

Correlation of Anthropometric parameters and Blood pressure in children between 8 -12 years

Rupesh R. Mendadkar¹, Prachi Karnik^{*2}, Avinash Khade³, Mahesh Gore⁴ and Alka Jadhav⁵

¹Consultant Pediatrician, Dr. Mendadkars Children Hospital, Kurla east, Mumbai 400024

²Assistant Professor, Department of Pediatrics, Lokmanya Tilak Municipal Medical College and General Hospital, Sion, Mumbai- 400022

³Chief Medical Officer, Acworth Municipal Hospital, Wadala, Mumbai-400031

⁴Resident Medical Officer, Kohinoor Hospital, Kurla West, Mumbai-400070

⁵Professor, Department of Pediatrics, Lokmanya Tilak Municipal Medical College and General Hospital, Sion, Mumbai-400022

QR Code



*Correspondence Info:

Dr. Prachi S. Karnik,
Assistant Professor,
Department of Pediatrics,
Lokmanya Tilak Municipal Medical College and General Hospital,
Sion, Mumbai- 400022,

*Article History:

Received: 06/03/2018

Revised: 17/03/2018

Accepted: 17/03/2018

DOI: <https://doi.org/10.7439/ijbar.v9i3.4698>

Abstract

Background: Blood pressure is a major determinant of health and cardiovascular morbidity. It is determined by a number of factors including BMI. Being a lifestyle disease, it has its roots in early childhood. The on-going pandemic of childhood obesity has resulted in a marked increase in cases of childhood hypertension. Therefore we studied the prevalence of overweight and obesity, the defining parameters and their correlation with blood pressure in school children.

Methods: A cross sectional observational study was conducted in three schools in Mumbai, with children largely from middle class population. Dietary history, physical activity details were noted. Anthropometric details such as weight, height, BMI, waist circumference, hip circumference, triceps skinfold thickness were noted. Blood pressure was recorded after being seated for 10 minutes. Statistical analysis was done to study correlation between anthropometry and blood pressure.

Results: 981 students were examined. 57.8% had normal BMI, 12.33% and 16.82% had severe thinness and thinness respectively. 9.07% and 3.98% were overweight and obese respectively. Mean Waist Hip Ratio (WHR) for boys and girls was 0.88 and 0.82 respectively. Mean Waist Height Ratio (WHtR) for boys and girls was 0.45 and 0.43 respectively. Mean Triceps Skin Fold Thickness (TSFT) for boys and girls was 5.47 mm and 6.31 mm respectively. 25% of children with systolic prehypertension were overweight, 6.66% were obese. 37.2% of children with diastolic prehypertension were overweight, 16.27% were obese. 32.7% of children with systolic stage 1 hypertension were overweight, 20% were obese. 47.05% of children with diastolic stage 1 hypertension were overweight, 26.47% were obese. 37.1% of children with Systolic stage 2 hypertension were overweight, 37.14% were obese. 30.76% of children with diastolic stage 2 hypertension were overweight, 23.07% were obese. The prevalence of both systolic and diastolic hypertension increased curvilinearly with increasing WHR, WHtR and TSFT. WHR at the cutoff of 0.85 revealed a sensitivity of 60 % and specificity of 53%. Positive predictive value was 11.4% and negative predictive value was 92.9%. WHtR at the cutoff of 0.45 showed a sensitivity of 76.7 % and specificity of 70%. Positive predictive value was 20.5% and negative predictive value was 96.7%. TSFT at the cutoff of 9 mm had a sensitivity of 73.3 % and specificity of 84.3%. Positive predictive value was 32% and negative predictive value was 96.9%.

Conclusions: BMI, WHR, WHtR and TSFT had a strong positive correlation with systolic & diastolic blood pressure. WHtR was more sensitive and TSFT was more specific in detecting hypertension. As a predictor of hypertension, TSFT was the most useful single parameter in our study.

Keywords: Overweight, Obesity, Anthropometric parameters, Anthropometry, Waist Hip Ratio.

