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Research Article

Prevalence and determinants of prehypertension and hypertension among adolescents: a school based study in a rural area of Kerala, India

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ABSTRACT

Background: Raised blood pressure is the leading cause of death and disability world-wide. Though hypertension is a problem of adults the aetiologic process and risk behaviours start early in life. The objective of the study was to assess the prevalence and determinants of prehypertension and hypertension among adolescents from high schools in a rural area of Kerala, India.
Methods: A cross sectional analytical study was carried out in 1000 adolescents from randomly selected Government, Aided and Unaided high schools of Ettumanoor, Kerala proportionate to sampling frame using WHO designed Global School based student Health Survey (GSHS) questionnaire. Anthropometry and blood pressure recordings were done by trained team members. Statistical analysis was done using SPSS 21. Chi-square test was used to find out the association between categorical variables. Significant variables were entered into logistic regression model to find out Adjusted Odds Ratio (AOR).
Results: Out of 1000 study subjects, 409(40.9%) were males and 591(59.1%) were females. Overall prevalence of prehypertension and hypertension was 24.5% (males-30.5%, females-20.3%) and 0.6% (males-0.98%, females-0.34%) respectively. Male sex (AOR-1.67 95%CI-1.23-2.28), low socio-economic status (AOR-1.55 95%CI-1.15-2.11), overweight/obese (AOR-5.7 95%CI- 2.4-13.6), low fruit consumption (AOR-2.02 95% CI-1.499-2.7) and high soft drink consumption (AOR-2.21 95%CI- 1.446-3.39) were the significant risk factors for prehypertension and hypertension.
Conclusion: Male sex, Low socio-economic status, obesity/overweight, low fruit and high soft drink consumption are the significant determinants of Pre hypertension and hypertension among adolescents. The findings may be used in developing messages to provide awareness of dangers of raised blood pressure among adolescents and its behavioural determinants.

Keywords: Prehypertension and hypertension, Adolescents, Rural Kerala

INTRODUCTION

Globally raised blood pressure is a major public health problem of concern because of its association with increased risk of cardiovascular diseases. It is the leading cause of death and disability worldwide and accounted for 9.4million deaths and 7% of disability adjusted life years (DALYs) in 2010.[1] Around one billion of adult world population was hypertensive in the year 2000 and this is expected to increase to two billion by 2025.[2] In India, it is the leading Non Communicable Disease (NCD) risk and estimated to be attributable for nearly 10% of all deaths.[3]

Adolescence (10-19 years) is an important period of growth and maturation and most of the changes that occur during this period are continued into adulthood.[4] Raised blood pressure in childhood has been recognized

as one of the most-important predictors of adult hypertension. Out of this interest many researchers investigated the patterns of blood pressure and determinants in childhood and adolescence.[5,6] Studies have shown that the level and patterns of blood pressure among children and adolescents may vary from population to population.[7] Prevalence of childhood hypertension was documented as 5-10%in developing countries and 1-2% in developed countries.[8] The prevalence of childhood hypertension in various Indian studies range from 0.96% to 11.4% respectively.[9]

Though hypertension is a problem of adults, its aetiologic process starts early in life. Adolescence is an important developmental stage in the life span of an individual as it is a transition period to adulthood. During adolescence teenagers start to make individual choices and develop personal life styles. Unfortunately many of the lifestyle choices adopted by adolescents are really a threat to their health and wellbeing. Nearly two third of premature death and one third of disease burden are associated with conditions or behaviours that began in adolescence including tobacco and alcohol use, physical inactivity and unhealthy diet.[10] Most of the behaviours and risk factors are preventable or modifiable if appropriate lifestyle modification is applied. Early adolescence is the appropriate time for appropriate intervention.

India is experiencing a rapid health transition, within India the state of Kerala is the most advanced in this transition heavily influenced by western living pattern including sedentary lifestyle with high cardiovascular (CVD) risk profile.[11] Kottayam is the first district in Kerala declared as 100% literate, but there is lack of data about magnitude and determinants of pre hypertension and hypertension among adolescents. This information is important in planning life style modification among adolescents. Hence the present study was planned to estimate the prevalence of pre hypertension and hypertension and to find out its determinants among adolescent high school students in Ettumanoor, which is the field practice area of rural health centre, government medical college Kottayam, Kerala.

