Original Research Article

Study of anthropometric indices and its correlation with blood pressure among early and mid adolescent at tertiary health care hospital

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Abstract

Background: Over the past two decades, it has been observed that hypertension shows an increasing trend in early and mid-adolescents. Various factors are contributing to this upward trend, and they primarily include changes in lifestyle and dietary habits. **Objectives:** The aim of this study was to study the correlation between bmi and blood Pressure in adolescent. **Materials and Methods:** The present study was conducted as a Cross sectional study at Department of Paediatrics, L.N.Medical College and Research Centre, Bhopal during the study period of two years. The study was conducted on Early and mid-adolescent age group i.e. 10 to 16 years. Study design – An observational cross-sectional study. Study duration – 2 years i.e., from December 2019 to November 2021. **Results:** Out of 1000 children recruited in the study Mean systolic and diastolic blood pressure was 113.11±9.01 and 71.58±6.92 mmHg respectively. Systolic blood pressure was above 95th centile in 5.2% whereas diastolic blood pressure was above 95th centile in 3.6% of the study participants. About 16.3% adolescent were overweight and 6.4% were obese **Conclusion:** We have observed prevalence of elevated BP is more in early adolescent(10-13 years) age group whereas hypertension is more in mid adolescent(14-16 years) age group .Hence implementation of routine blood pressure measurement in early age can give us a head start in management of hypertension and prevention of cardiovascular diseases.

Keywords: Adolescents, blood pressure, body mass index, height, hypertension, weight

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INTRODUCTION

According to World Health Organization (WHO) "adolescence" is described as a phase of life between childhood and adulthood i.e. from the age range of 10 years to 19 years. Adolescent health has recently gained importance as a separate phase of life during which individual experience rapid physical, cognitive and psychosocial growth. This stage plays an important role in laying the foundation of good health.[1] Adolescents contribute to approximately to 21% of Indian population.[2] The period of adolescence is categorized into three stages (i) early adolescence (10 – 13 years), (ii) mid adolescence (14 – 16 years) and (iii) late adolescence (17 to 19 years).[3] Adolescents have unique needs depending upon gender, socioeconomic status and circumstances. Though the period of adolescence is considered as healthy phase, but it is an important determinant of health status in adulthood.[4] Majority of diseases appearing in adulthood have their roots in adolescence. This age group faces a unique set of health problems, most common being mental health problems, sexually transmitted infections (including HIV), substance abuse, under nutrition, obesity, unintentional

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injuries, violence etc.[4] Since this period is characterized by rapid growth, the nutritional requirements are increased demanding diet rich in protein, vitamins and minerals. Also the use of mass media is higher among them, which plays an important role in determining lifestyle pattern among them.[5] Non communicable disease such as hypertension, diabetes, cardiovascular disease and cancers are major cause of morbidity and mortality. India is facing double burden of disease i.e. India is still tackling communicable disease while the prevalence of noncommunicable disease is rising rapidly.[6] Hypertension is a major public health problem and is positively correlated with risk of cardiovascular disease and stroke. It is also linked to peripheral vascular disease, visual impairment and renal impairment.[7] According to American Academy of Pediatrics new pediatric hypertension clinical practice guideline was issued in 2017, where hypertension is defined as systolic blood pressure level of ≥95th percentile or ≥130 mmHg and diastolic blood pressure level ≥95th percentile or ≥ 80 mmHg.[8] There are four major risk factors associated with non-communicable disease. These include lack of physical activity, unhealthy diet, use of tobacco and alcohol. Apart from this aging, rapid urbanization and globalization further contribute to hypertension and other non-communicable diseases.[9] As majority of lifestyle habits are acquired in adolescent, primordial and primary level of prevention during early and mid-adolescence might help in reducing the burden of non-communicable disease in adulthood. Literature suggests that risk of hypertension is three fold higher in obese individuals.[10,11] Anthropometry is a single most non-invasive systematized measuring technique which helps in assessments of body size and proportions. It is the universally applicable, inexpensive and easily available tool which can be utilized at peripheral levels for assessment of body dimensions.[12,13] Various anthropometric parameters which can be used in adolescents include BMI, skin fold thickness, waist circumference and waist hip ratio. The increase in rate of BMI in adolescents has been considered as a strong predictor of blood pressure, insulin resistance and dyslipidemia among adults.[13] The American Heart Association (AHA) recommends that all the children from the age of 3 years must be subjected to blood pressure checking annually till adulthood.[14] But blood pressure measurement among children and adolescents is not routinely practiced. High blood pressure and obesity may be associated with adverse health consequences such as dyslipidemia, metabolic disorders and insulin resistance. Early detection of these risk factors associated with cardiovascular disease and other non-communicable disease is need of an hour. As OPD services provide a platform to detect the health problems early and treat them, we aimed to identify population at risk in advance.The present study was therefore conducted at tertiary care center to find out spectrum of nutrition among adolescents and to study the correlation between BMI and blood pressure in adolescent.