1. Introduction

Lung Blood pressure is a major determinant of health. It is determined by a number of factors including genetics, lifestyle, sex, race, body mass index, etc. Long standing untreated hypertension increases cardiovascular morbidity [1]. Severe and symptomatic hypertension in children is usually indicative of an underlying disease process (secondary hypertension). Hypertension in children is most often secondary hypertension. However, the prevalence of primary essential hypertension, particularly in older school aged children and adolescents, has increased in prevalence, in parallel with the obesity epidemic. Approximately 20% of American youth are obese, and up to 10% of obese youth have hypertension [2]. But a very limited data is available for developing countries like India on paediatric hypertension, small surveys in school children suggest a prevalence ranging from 2-5% [3].

Blood pressure in children exhibits strong correlation with various factors, among which bodyweight assumes considerable significance. Data from diverse populations shows that the tracking of blood pressure from childhood into adulthood is very strong [1, 2]. Therefore, the determinants of blood pressure during childhood may also be important predictors of adult blood pressure levels. The association between overweight and hypertension in children has been reported in a variety of ethnic and racial groups, with virtually all studies finding higher blood pressures and/or higher prevalence of hypertension in overweight compared with lean children. Prevalence of paediatric hypertension varies, as per various studies, from 2-15%.

Excess body fat leads to metabolic complications in childhood [4-5], with central (intra-abdominal) distribution of body fat increasing the risk for metabolic syndrome more than peripheral distribution [6] Waist circumference (WC) measurements have been used to estimate intra-abdominal fat in adults [7], and the importance of intra-abdominal fat in childhood obesity has also been confirmed [8]. Paediatric studies consistently show direct correlation of WC with components of the metabolic syndrome, including dyslipidaemia and fasting insulin concentrations [9].

The current definition of the International Diabetes Federation (IDF) of the metabolic syndrome in children, also recommends using increased WC and not BMI as a criterion for the diagnosis of the metabolic syndrome [10]. Despite this, the tool most widely used to determine overweight and obesity in children is the body mass index (BMI). The determination of BMI is simple and BMI references for clinical use in children are available. However, the use of BMI to identify overweight children, specifically those at risk for metabolic disorders, has limitations. Due to its low sensitivity, a considerable number of children with high body fat may be misclassified

as normal weight [11]. Furthermore, using the BMI, it is not possible to distinguish between changes in fat and fat free mass during treatment, and it provides no indication on fat distribution [12].

WC percentiles could therefore be a useful additional tool in the clinical assessment of childhood obesity, especially for estimating the risk for the development of the metabolic syndrome. Even though WC has been shown to be well correlated to intra-abdominal fat depots measured by advanced imaging techniques, over- and under-estimations may occur for very tall or very short persons with similar WC [13]. To overcome those difficulties, several authors suggest using the waist-to-height ratio (WHtR) for a more accurate estimation of fat distribution and body shape [14,15]. Even in children, WHtR has been shown to be a useful predictor of cardiovascular risk, superior to BMI or waist to hip ratio.

Hence Waist to Height ratio must be evaluated in every child irrespective of their BMI so as to identify cases at risk for hypertension. Therefore we studied prevalence of overweight and obesity using different parameters and also the correlation between anthropometric parameters and blood pressure.

2. Materials and Methods

This was a school based study done in 3 schools in Mumbai. All three schools were located in different localities and students were mainly from the middle socioeconomic class. Parents & teachers informed consent was taken. Children were given a brief questionnaire to fill, which included their eating behaviour, amount of time, spent in outdoor/indoor games. Any history of medication was noted. Students consuming pre-enlisted junk food more than three times per week were classified as frequent junk food eaters. Anthropometric parameters such as Weight, Height, BMI, Waist Circumference (WC), Hip Circumference (HC), Triceps Skinfold thickness (TSFT) were measured in the standard manner. A digital weighing scale was used. The child was weighed in his/ her clothes without shoes or heavy outer garments. No correction was made for the weight of clothing. Weight was measured twice, to the nearest 0.1kg.