METHODS

A cross sectional analytical study was carried out among adolescents studying in selected high schools of Ettumanoor panchayath of Kottayam district which is also the field practice area of govt. medical college, Kottayam, Kerala. Details of high schools in the study area and student strength were taken from district education office. There were three high schools under Govt. sector, two under Aided and seven under Un-Aided sector and all the students admitted in 8th, 9th and 10th standards during the academic year 2013-2014 in government, aided and unaided schools in the study area constituted the sampling frame. Considering the lowest prevalence of hypertension of 2.5% as reported by Mohan et al.,[12] alpha error of 5% and 1% absolute allowable error, the sample size calculated was 975. From a sampling frame of 2112 students distributed in high schools of govt. (10%) aided (20%) and unaided (70%) sectors the investigator selected 1000 students based on probability proportionate to size. School selection was randomly carried out in each sector. From the selected school one class room was selected from 8th, 9th and 10th classes. All the students in the selected class were included. If the required number was not sufficient next school was selected at random and the process was repeated till the required sample size was obtained. Accordingly two schools from government sector, two schools from aided and four schools from unaided sector provided the required sample size. The study was carried out over a period of nine months from July 2013 to March 2014. WHO designed Global School based student Health Survey (GSHS) questionnaire was used for data collection which included respondents' socio-demographic details and risk behaviours related to tobacco and alcohol use, dietary habits and physical activity.

Anthropometry and blood pressure recording of all students were done. Height was measured to the nearest centimeter. Weight was measured to the nearest 500 gm. Blood pressure was measured by the trained team members using a mercury sphygmomanometer. Measurements were taken in the right arm of the subjects seated and at rest for five minutes. Blood pressure was measured three times, over a period of 10 minutes. Average of all three readings was taken as final observation.

Ethical committee approval was obtained from the institution and the study was conducted after obtaining written permission from district education officer and head masters/head mistresses of the selected schools. Informed and written consent was obtained from parents on a printed consent form distributed a day prior to the filling of the questionnaire.

Pre hypertension was defined as average Systolic Blood Pressure (SBP) or Diastolic Blood Pressure (DBP) levels that are greater than or equal to 90th percentile but less than 95th percentile for gender age and height. Hypertension was defined as average SBP or DBP greater than or equal to 95th percentile for gender, age and height on at least three separate occasions.[13]

Age adjusted Body Mass Index (BMI) was found out using WHO Anthro-plus software. Categorization of nutritional status was based on Z score, the three categories were normal (Z score from -2 to +2), over weight (Z score 2 to 3) and obese (Z score >3).

Statistical analysis was carried out using SPSS version 21.0. Descriptive statistics such as means and standard deviation were used to summarize quantitative variable. Proportions and percentages were used to summarize categorical variables. Chi-square test was used to find out

association between raised blood pressure (dependent variable) and selected socio demographic and behavioural variables (independent variables). A P value ≤0.05 was considered as statistically significant. Binary logistic regression analysis was done to find out Adjusted Odds Ratio (AOR) for variables that found to be significant in univariate analysis.

RESULTS

A total of 1000 subjects were studied of which 409 (40.9%) were males and 591 (59.1%) were females. The age range of study subjects was 13 years to 17 years. The mean age was 14.78 years (14.78 ± 0.954) (Table 1).

Table 1: Age and sex distribution of study subjects.

Age (years)	Male		Female		Total	
	No.	(%)	No.	(%)	No.	(%)
13	19	4.65	38	6.43	57	(5.7)
14	164	40.10	222	37.56	386	(38.6)
15	137	33.50	175	29.61	312	(31.2)
16	68	16.63	144	24.37	212	(21.2)
17	21	5.13	12	2.03	33	(3.3)
Total	409	100	591	100	1000	100

Overall the mean SBP level was 106.28 mm of Hg (SD - 10.594) and mean DBP was 68.75 mmHg (SD - 7.587). Among males the mean SBP was 107.89 (SD - 10.569) which was higher than females (105.16 ± 10.475). The mean DBP was also higher for males (69.2 ± 7.369) than females (68.44 ± 7.72).

In the present study, the prevalence of hypertension among adolescents was found to be 0.6% (0.98% among boys and 0.34% among females). However, the prevalence of pre hypertension was 24.5% (30.56% of boys and 20.3% of girls were pre hypertensive) (Table 2). Among the six hypertensive subjects, two were already on medication and follow up and the four others were referred to physician for further evaluation.