MATERIAL AND METHOD

The study is cross sectional study at Department of Paediatrics, L.N.Medical College and Research Centre, Bhopal during the study period of two years. The study was conducted on early and mid-adolescent age group i.e. 10 to 16 years.

Inclusion criteria: 1. All children 10-16 year attending Pediatric outpatient department(OPD), 2. Parents/legal guardian giving consent, 3.Children giving assent

Exclusion criteria:1. Children who were seriously ill, 2. Children unwilling for anthropometric measurements, 3. Parents/legal guardian not giving consent

Sample size – 1000(using statistical formula: n =Z2 pq/l2) Written consent Written consent was obtained from parents/legal guardians of the study participants after explaining them nature and purpose of the study in their language.

All the participants in presence of their parents/guardians were interviewed about sociodemographic variables such as age, gender, place of residence, religion, education etc. Socioeconomic status was done using Modified Kuppuswamy scale. All the participants were subjected to anthropometry and general examination. Their weight, height, triceps skinfold thickness and waist circumference were recorded. The weight and height of eligible participants was taken to help calculate their body mass index (BMI). The weight was recorded using a digital weighing machine. The height was measured using a stadiometer.BMI was calculated using Quetelet index i.e. weight in kg/height in mt2 and values were compared with IAP classification 2015 growth chart Triceps Skin fold thickness was taken in left hand (non-dominant hand) with an Accumeasure® skinfold calliper made in USA, with an accuracy of 0.1 mm. Waist circumference measurements was done with a non-stretchable tape over at the midpoint of the lowest rib cage and the iliac crest. Their vitals such as heart rate and respiratory rate were recorded. Blood pressure was recorded in sitting position with both hands resting on the

examination table and the cubital fossa supported at the level of heart.

Table 1: Definition and classification of hypertension in children and adolescent

For children aged 1-13yr	For children aged ≥ 13yr
Normal BP:<90th percentile	Normal BP:< 120/<80mmHg
Elevated BP: ≥ 90th percentile to < 95th percentile or 120/80mm Hg to 95th percentile (whichever lower)	Elevated BP: 120/< 80 to 129/< 80mm Hg
Stage 1 HTN: ≥95th percentile to < 95th percentile+12mm Hg, or 130/80 to 139/89mmHg (Whichever is lower)	Stage 1 HTN: 130/80 to 139/89mm Hg
Stage 2 HTN:≥95th percentile +12mmHg. Or ≥140/90mmHg (Whichever is lower)	Stage 2 HTN: ≥140/90mmHg

Correlation of Anthropometric parameters with blood pressure was assessed using Pearson correlation coefficient.

Table 2: Correlation coefficient was expressed as following

R	Corelation
1	Perfect
0.8-0.99	Very strong
0.6-0.8	Strong
0.4-0.6	Moderate
0.2-0.4	Weak
0.02	Very weak

P value less than 0.05 was considered statistically significant

OBSERVATION AND RESULTS

The present study was conducted on a total of 1000 adolescents belonging to
age range of 10 to 16 years. Mean age of study participants in our study was 13.18±1.84 years and majority i.e. 52% of the participants belonged to mid adolescent age group (14 to 16 years). Slight male predominance was observed in our study i.e. about 55.2% of the participants were males. All the participants in our study were resident of urban area and immunization was complete for all. Maximum participants belonged to upper middle socio-economic status.