Height was measured with a non-stretchable metallic tape fixed to the wall. The children stood erect with their heels, buttocks, shoulder blades and occiput against the wall, so that the external auditory meatus and lower border of the orbit were in the same horizontal plane. The measurements were recorded to the nearest 0.1 cm. For waist and hip measurement, students were made to stand with feet close together, arms at the side and body weight evenly distributed. Measurements were taken at the end of a normal expiration. Waist was measured at the level of the outermost point of iliac crest, and the hip circumference

was measured at the widest part of the buttocks or hip, with the tape parallel to the floor, with minimal clothing. Each measurement was repeated twice; if the measurements were within 1 cm of one another, the average was calculated. If the difference between the two measurements was exceeding 1 cm, the two measurements were repeated. Skin fold measurement was obtained at the triceps, with an Accumeasure adipometer in accordance with standard procedure. Triceps skinfold thickness was taken at the mid-point of the acromion process and the lateral condyle.

- Body mass index (BMI) was calculated as per the following formula-

$$\text{BMI} = \text{weight (in kg)} / \text{height (in meter)}^2$$

- Waist to hip ratio was calculated as per following formula-

$$\text{WHR} =$$

$$\text{Waist Circumference (in cm)} / \text{Hip Circumference (in cm)}$$

- Waist to height ratio (WHtR) was calculated as per following formula-

$$\text{WHtR} = \text{Waist Circumference (in cm)} / \text{height (in cm)}$$

All blood pressure measurements were carried out by a BP apparatus using oscillometric principles. Model used for measurement was Omron Model BP710. A cuff of the appropriate size was selected on the basis of upper arm circumference. Readings were taken after sitting quietly for 10 minutes, preferably on the right arm in the sitting position. Three readings were taken at 10 minutes interval. Average of all three readings was taken to represent the individual's blood pressure. Readings were cross-checked by mercury sphygmomanometer for every 20th participant. Students were classified as per their BMI into Severe thinness (BMI <-3SD), Thinness (BMI >-3SD but <-2SD), Normal (BMI >-2SD but <+1SD), Overweight (BMI >+1SD but <+2SD) and Obesity (BMI >+2SD).

In accordance with The National High Blood Pressure Education Program (NHBPEP) Working Group on High Blood Pressure in Children and Adolescents², students were classified based on the systolic and diastolic blood pressure measurements into

Pre-hypertension: Average systolic blood pressure (SBP) and/or diastolic blood pressure (DBP) >90th percentile but <95th percentile

Hypertension: Average systolic blood pressure (SBP) and/or diastolic blood pressure (DBP) >95th percentile

Hypertension was further staged as -

Stage1: BP >95th to 99th percentile plus 5mm Hg

Stage2: BP >99th percentile plus 5mm Hg

For statistical analysis, we calculated proportion for categorical variables, mean & standard deviation for linear variables. Categorical Proportions were compared using chi square test. Means were compared with 't' test. Furthermore we also performed sensitivity & specificity, positive & negative predictive value at a specific cut off for

waist to hip ratio (WHR), waist to height ratio (WHtR), triceps skinfold thickness (TSF).

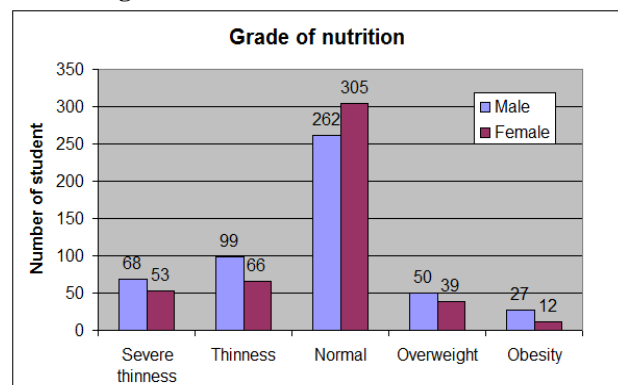
We visualized area under receiver operating characteristics (ROC) curve for systolic BP, diastolic BP & waist to hip ratio (WHR), waist to height ratio (WHtR), triceps skinfold thickness (TSF).

3. Results

Total of 981 school children in age group of 8-12 years were included in the study, among which were 506 were males (51.58%), & 475 (48.42%) were females. Mean age was 10.82 years for males and 10.75 years for females. Mean hours of time spent in outdoor games was 1.72 hours per day for males & 1.12 hours in females. Mean hours of time spent in indoor games was 2.19 hours per day for males & 1.88 hours in females.