Table 2: Prevalence of pre hypertension and hypertension among study subjects.

Classification[13]	Male		Female		Total	
	No.	(%)	No.	(%)	No.	(%)
Normal (SBP & DBP <90th percentile)	280	68.46	469	79.36	749	74.9
Prehypertension (SBP or DBP ≥90th percentile but <95th percentile	125	30.56	120	20.30	245	24.5
Hypertension (SBP &/or DBP ≥95th percentile	4	0.98	2	0.34	6	0.6
Total	409	100	591	100	1000	100

Table 3 shows distribution of blood pressure according to different variables. With regard to gender, 31.5% of males and 20.6% of females were either pre-hypertensive or hypertensive and the difference was statistically significant (P <0.05).

Table 3: Distribution of study subjects according to levels of blood pressure and different variables.

Variables	Group	Normal		Prehypertension + Hypertension		Total	Significance
		No.	%	No.	%		
Gender	Male	280	68.5	129	31.5	409	P = 0.0001
	Female	469	79.4	122	20.6	591	
SES	High	470	78.1	132	21.9	602	P = 0.004
	Low	279	70.1	119	29.9	398	
Frequency of eating fruit during previous 30 days	Not eaten or eaten <1 time per day	310	68.7	141	31.3	451	P = 0.0004
	Eaten one or more times/day	439	80	110	20	549	
Drinking carbonated soft drinks	2 or more times/day	75	61	48	39	123	P = 0.0001
	Not taken soft drinks or taken <2 times/day	674	76.9	203	23.1	877	
Physical activity	<3 days/weak	518	75.2	171	24.8	689	P = 0.75
	>3 days/weak	231	74.3	80	25.7	311	
Smoked one or more days/30 days	Yes	15	78.9	4	21.1	19	P = 0.6
	No	734	74.8	247	25.2	981	
Use of tobacco products during 30 days	Yes	25	89.3	3	10.7	28	P = 0.07
	No	724	74.5	248	25.5	972	
Alcohol consumption during previous 30 days	Yes	19	65.5	10	34.5	29	P = 0.23
	No	730	75.2	241	24.8	971	
Nutritional status	Overweight + obese	9	36	16	64	25	P = 0.0001
	Normal + underweight	740	75.9	235	24.1	975	

Among the high socio-economic group 21.9% and among the low socio-economic group 29.9% were either pre-hypertensive/ hypertensive and the difference was significant (P <0.05). Dietary practices found significant in the study were low fruit eating behaviour (not eaten fruits during the previous 30 days or eaten <1 time/day, P = 0.0004) and habit of taking carbonated soft drinks (P = 0.0001). (Table 3).

Tobacco smoking and alcohol use did not show statistically significant association with blood pressure. Regarding nutritional status 64% of obese/overweight subjects were pre hypertensive/hypertensive whereas only 24% normal subjects were hypertensive, the difference was found statistically significant (P <0.05). Low physical activity did not evolve as significant risk factors in this study.

For further analysis the significant variables from the Chi-square test such as nutritional status as indicated by age adjusted BMI, gender, Socio-economic status, fruit eating behaviour, drinking carbonated soft drinks were included. Logistic regression analysis was performed to find out Adjusted Odds Ratio (AOR). All variables were taken as categorical. Adjusted odds ratio for nutritional status was 5.78 which is statistically significant which meant obese individuals are 5.78 times more prone to go for pre-hypertension/hypertension than normal weight / underweight subjects. Similarly those who are not eating fruits every day are having two times more risk to have pre-hypertension/hypertension than those eaten fruits daily. Those subjects who have consumed carbonated soft drinks two or more times/day were having two times more risk of developing pre-hypertension/hypertension than those who did not consume or <2 times/day.

Low socio economic status also evolved as a significant risk factor for pre-hypertension/hypertension (AOR - 1.559 (1.15-2.11). Table 4 shows details of logistic regression analysis.

Table 4: Binary logistic regression analysis of factors associated with hypertension.