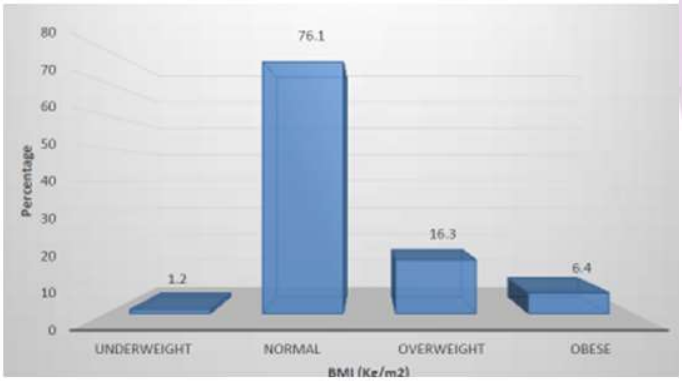

Table 3: Distribution of study participants according to BMI

Majority of adolescents had normal body mass index (76.1%), whereas 16.3% adolescent were overweight and 6.4% were obese.

Table 4: Distribution of study participants to mean anthropometric variables

Anthropometric variables	Mean	SD
Weight(kg)	43.95	12.82
Height9Cm)	154.31	12.21
BMI(Kg/m^2)	18.12	3.52
Triceps skin fold thickness(mm)	15.66	5.09
Waist circumferences(cm)	75.95	8.29

Mean weight of adolescents was 43.95±12.92 kg whereas mean height was 154.31±12.21 cm. BMI was 18.12± 3.52 kg/m2. Skin fold thickness and waist circumference was 15.66±5.09 mm and 75.95±8.29 cm respectively.

Majority of study participants had their systolic as well as diastolic blood pressure below 90th centile (80% and 82.4% respectively). Systolic blood pressure was above 95th centile in 5.2% whereas diastolic blood pressure was above 95th
centile in 3.6% of the study participants. In our study, majority of adolescent belonging to age range of 10 to 13 years had SBP in the range of 90 to 95th centile (56.8%), whereas majority of adolescents in the age range of 14 to 16 years had SBP above 95th centile (61.5%) Significantly higher proportion of participants in early adolescence had normal BMI (53.1%), whereas significantly higher proportions of mid adolescent participants were underweight or overweight/ obese ($p<0.05$). Our study documented no significant association between age and triceps skinfold thickness centile ($p>0.05$). Significant association of waist circumference centile with age, i.e. majority of adolescents in 10 to 13 years of age had waist circumference in 50th to 75th centile whereas majority of adolescents in 14 to 16 years of age had waist circumference above 75th centile ($p<0.05$). Significant association of BMI with SBP centile, BMI with DBP centile, Triceps Skinfold thickness with systolic blood pressure centiles, Triceps Skinfold thickness with diastolic blood pressure centiles, waist circumference with systolic blood pressure centiles, waist circumference with diastolic blood pressure centiles ($p<0.05$). Our study showed a moderately positive but significant correlation of skinfold

thickness with SBP and DBP (r=>0.40, p<0.05), i.e. as the skinfold thickness increased, SBP as well DBP increased significantly (p<0.05). Strong and moderate positive correlation of Waist circumference with SBP and DBP respectively (r=>0.60 and 0.567, p<0.05), i.e. as the Waist circumference increased, SBP as well DBP increased significantly (p<0.05).

