	72.73	65.53	0.643	0.029	0.615-0.671	0.0001	55.65	69.02

hypertension. The risk remained static even after adjusting for other confounding factors. Our results strongly advocate the necessity to educate the parents about the menace. Family income found to be the other significant predictor of hypertension in adolescents. But this trend failed to be significant upon adjusting for other variables especially parental education. Thus parental education is an important element in assessing the hypertension irrespective of family income. The reason for this probably lies in societal changes that are taking place in economic transient communities like India. Parents with low economic levels also compete with economically affluent communities in providing the amenities to their wards. Further, modernization and urbanization were allowing population groups to offer calorie rich foods for their children. Eating behavior of chocolates positively associated with high blood pressure levels in the present study. However parents are not serious to compensate this trend by involving their children with increased physical activity to burn the excessive calories. On the other side sedentary behavior was further magnified in the form of video watching. Hence, interventional strategies to encourage students actively to participate in physical activity either in the form of walking or involving in playing games may reduce risk of being hypertensive.

The major limitations of the present study are 1) lack of data on mental stress and 2) lack of association between food consumption patterns and BP levels. The captured information on adolescents eating behavior of ice creams, chats and fast foods etc failed to show any association. Probably both parents and children might have failed to explain otherwise the techniques were not properly validated by the researchers. The market based ice creams, chats and fast foods in India are not uniform in terms of serving containers which hold difficulty for the parents and children to explain the consumption pattern.

Conclusion

In conclusion, BMI, parental education, video watching, leisure time physical activity and eating behavior of chocolates were the predominant risk factors in the elevation of adolescent's BP levels. The findings of the study strongly advocate the need to implement interventional measures for preventing adolescent high blood pressure.

Implications and Summary Statement

The study supports the burgeoning prevalence of high blood pressure among the adolescent school children in Indian setting. Our findings add to the body of evidence that apart from body mass index, there is a dire need to correct the environmental factors in the alleviation of high blood pressure.

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Conflict of Interest

None of the authors has a personal or financial conflict that has an interest in the subject of this Manuscript.

Individual contributions

The protocol was designed by RKA, TMR, KSR and KKR. Data were collected by RKA, TMR and PG. Statistical analysis was carried out by PG and KKR. The manuscript was prepared by KKR, RKA, TMR and KSR. KKR was the guarantor for the entire manuscript. All authors read and approved the final manuscript.

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