Factors	Group	Number	Adjusted odds ratio (AOR)	95% CI	P value
Nutritional status	Obese/over weight	25	5.782	2.448-13.655	0.001
	Normal/under weight	975			
Gender	Male	409	1.675	1.23-2.28	0.001
	Female	591			
SE status	Low	398	1.559	1.15-2.112	0.004
	High	602			
Fruit consumption	Not eaten or eaten <1 time/ day	451	2.026	1.499-2.737	0.001
	Eaten one or more times/day	549			
Soft drinks	Consumed carbonated soft drinks two or >times/day	123	2.214	1.446-3.392	0.001
	Did not drink or <2 times/day	877			

DISCUSSION

Prevalence of hypertension among adolescents in this study was 0.6% (4 boys and 2 girls). However, the prevalence of pre hypertension was 24.5% which included 30.56% of boys and 20.3% of girls.

In a study done by A. K. Singh et al. the prevalence of systolic hypertension (SBP $\geq$140) was 7.84% and diastolic hypertension (DBP $\geq$90) 2.15%.[14] Mohan et al. in his study among children from rural areas reported a prevalence of 2.56%.[12] Reported prevalence of hypertension among children aged 6-16 years by Patil and Garg was 3%.[15] Though the reported prevalence of hypertension in the present study was low compared to the above studies, the prevalence of pre hypertension was high (24.5%) which is an alarming situation which necessitates urgent intervention among adolescents.

Several studies reported sex differences and blood pressure with males having high blood pressure than females during adolescence and early adulthood.[16,17] The present study also supported the observation made by other authors in this regard. Raised levels of blood pressure in young men compared to women are explained on the basis of lack of endogenous oestrogens. Evidence suggests that estrogen may modulate vascular endothelial function, causing vasodilatation. This may be the reason for women having low blood pressure compared to men.[18]

Low socioeconomic status was evolved as a significant risk factor for raised blood pressure in this study. Recent case control studies from India reported that being illiterate and belonging to low socioeconomic group are independent risk factors for cardiovascular diseases.[19-22] This is an indirect evidence of maturing of the non-

communicable disease epidemic as shown by the risk factor shift from affluent to low socio economic group.[23]

Previous studies demonstrated that blood pressure increased significantly as Body Mass Index (BMI) increased.[24-27] A recent study done among youth at Ajman observed that there is 14% increased chance for getting pre-hypertension or hypertension for a unit increase in BMI.[28] Berenson et al. reported high BMI as one of the strongest risk factors of hypertension.[29] The present study also supported the observation made by other authors with regard to overweight or obesity. This study observed that overweight or obese adolescents were 5.7 times at high risk than normal or underweight to develop raised blood pressure. Davy and Hall pointed out that high blood pressure in obese may be due to higher adiposity.[30] BMI measures obesity and is associated with increased arterial stiffness and various haemodynamic changes that may contribute to hypertension.[31-33]

Daily regular consumption of fruits and vegetables lower risk of high blood pressure. Study by Shil, Krupp D, Ramu T observed that low fruit and vegetable intake was related to a 0.4 mmHg higher blood pressure value among adolescents.[34] A study done among adolescents by Damasceno mm et al. observed that low values of systolic and diastolic blood pressure were identified in adolescents with a consumption of fruits ≥2 times/day (P = 0.001).[35] The present study observed that those who did not eat fruit on all days are two times at a high risk of developing pre-hypertension/hypertension. But several studies could not observe the similar findings.[14,36] Fruits are rich in Potassium which may be the reason for its protective effect. These findings should be highlighted in life style modification classes especially to adolescents. It is easier to inculcate healthy behaviours in a younger age rather than modifying it later or treating the diseases later.

Soft drink consumption (one or more times per day) was emerged as a significant risk factor for pre-hypertension/hypertension in this study. In a study at Chandigarh, Abhiruchi Galhotra et al. observed 36.8% adolescents were taking carbonated soft drinks one or more time per day but no significant association was established between raised blood pressure and soft drink consumption.[36] Winkelmayer et al. in a prospective study among nurses reported an adjusted odds ratio of 1.16 for hypertension among those who consumed carbonated soft drinks.[37] Wolf A et al. in a prospective observational study reported relationship between soft drinks and metabolic syndrome.[38]

In this study smoking or alcohol use did not appear to contribute to an increase in blood pressure. Jayanth et al. had reported that 49.1% of ever smokers were regular smokers in English private schools.[39] So those children who have tried smoking or consumed alcohol in our study have a high risk of becoming regular smokers and alcoholics which would then increase the risk of hypertension and other non-communicable diseases.

The results of this study suggest that health education activities in schools can be developed to encourage consumption of fruits and reduce consumption of soft drinks especially among those adolescents who are likely to develop arterial hypertension. The parents and teachers should also be educated to reduce the availability of soft drinks in home and school and replace them with more homemade nutritive drinks.