DISCUSSION

Adolescence is an important stage of life which is a separate phase between childhood and adulthood. The behavioral habits inculcated during this period are often persisted throughout life and may be associated with diseases in the adulthood.[4] As this period is characterized by rapid physical growth, it is essential to determine the body proportions and size, for which anthropometry is a single most non-invasive, inexpensive, universally applicable and easily available tool.[12,13] In our study mean age of participant was 13.18±1.84 of which about 52% (n=520) participants belonged to mid adolescence and majority of them i.e. 55.2% (n=520) cases were males whereas female predominance i.e. 54.5% (n=786) was present in Moser D C *et al.*(2013) study. Majority of the participants belonged to upper middle 30.2% (n=302) followed by middle socioeconomic status i.e. 26.6% (n=266) according to modified kuppuswamy scale 2020-21 whereas In Goel M *et al.* (2016) 272 (22.7%) children were of upper socioeconomic class, but a majority of them i.e. 565 (46.3%) participants belonged to middle socioeconomic class.[15] Anthropometric assessment was done in all the cases in our study which included weight, height, BMI, triceps skin fold thickness and waist circumference. Mean height, BMI and triceps skin fold thickness of adolescents enrolled in our study were 154.31±12.21 cm, 18.12±3.52 kg/m2 and 15.66±5.09 mm respectively. Similar result was obtained by Moser D C *et al.*, Mean height, BMI and triceps skin fold thickness of adolescents was 1.54±0.1 m, 19.9±3.7 kg/m2 and 16.9±7 mm respectively. However, mean weight in our study was 43.95±12.82 kg and mean waist circumference which is an indicator of central obesity was 75.95±8.29 cm.Mean BMI, Waist circumference, Waist-to-hip ratio in a study of Abbaszadeh F *et al.* were 21.77±4.27 kg/m2, 73.57±10.67 cm, and 0.46±0.07 respectively. [16] The prevalence of obesity and overweight was 6.4% and 16.3% similarly in Goel M *et al.* (2016) study, 69 (5.65%) adolescents were obese and 112 (9.17%) participants were overweight. Similar results were seen in studies done among school going children by Kapil *et al.*,[105] Khadilkar *et al.*,[17] and Marwaha *et al.*[18] and reported obesity was 7.5%, 5.7% and 5.3% of the study population, respectively and prevalence of overweight was also similar to our study (18.4%, 19.9%, and 16.75%, respectively).Staub K *et al.* (2018) observed overweight and obesity in 25% cases.[19] Blood pressure was observed in all the adolescents at a single visit 3 reading were taken and its mean was then categorized as normotensive, elevated BP and hypertensive following AAP,2017 revised guidelines.[8] Mean systolic and diastolic blood pressure amongst adolescents enrolled in our study were 113.11±9.01 and 71.58±6.92 mmHg respectively whereas mean systolic and diastolic blood pressure in Moser D C *et al.* were 106±12 and 60±10 mm Hg.[20] Mean systolic and diastolic blood pressure in a study of Abbaszadeh F *et al.* (2017) was 110.60±15.68 and 71.23±10.39 mmHg respectively which was similar to our study.[16] Systolic hypertension was present in 5.2% cases whereas Diastolic hypertension was present in 3.6% of the adolescence. In study conducted by Goel M *et al.*, the prevalence of systolic hypertension and diastolic hypertension was 4.9% and 3.9% that is in agreement with our study results.[15] However, systolic and diastolic blood pressure in elevated BP range was 14.8% and 14% cases respectively which is more than those recorded in Goel M *et al.* systolic and diastolic blood pressure in pre hypertension (now known as elevated BP) range is 7.3% and 5.6% cases respectively.[15] The findings of present study were concordant with the findings of Papalia T *et al.* (2012) documented high blood pressure in 4.6% of the adolescents.[21] Durrani AM *et al.* (2011) reported hypertension in 9.4% of the adolescent belonging to age range of 12 to 16 years.[22] Cheah W L *et al.* (2018) in their study documented hypertension in 22.5% boys and 12.9% girls whereas 19.3% and 8.8% boys and girls were pre-hypertensive(now known as elevated BP).[23] Santos-Beneit G *et al.* (2015) observed raised blood pressure i.e. BP percentile above 90 in 20% of the adolescents.[24] We observed systolic blood pressure, BMI and waist circumference to be significantly associated with age. The findings of our study were concordant with the findings of Yazdi M *et al.* (2020), in which age was significantly associated with raised blood pressure as well as anthropometric variables.[25] Amritanshu *et al.*(2015) study also reported, BP showed a gradual increase over age.[26] Our study findings were also supported by the findings of Akor F *et al.* (2010) ,in which mean blood pressures (including systolic and diastolic) increased significantly with age irrespective of their genders.[27] Durrani A M *et al.* (2011) in their study reported highest prevalence of hypertension in adolescent belonging to 15 years of age.[22] Our study findings were also supported by findings of Santos-Beneit G *et al.* (2015), in which the authors reported increasing prevalence of obesity with increase in age of children with estimated prevalence of 2% at 3 years and 3 to 8% in children belonging to 5 years.[24] This effect of obesity may further increase during the adolescent phase. In another study by Staub K *et al.*, the authors