Overall frequency of junk food consumption was 29.36%. The frequency of junk food consumption was 79.48% in obese children, 53.93% in overweight children, where as 24.5% in non-overweight children.

Figure 1: Nutritional status of children



57.8% of total students had a normal BMI. Proportion of females was more in the normal category. Prevalence of overweight was 9.07%. Prevalence of overweight was 9.88% in males and 8.21% in females. Overall prevalence of obesity was 3.98%, with 5.36% in males & 2.52% in females. Prevalence of thinness was 16.82%. Prevalence of thinness in males was 19.57% and in females, it was 13.89%. Prevalence of severe thinness was 12.33%; 13.44% in males & 11.16% in females.

Mean systolic BP in males was 108.22 mm of Hg (SD-10.66) (CI-107.28-109.15).

Mean systolic BP in females was 108.91 mm of Hg (SD-10.21) (CI-107.99-109.83)

Mean diastolic BP in males was 65.74 mm of Hg (SD-8.67) (CI-64.98-66.50).

Mean diastolic BP in females was 65.71 mm of Hg (SD-8.51) (CI-64.94-66.48)

Mean arterial BP in males was 79.91 mm of Hg (SD- 8.53) (CI-79.16-80.65).

Mean arterial BP in females was 80.12 mm of Hg (SD- 8.17) (CI-79.38-80.86)

Table 1: Correlation between age & mean systolic blood pressure and Diastolic blood pressure

Age group (Years)	Sex	N. of cases	Systolic B.P (Mean±SD)	Diastolic B.P (Mean±SD)
8	Male	16	100.31±6.91	66.00±6.68
	Female	16	104.25±10.76	65.88±10.99
9	Male	42	102.60±10.04	64.67±6.81
	Female	47	105.51±9.28	64.19±7.78
10	Male	128	106.21±10.31	63.93±9.33
	Female	130	106.34±10.13	64.09±8.81
11	Male	153	108.88±11.00	66.47±8.47
	Female	130	108.92±10.03	66.32±8.45
12	Male	167	111.31±9.86	66.70±8.74
	Female	152	112.64±9.49	67.02±8.04

There was a positive correlation between age & mean systolic blood pressure. Mean systolic BP was more in females, but the difference was not statistically significant. Out of 981 children, 150 children had high systolic BP reading. Prevalence of systolic pre-hypertension was 6.1%, whereas prevalence of systolic hypertension was 9.17%.

60 children had systolic pre-hypertension, 55 children had systolic Stage 1 hypertension and 35 children had systolic stage 2 hypertension. Systolic pre-hypertension (90-95th percentile) was 7.57% in females and 4.74% in males. Stage 1 systolic hypertension (95-99th percentile) was present in 6.32% of male students and 4.84% of female students. Stage 2 systolic hypertension (>99th percentile) was seen in 3.95% male students and 3.15% female students. 21.4% of all students had systolic BP less than 50th percentile.

Out of 981 students, 90 students had high diastolic BP. Prevalence of diastolic pre-hypertension was 4.38%, whereas prevalence of diastolic hypertension was 4.79%. 43 children had diastolic pre-hypertension, 34 children had diastolic stage 1 hypertension, 13 children had diastolic stage 2 hypertension.

Diastolic pre-hypertension (90-95th percentile) in female students was 4.42% and it was 4.34% in males. Stage 1 diastolic hypertension (95-99th percentile) was present in 3.16% of male students & 3.78% female students. Stage 2 diastolic hypertension (>99th percentile) was seen in 1.58% male students, & 1.05% female students. 24.36% of all students had diastolic BP less than 50th percentile.

Prevalence of hypertension had a positive correlation with BMI ($p < 0.0001$), increasing with change in nutritional status from severe thinness to obesity.

Prevalence of pre-hypertension was maximum in overweight females (20.5%). Prevalence of stage 1 hypertension was maximum in obese males (29.6%). Prevalence of stage 2 hypertension was maximum in obese females (41.66%).

25% of the children with Systolic pre-hypertension were overweight & 6.66% were obese. 37.2% of children with diastolic pre-hypertension had overweight & 16.27% were obese.

