Study of blood pressure to height ratio and its relation with standard BP percentile charts to detect the prehypertension in age group 12 to 15 yrs

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Abstract

Introduction: The prevalence of adolescent (pre) hypertension, even in developing countries, is rising steeply, probably due to urbanization and the positive energy balance – typified by excess weight gain – that comes with it. Primary prevention of one of the leading health problems, i.e. hypertension and ischemic heart disease in adults necessitates a scientific evaluation of the predictors in children. Currently, blood pressure percentile in childhood is assessed according to age, gender, height. **Aim & Objectives**: To study blood pressure to height ratio and its relation with standard BP percentile charts to detect (pre) hypertension. **Methodology**: BP percentile was calculated for 2000 adolescents. Receiver operating characteristic (ROC) curve analyses were performed to calculate sensitivity and specificity of BP/height ratios as diagnostic tests for elevated BP (90%). Correlation analysis was performed between BP percentile and BP/height ratios. **Result**: In our study average age was 13.1 ± 1.2 years. SBP/height ratio was ≥ 0.7607 and ≥ 0.7795 in boys and girls respectively. And DBP/height ratio was ≥ 0.4513 and ≥ 0.46 in boys and girls respectively. The ratios strongly correlate with the BP percentile charts with high sensitivity and specificity. **Conclusion**: The BP/height ratios correlate with the corresponding standard BP percentiles charts in both genders. It may eliminate the under-diagnosis of adolescent (pre)hypertension and hypertension, and in turn, may help to reduce morbidity and mortality resulting from its sequelae.

Keywords: Adolescent, Hypertension, Systolic BP(SBP), Diastolic BP(DBP).

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Introduction

Hypertension is a global health problem and it is well documented that increased blood pressure becomes established in childhood [1,2]. Hypertension in children and adolescents is defined as systolic BP (SBP) and /or diastolic BP (DBP) above the 95th percentile. BP between the 90th and 95th percentile is designated "high normal" or pre- hypertensive [2].

The prevalence of prehypertension and hypertension increases progressively with increasing body mass index (BMI) and hypertension is detectable in over 30% of overweight children with BMI above 95th percentile [3]. Hypertension in childhood and adolescence has been a proven risk factor for hypertension in adult[4, 5].

Currently the available data to quantify hypertension in children is in the form of a table reference matched by age, gender, and height percentile that identifies the BP as 50th, 90th, 95th and 99th percentile [2].

The criteria for diagnosis of pre hypertension and hypertension in children and adolescents can be complex and challenging to apply in clinical practice because of age, gender and height specific reference values [6]. Both pre hypertension and hypertension though prevalent and increasing in incidence remain widely undiagnosed.

Lu et al [6] reported that blood pressure to height ratios were both feasible and accurate as diagnostic tool for (pre) hypertension and hypertension in Han adolescents of China, and proposed optimal thresholds for SBP to

height ratio (SBPHR) and DBP to height ratio (DBPHR) for the said population. This study recognizes the racial differences in adolescent hypertension [7,8].

These studies have recommended determining the sensitivity and specificity of these indices in various populations. In order to validate the BP/ Height ratios, similar studies are needed to be carried out. This has formed the basis of our study.

In our study we have tested that simple BP/ Height ratios can be used as accurate clinical tests to identify children and adolescents at risk for pre hypertension and hypertension. We also report the co relation of BP/ height ratios with commonly used BP percentile charts.

Methodology

Study Population: A cohort study of 2000 children was conducted in Dr. D. Y. Patil Hospital. The data used in this study is collected from private schools in Kolhapur city. The study sample consist of 2000 (1,398 boys and 602 girls) school children, in the age group of 12-15 years. A sample size was obtained after detailed discussion with statistician.

Inclusion Criteria
All school going boys and girls between age 12 – 15 yrs.

Exclusion Criteria
Children with history of known secondary hypertension were excluded from study.

The study was approved by Research and Ethical committee of Dr D Y Patil Medical College and Research Institute. Permission from the concerned authority of schools was obtained to conduct the study among school children. After detailed explanation of the objectives and protocols of the study, informed consents were obtained from parents. Parents were asked if there was any history of hypertension due to secondary causes in children and if child is on any antihypertensive medications and such children were excluded from the study.

Procedure and Measurements: The following parameters were taken. Age, sex, weight, height, systolic and diastolic blood pressure. Age in completed years was recorded as per school admission registers.

Measurements were made by a single person and same equipment was used to obtain accurate measurement

and to increase the sensitivity of the results. Weight was recorded using spring balance (bathroom scale) calibrated to 0.5 kg accuracy.