reported advancing age as an important determinant of increase in BMI, WC and WHtR.[19] The overall incidence of non-communicable diseases and their risk factors are increasing rapidly and these factors are mainly attributed to lifestyle and dietary behaviors. Not only in adulthood, obesity and hypertension are increasingly been recognized in adolescent and childhood which is further linked with early vascular ageing.[28,29] We aimed to assess the correlation between BMI and blood pressure in adolescent age group. In present study, we reported a significant association of blood pressure (systolic and diastolic) with obesity as assessed by BMI and waist circumference ($p<0.05$). BMI ($r=>0.710$, $p<0.05$) and waist circumference ($r=>0.613$, $p<0.05$) showed a strong positive correlation, whereas skinfold thickness ($r=>0.495$, $p<0.05$) showed moderately positive correlation with systolic blood pressure. However, BMI ($r=0.736$, $p<0.05$) was strongly correlated with DBP whereas skinfold thickness ($r=0.537$, $p<0.05$) and waist circumference ($r=0.567$, $p<0.05$) showed moderate positive correlation. Our study findings were supported by findings of Akor F *et al.* (2010) observed significant positive correlation of anthropometric variables with systolic and diastolic blood pressures ($r=0.26$ - 1.22, $p<0.05$) in adolescent age.[27] Beck CC *et al.* (2010) in their study on 660 adolescents (14 to 19 years observed waist circumference to be best predictor of hypertension in boys (AUC-0.80; 95% CI- 0.72 to 0.89) and girls (AUC-0.96, 95% CI- 0.92 to 1.00).[30] Durrani A M *et al.* (2011) observed a correlation coefficient of weight with SBP of 0.47 and 0.50 and that with DBP of 0.46 and 0.42 in boys and girls respectively.[20] Moser D C *et al.* (2013) also reported a weak correlations of all the anthropometric variables with systolic and diastolic levels. They reported body mass index and skin fold thickness (OR- 2.9% and 1.9% respectively;$p<0.05$) as independent predictors of raised blood pressure in adolescents.[20] Goel M *et al.* (2016) reported significant correlation of BMI with SBP and DBP (Pearson's correlation coefficient - [$r = 0.701$, $P < 0.01$] and [$r = 0.664$, $P < 0.01$] for SBP and DBP, respectively).[15]

CONCLUSION

Anthropometry is a simple, non-invasive, easily available tool which may be utilized for not only the assessment of obesity but also predicting the risk of elevated BP and hypertension in early and mid-adolescent phase. We have observed prevalence of elevated BP is more in early adolescent(10-13 years) age group whereas hypertension is more in mid adolescent(14-16 years) age group .Hence implementation of routine blood pressure measurement in early age can give us a head start in management of hypertension and prevention of cardiovascular diseases. Amongst various anthropometric parameters, BMI had highest correlation with systolic as well as diastolic blood pressure followed by central obesity as measured by waist circumference. Monitoring of anthropometric parameters along with blood pressure in adolescent age groups must be incorporated as a component of school health programme, so as to identify the cases early, preferably in elevated BP phase. Apart from this, blood pressure measurement must be promoted in adolescents at each point of their contact with the health facility.

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