CONCLUSION

The results of this study provide an insight into the prevalence of raised blood pressure among adolescents and also an understanding of the association between gender, socioeconomic status, unhealthy diet and increased blood pressure among the study subjects. The high prevalence of prehypertension necessitates urgent intervention in the form of counseling regarding lifestyle modification. The results may be used to develop messages which can be used in health education classes for adolescence to raise their awareness regarding dangers of high blood pressure and its behavioural determinants especially promotion of fruit eating and avoiding soft drinks.

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REFERENCES

1. Lim SS, Vos T, Flaxman AD, Danaei G, Shibuya K, Adair-Rohani H, et al. A comparative risk assessment of burden of disease and injury attributable to67 risk factors and risk factor clusters in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease study 2010. Lancet. 2013;380:2224-60.
2. Reddy KS, Shah B, Varghese C, Ramdoss A. Responding to the threat of chronic diseases in India. Lancet. 2005;366:1744-9.
3. Patel V, Chatterji S, Chisholm D, Ebrahim S, Gopalakrishna G, Mathers C, et al. Chronic diseases and injuries in India. Lancet. 2011;377:413-28.
4. WHO. Health needs of adolescents. Report of a WHO Expert Committee. Geneva, World Health Organization, 1977 (WHO Technical Report Series,