32.7% of the children with Systolic stage 1 hypertension were overweight and 20% were obese. 47.05% of the children with diastolic stage 1 hypertension were overweight and 26.47% were obese.

37.1% of the children with Systolic stage 2 hypertension were overweight and 37.14% were obese. 30.76% of the children with diastolic stage 2 hypertension were overweight and 23.07% were obese. Prevalence of diastolic pre-hypertension was highest in overweight males. Prevalence of diastolic stage 1 hypertension was more in females. Prevalence increased as nutritional status changed from severe thinness to obesity. Prevalence of diastolic stage 2 hypertension was highest in obese females.

Mean WHR increased as blood pressure increased from normotensive category to stage 2 hypertension. This correlation was found between both systolic and diastolic BP and WHR.

Means WHR increased as blood pressure increased from normotensive category to stage 2 hypertension.

This correlation was found between both systolic & diastolic BP, & WHR. There was increase in prevalence of hypertension as waist to height ratio increased. Similarly, with increasing triceps skinfold thickness (TSF) also, the systolic as well as diastolic BP increased.

Waist to hip ratio at the cutoff of 0.85 revealed the sensitivity of 60 % and specificity of 53%. The area under ROC curve (Receiver Operator Characteristics) was 0.57. Its positive predictive value was 11.4% and negative predictive value of 92.9%.

Waist to height ratio at the cutoff of 0.45 revealed the sensitivity of 76.7 % and specificity of 70%. The area under ROC curve (Receiver Operator Characteristics) was 0.73. Its positive predictive value was 20.5% and negative predictive value of 96.7%.

Triceps skin fold thickness at the cutoff of 9 mm revealed a sensitivity of 73.3 % and specificity of 84.3%. The area under ROC curve (Receiver Operator Characteristics) was 0.79. Its positive predictive value was 32% and negative predictive value of 96.9%.

Triceps skinfold thickness and Waist/Height ratio were better predictors of hypertension.

4. Discussion

This school based study was done to find out prevalence of overweight, obesity and hypertension. We also aimed to find out prevalence of junk food consumption. This study included children mainly from middle income families. Schools were selected such as to have representation from various areas of Mumbai. Most of

the children were from age group of 10, 11, 12 years of age. Representation from age group of 8 and 9 years was small.

46.17% students were from Marathi medium and 53.83% were from English medium.

Frequency of junk food consumption was 29.36%. It was more in overweight (53.98%) and obese (74.48%) children, thereby implying that most cases of overweight and obesity were secondary to junk food consumption. Under-nutrition as well as over-nutrition was observed more commonly in males. Females had better BMI than males.

Prevalence of hypertension found by our study was lower than in other countries [16-18] and other studies conducted in urban India. But it was more than the rural counterparts [19].

Systolic as well as diastolic BP had positive correlation to BMI. Severity of hypertension and probability of having hypertension both increases as grade of nutrition becomes overweight and obese.

Table 2: showing percentage wise distribution of overweight & obesity amongst students with high systolic BP readings

Systolic BP	Overweight (%)	Obese (%)
Prehypertension	25	6.66
Stage 1	32.7	20
Stage 2	37.1	37.14

Table 3: showing percentage wise distribution of overweight & obesity amongst students with high diastolic BP readings

Diastolic BP	Overweight (%)	Obese (%)
Prehypertension	37.2	16.27
Stage 1	47.05	26.47
Stage 2	30.76	23.07

Waist circumference had positive correlation to both systolic and diastolic BP, but relation with systolic BP was stronger.