The height was measured by making the child to stand upright, barefoot on the ground with heels, head in Frankfurt plane. The height was measured using sliding stadiometer (Johnson and Johnson) with an accuracy of 1mm.

Diamond mercury manometer was used to record blood pressure, with a set of different sized cuffs as per the recommendation given by the fourth report on the diagnosis, evaluation and treatment of high blood pressure in children28. The cuff bladder was wide enough to cover at least 2/3 of arm and long enough to encircle arm completely. Auscultatory method was used and the 1st and 5th Korotkoff's sounds were taken as indicative of the systolic and diastolic blood pressure respectively. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were reported to be measured by a standard protocol used by NHANES 8. Blood pressure was recorded 3 times with 2 min interval between each. All recordings were done by a single individual to eliminate observer subjective bias. Before recording blood pressure, the procedure was explained to children and sufficient time was given to allay anxiety and fear. Blood pressure was measured in supine position. In children where a higher range of blood pressure was observed, the factors like anxiety and fear were removed and re-recorded after one hour. Average of 3 BP readings was taken.

Statistical Analysis: Correlation coefficient and simple linear regression analysis was done for predicting blood pressure (SBP and DBP) separately for age, sex, weight and height. BP percentiles were calculated according to the standard formula provided in the following reference manuscript.

Statistical Analysis: Receiver-operating characteristic (ROC) curve analyses were performed to calculate sensitivity and specificity of SBP/height and DBP/height ratios as diagnostic tests for elevated, that is, >90th percentile of SBP and DBP, respectively.

Correlation analysis was performed between SBP percentile and SBP/height ratio. Similar correlation was studied for DBP percentiles and DBP/height ratio. ROC analysis and curve generation were performed using Analyse-it Method Evaluation edition. For data analysis and interpretation we used SPSS v.19.

Results

This study included 2000 children in the age group 12 to 15 years. Participants consisted of 1398 boys aged 13.1 ±1.2 years old and 602 girls aged 13.0 ±1.0 years old. The proportion of BP above 90th percentile in all boys and girls was 2.57% (36 out of 1398 boys) and 3.98% (24 out of 602 girls) respectively.
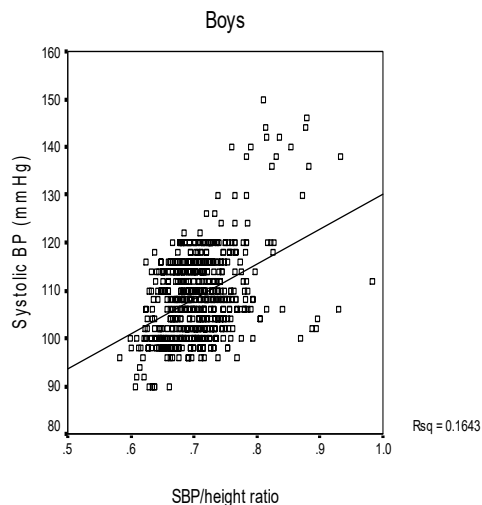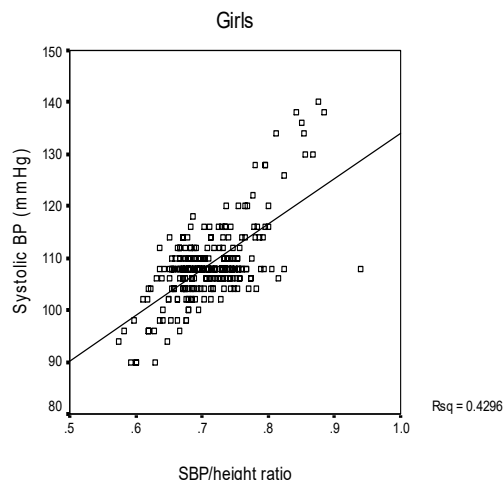

Figure 1(a)   Figure 1(b)