No. 609). Available at: whqlibdoc.who.int/trs/WHO TRS 609.pdf.
5. Chadha SL, Vasan RS, Sarma PS, Shekhawat S, Tandon R, Gopinath N. Age and height specific reference limits of blood pressure of Indian Children. Natl Med J India. 1999;12(4):150-6.
6. Lawlor DA, Smith GD. Early life determinants of adult blood pressure. Curr Opin Nephrol Hypertens. 2005;14(3):259-64.
7. Sung RYT, Lam YM, Leung SSF. Blood pressure in Hong Kong Chinese children: correlation with anthropometric data. JHK Coll Cardiol. 1994;2:99-106.
8. Luma GB, Spiotta RT. Hypertension in children and adolescents. Am Fam Physician. 2006;73:1558-68.
9. de Onis M, Blossner M. Prevalence and trends of overweight among preschool children in developing countries. Am J Clin Nutr. 2000;72:1032-9.
10. World Health Organization. Mortality estimates by cause, age and sex for the year, 2008. Available at: www.who.int/health info/ global burden disease/en/. Accessed 29 April 2014.
11. Thankappan KR, Bela Shah, Prashant Mathur, Sarma PS, Srinivasa G, Mini GK, et al. Risk factor Profile for chronic non-communicable diseases: results of a community based study in Kerala, India. Indian J Med Res. 2010 Jan;131:53-63.
12. Mohan B, Kumar N, Aslam N, Rangbulla A, Kumbkarni S, Sood NK, et al. Prevalence of sustained hypertension and obesity in urban and rural school going children in Ludhiana. Indian Heart J. 2004;56:310-4.
13. National High Blood Pressure Education Programme Working Group on High Blood Pressure in Children and Adolescents. The fourth report on the diagnosis, evaluation and treatment of high blood pressure in children and adolescents. Paediatrics. 2004;114:555-76.
14. Akhil Kant Singh, Ankit Maheswari, Nidhi Sarma, K. Anand. Lifestyle associated risk factors in adolescents. Indian J Paediatr. 2006;73(10):901-6.
15. Rohan Raosaheb Patel, Bishan Swarup Garg. Prevalence of hypertension and variation in blood pressure among school children in rural area of Wardha. Indian J Public Health. 2014;58(2):78-83.
16. Percy C, Freedman DS, Gilbert TJ, White L, Ballew C, Mokhad A. Prevalence of hypertension among Navajo Indians: finding from the Navajo and nutritional survey. J Nutr. 1997;127(10):2114S-9S.
17. Sugarman JR, White LL, Gilbert TJ. Evidence for a secular change among Navajo Indian school children. Am J Clin Nutr. 1990;52(6):960-6.
18. Mendelsohn ME, Karas RH. The protective effect of estrogen on the cardiovascular system. N Engl J Med. 1999;340(23):180-91.
19. Pais P, Pogue J, Gerstein H, Zachariah E, Savitha D, Jayaprakash S, et al. Risk factor for acute myocardial infarction in Indians: a case control study. Lancet. 1996;348:358-63.
20. Rastogi T, Reddy KS, Vaz M, Spiegalman D, Prabhakaran D, Willet WC, et al. Diet and risk of ischaemic heart disease in India. Am J Clin Nutr. 2004;79:582-92.
21. Joshi PP, Islam S, Pais P, Reddy KS, Prabhakaran D, Kazmi K, et al. Risk factors for early myocardial infarction in South Asians compared with individuals in other countries. JAMA. 2007;297:286-94.
22. Gupta R, Gupta VP, Ahluvalia NS. Educational status, coronary heart disease and coronary risk factor prevalence in a rural population of India. BMJ. 1994;309:1332-6.
23. Rajeev Gupta, KD Gupta. Coronary heart disease in low socio economic status subjects in India, "an evolving epidemic". Indian Heart J. 2009 Jul-Aug;61(4):358-67.
24. Brown CD, Higgins M, Donato KA, Rohde FC, garrison R, Obarzanek E, et al. Body mass index and the prevalence of hypertension and dyslipidaemia. Obes Res. 2000;8(9):605-19.
25. Gan SK, Loh CY, Seet B. Hypertension in young adults- an under estimated problem. Singapore Med J. 2003;44(9):448-52.
26. Sonne-Holm S, Sorensen TI, Jensen G, Schnohr P. Independent effects of weight change and attained body weight on prevalence of arterial hypertension in obese and non-obese men. BMJ. 1989;299(6702):767-70.
27. Thompson D, Edelsberg J, Colditz GA, Bird AP, Oster G. Life time health and economic consequences of obesity. Arch Intern Med. 1999;159(18):2177-83.
28. Sreedharan J, Mathew E, Muttappallymyalil J, Sharbati SA, Shaikh RB, Basha SA. Determinants of blood pressure among youth in Ajman, UAE. Natl J Epidemiol. 2010;1(1):17-21.
29. Berenson GS, Srinivasan SR, Bao W, Newman WP, Tracy RE, Wattigney WA. Association between multiple cardiovascular risk factors and atherosclerosis in children and young adults. The Bogalusa heart study. N Engl Med. 1998;338(23):1650-6.
30. Davy KP, Hail JE. Obesity and hypertension: two epidemics or one? Am J Physiol Regul Integr Comp Physiol. 2004;286(5):R803-13.
31. Jannuzzi A, Licenziati MR, Acampora C, Renis M, Agrusta M, Romano L, et al. Carotid artery stiffness in obese children with metabolic syndrome. Am J Cardiol. 2006;97(4):528-31.
32. Stelfox HT, Ahmed SB, Ribeiro RA, Gettings EM, Pomerantsev E, SCHmidt U. Haemodynamic monitoring in obese patients: the impact of body mass index on cardiac output and stroke volume. Crit Care Med. 2006;34(4):1243-6.
33. De Simone G, Devereux RB, Kizer JR, Chinali M, Bella JN, Oberman A, et al. Body composition and fat distribution influenze systemic haemodynamics in the absence of obesity: the hyper GEN study. Am J Clin Nutr. 2005;81(4):757-61.

34. Shi L, Krupp D, Remes R. Salt fruit and vegetable consumption and blood pressure development: a longitudinal study in healthy children. Br J Nutr. 2014 Feb;111(4):662-71.
35. Damasceno MM, de Araiyo MF, de Freitas RW, de Alemdia PC, Zandli MI. The association between blood pressure and consumption of fruits, vegetables and fruit juice. An exploratory study. J Clin Nurs. 2011 Jun;20(11-12):553-60.
36. Galhotra A, Abrol A, Agarwal N, Goel N, Gupta S. Life style related riskfactors for cardiovascular diseases in Indian adolescents. Internet J Health. 2009;9(2):doi: 10.5580/4d4.
37. Winkelmayer WC, Stampfer MJ, Willet WC, Lurhan GC. Habitual caffeine intake and risk of hypertension in women. JAMA. 2005;294(18):2330-5.
38. Wolf A, Bray GA, Popkin BM. A short history of beverage and how our body treats them. Obese Rev. 2008;9(2):151-64.
39. Jayanth K, Notani PN, Gualti SS, Gadre VV. Tobacco usage in school children in Bombay, India. A study of knowledge, attitude and practice. Indian J Cancer. 1991;28:139-47.

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