Figure 2: Scattered diagram showing distribution of systolic BP against waist circumference

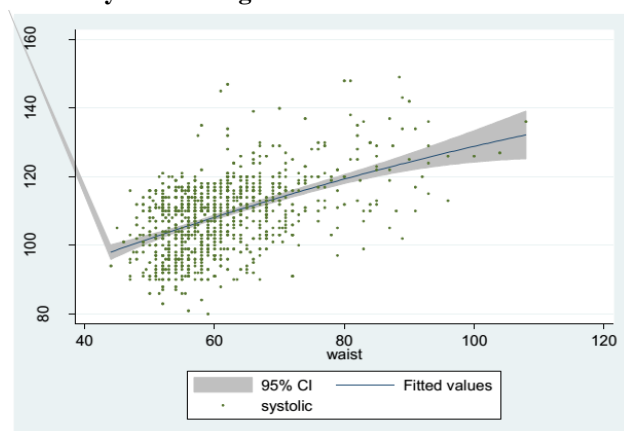
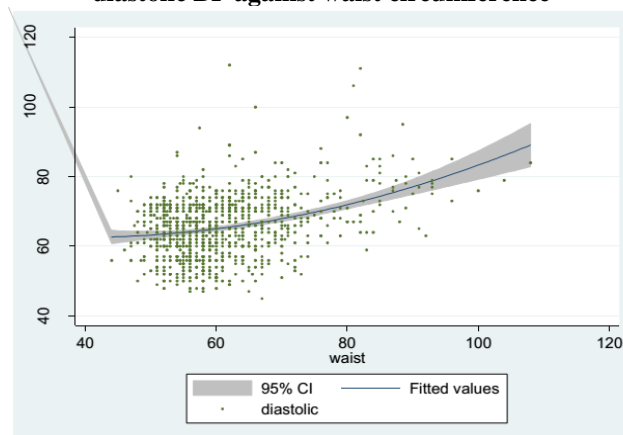


Figure 3: Scattered diagram showing distribution of diastolic BP against waist circumference



There was progressive increase in diastolic BP with increasing waist circumference. But relation between two factors was not linear. Waist circumference could be used as a single isolated possible risk marker to identify children at risk of possible high BP (p value <0.0001).

With increasing waist to height ratio, blood pressure increased. Positive relationship was observed for systolic BP as well as diastolic BP. (p <0.0001). The chance of systolic pre-hypertension & hypertension was 8.9% with BMI below +1 SD. As the BMI increases between +1SD to +2SD (overweight), the chance of developing systolic pre-hypertension and hypertension increases to 51.68% & for BMI >+2SD (obese), the chance increases to 71.79%.

Prevalence of hypertension increases markedly in overweight and obese children, risk was more for females. Correlation of BMI to BP was stronger in case of diastolic BP.

Waist to Hip ratio ≤ 0.85 can be used to exclude cases at risk of hypertension. Negative predictive value for the same was 92.9%.

Waist to Height ratio ≤ 0.45 should be used irrespective of BMI, to exclude possibility of high BP or metabolic syndrome. Triceps skinfold thickness ≤ 9 mm can be used to exclude cases with hypertension. Routine BP measurement should be done in routine paediatric office practice, and appropriate age, sex and height BP charts should be used.

Cuff selection has to be proper, proper technique must be followed.

1. The BP cuff width should be 40% to 50% of the circumference of extremity with the cuff long enough to encircle the extremities completely or nearly completely.
2. The NHBPEP recommends Korotkoff phase 5 (K5) as the diastolic pressure, whereas AHA recommends use of Korotkoff phase 4 (K4).
3. Two or more readings should be averaged (because the averaged values are closer to the basal BP level and are more reproducible).

4. The child should be in sitting position with the arm at heart level.

Waist Height ratio and BMI calculation should be part of routine paediatric practice.

Use of BMI only may miss those cases with more intra-abdominal fat and preserved BMI. Cases with normal BMI, but still having Waist to height ratio more than 0.45 have increased risk of having hypertension and developing metabolic syndrome as an adult.

5. Conclusion

1. In a developing country like India, malnutrition is still more prevalent than overweight.
2. As BMI increases, the chance of developing both systolic & diastolic pre- hypertension and hyper tension increases considerably.
3. Waist to hip ratio (WHR) increased sharply above 0.8, waist to height ratio (WHtR) above 0.45 and Triceps Skin Fold Thickness (TSFT) above 9 mm in overweight & obese category. As the mean WHR, WHtR & TSFT increased the risk of developing systolic as well as diastolic hypertension increased.
4. As a predictor of high blood pressure, Triceps Skin Fold thickness was the most useful single parameter in our study.