SBP / Height ratio strongly correlated with SBP percentiles in both boys (Figure 1(a); $P < 0.001$, $R^2 = 0.1643$) and girls (Figure 1(b) ; $P < 0.001$, $R^2 = 0.1643$).
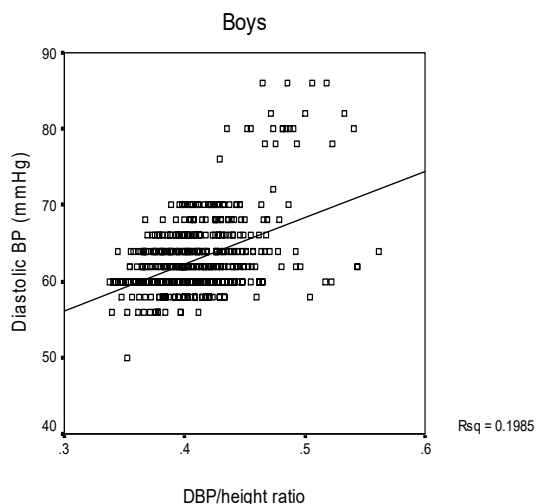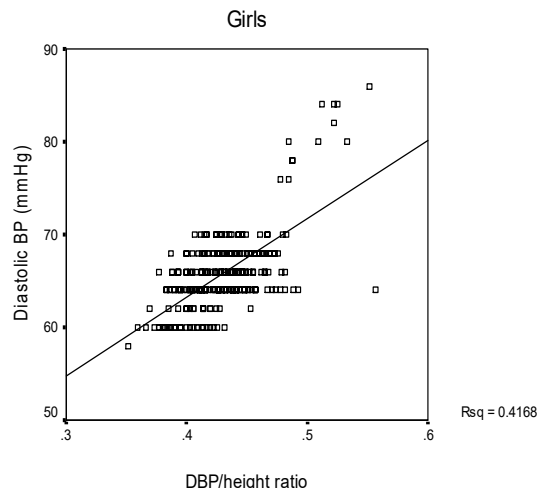

Figure 2(a) Figure 2(b)

Similar results were obtained for DBP/ Height ratio and DBP percentiles : boys (Figure 2(a) ; $P < 0.001$, $R^2 = 0.1985$)and girls (Figure 2(b); P , 0.001, $R^2 = 0.1985$).

ROC analysis showed a very steep progression of sensitivity and specificity above certain cut off values. The cut off values of elevated SBP/Height ratios in boys and girls was ≥0.74 and ≥0.78 respectively.

The cut off values for elevated DBP/Height ratios was ≥0.44 in boys and ≥0.49 in girls. Above the cut off values of the ratios the sensitivity and specificity of detection of elevated BP (>90th percentile) was very high.

Discussion

Hypertension in the pediatric and adolescent population may remain undiagnosed, although the BP charting for age, gender and height are readily available. They are generally not used in a busy pediatric practice, so the diagnosis of hypertension may be missed in some children.

This study may provide a simplified diagnostic test for primary assessment of BP and for detecting children & adolescent in need of further follow up for diagnosis of pre-hypertension & hypertension.

In this study we have shown that BP/Height ratios are simple & accurate method of diagnosing elevated blood pressure. Our findings are in complete agreement with preceding studies on this matter.

The author in respective studies have clearly demonstrated the feasibility and accuracy of BP/Height & DBP/Height ratios in there cohort of Chinese, Italian and Nigerian adolescents, in our study the cut off for SBP/Height ratio for both boys and girls in ≥ 0.74 and ≥ 0.78 respectively[6,9,10].

The DBP/Height ratio in boys & girls are ≥ 0.44 and ≥ 0.49 respectively. The sensitivities and specificities of these ratios are from 84.4% to 98% in identifying elevated BP above the 90th percentile. Present study shows both SBP/height ratio and DBP/ height ratio correlates with the corresponding BP percentile charts. p value of present study is < 0.001 it states that values of SBP/height ratio and DBP/height ratio is statistically significant. Similarly Lu et al, Chukwunonso ECC Ejike, Ovidiu Galescu et al shows P value <0.001. It shows that present study correlates with the above studies[6,9,10]. This study may be limited by some factors. First, the not-too-large sample size for this study may imply a debatably reduced statistical power of entire analysis. Though a larger population may yield different threshold values, the differences may not be significant. These results therefore call for a very much larger national (or even regional) study aimed at determining cut off values for SBPHR and DBPHR in India.

Conclusion

BP/Height ratio is a simple, excellent screening and diagnostic tool with high sensitivity and specificity to detect (pre)hypertension. The BP/Height ratios also co-relate with the corresponding standard BP percentile charts in both genders. The BP/Height ratio can be easily used in routine medical care of children to detect prehypertension.

It is suggested that the use of this simple, inexpensive and accurate indices should be standardized into screening programs for diagnosis of elevated BP in the pediatric age group. It would be appreciated by non medical professionals as well.

It may also eliminate the under- diagnosis of adolescent (pre)hypertension and in turn, help in the early management of cases , and ultimately a reduction in the morbidity and mortality arising from its sequale.

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