References

- [1]. Gary E. Fraser, Roland L. Phillips, and Ralph Harris. Physical Fitness and Blood Pressure in School Children. *Circulation*. 1983; 67:405-11.
- [2]. Marc B. Lande, Systemic Hypertension. In: Robert M. Kliegman, MD, Bonita M.D. Stanton, MD, Joseph St. Geme, Nina Schor, MD, PhD and Richard E. Behrman, MD editors. Nelson textbook of paediatrics. 19th ed. Philadelphia. Elsevier; 2011. Chapter no 439.
- [3]. 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: 310-314.
- [4]. Dietz WH. Health consequences of obesity in youth: childhood predictors of adult disease. *Pediatrics*. 1998; 101:518-25.
- [5]. Weiss R, Caprio S. The metabolic consequences of childhood obesity. *Best Pract Res Clin Endocrinol Metab*. 2005; 19:405-19.
- [6]. Pouliot MC, Despres JP, Lemieux S, et al. Waist Circumference and Abdominal Sagittal Diameter - Best Simple Anthropometric Indexes of Abdominal Visceral Adipose-Tissue Accumulation and Related cardiovascular risk in Men and Women. *Am J Cardiol*. 1994; 73:460-8.
- [7]. Lean ME, Han TS, Morrison CE. Waist circumference as a measure for indicating need for weight management. *BMJ*. 1995; 311:158-61.
- [8]. Goran MI, Gower BA. Relation between visceral fat and disease risk in children and adolescents. *Am J Clin Nutr*. 1999; 70:149S- 156S.
- [9]. Freedman DS, Serdula MK, Srinivasan SR, Berenson GS. Relation of circumferences and skinfold thickness to lipid and insulin concentrations in children and adolescents: the Bogalusa Heart Study. *Am J Clin Nutr*. 1999; 69:308-17.
- [10]. Zimmet P, Alberti G, Kaufman F, et al. The metabolic syndrome in children and adolescents. *Lancet*. 2007; 369: 2059-61.
- [11]. Zimmermann MB, Gubeli C, Puntener C, Molinari L. Detection of overweight and obesity in a national sample of 6-12-y-old Swiss children: accuracy and validity of reference values for body mass index from the US Centers for Disease Control and Prevention and the International Obesity Task Force. *Am J Clin Nutr*. 2004; 79:838- 43.
- [12]. McCarthy HD. Body fat measurements in children as predictors for the metabolic syndrome: focus on waist circumference. *Proc Nutr Soc*. 2006; 65:385-92.
- [13]. Browning L, Hsieh S, Ashwell M. A systematic review of waist-to height ratio as a screening tool for the prediction of cardiovascular disease and diabetes: 0.5 could be a suitable global boundary value *Nutrition Research Reviews* 2010; 23:247-69.
- [14]. Ashwell M, Cole TJ, Dixon AK. Ratio of waist circumference to height is strong predictor of intra-abdominal fat. *BMJ*. 1996; 313:559-60.
- [15]. Hsieh SD, Yoshinaga H. Waist/height ratio as a simple and useful predictor of coronary heart disease risk factors in women. *Intern Med*. 1995; 34:1147-52.
- [16]. Mohkam M, Karimi A, Eslami N, Khatami A, Fallah F, Maham S, et al. Blood pressure screening in school-aged children in Tehran. *Iran J Kidney Dis*. 2011 Jul; 5(4): 229-33.
- [17]. Chanelle Kemp, Anita E Pienaar, Aletta E Schutte. The prevalence of hypertension and the relationship with body composition in Grade 1 learners in the North West Province of South Africa. *SAJSM* 2011; 23:117-22.
- [18]. Jonathan M. Sorof, Dejian Lai, Jennifer Turner, Tim Poffenbarger & Ronald J. Portman. Overweight, Ethnicity, and the Prevalence of Hypertension in School-Aged Children. *PEDIATRICS* 2004; 113:475- 81.
- [19]. Buch Nirav, Goyal Jagdish P., Nagendra Kumar, Parmar Indira, Shah Vijay B., and Charan Jaykaran. Prevalence of hypertension in school going children of Surat city, Western India. *J Cardiovasc Dis Res*. 2011 Oct-Dec; 2(4): 228-232.