Original Article

Blood pressure to height ratio as a screening tool for prehypertension and hypertension in adolescents

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Abstract

Background: Current methods of detection of childhood hypertension are cumbersome and contribute to under-diagnosis hence, the need to generate simpler diagnostic tools. The blood pressure to height ratio has recently been proposed as a novel screening tool for prehypertension and hypertension in some populations. We evaluated its applicability in our environment.
Materials and Methods: The weights, heights, and blood pressure measurements of 2364 apparently healthy adolescents were determined. Sex-specific systolic and diastolic blood pressure to height ratios (SBPHR) and (DBPHR) were calculated, and their ability to detect prehypertension and hypertension was determined using receiver operating curves. Discriminatory ability was measured by the area under the curve (AUC) and optimal cutoff points along the curve were determined. *P* < 0.05 was considered statistically significant.
Results: The SBPHR and DBPHR were similar across all age groups and sexes. The AUC of SBPHR and DBPHR for diagnosing prehypertension and hypertension by sex was >0.95 for both diastolic and systolic hypertension in both sexes. It ranged between 0.803 and 0.922 for prehypertension and 0.954–0.978 for hypertension indicating higher accuracy for hypertension. Sensitivity was higher for systolic and diastolic hypertension (90–98%) compared with prehypertension (87–98%). Specificity was lower than sensitivity across all categories of hypertension and prehypertension (0.64–0.88%) though higher for hypertension (0.75–0.88) compared with prehypertension (0.64–0.75).
Conclusion: BPHR is a useful screening tool for prehypertension and hypertension in black adolescents. Accuracy increased with higher degrees of hypertension.

Key words: Adolescents, blood pressure, height, hypertension

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Introduction

The association of childhood hypertension with cardiovascular morbidity and recognition of its progression to adult hypertension has drawn attention to the need for prompt diagnosis and management in childhood.[1-3] Pediatric hypertension is diagnosed based on centile charts derived by the United States Task Force on High Blood Pressure in Children and Adolescents.[4] These charts are age, gender, and height centile-dependent and need to be referred to for every child seen. This cumbersome process is often difficult to employ in everyday clinical settings, even

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for pediatricians and has been proposed to be one of the main factors mitigating blood pressure measurements in children.[5] In a large study in the USA,[5] alarmingly large rates of under-diagnosis of both childhood hypertension and prehypertension were reported. The figures are likely to be higher in developing countries such as ours where health awareness is lower. Clearly, such high rates of undetection could undermine efforts directed at control of hypertension.

In recognition of this challenge, simpler tools for the diagnosis of pediatric high blood pressure have been proposed. The blood pressure height ratio (BPHR) was first proposed as a simple, accurate, and nonage dependent screening index for adolescent hypertension by Lu *et al*.[6] in China. Subsequently, there have been efforts to validate this tool among Caucasian and Asian populations.[7-13] Ejike and Ejike,[14,15] in, to our knowledge, the only reports in blacks, reported similar observations for both prehypertension and hypertension in children from the North Central and South Eastern Regions of Nigeria. One study was in children aged 7–10 years.[14] while the other which was among 1173 adolescents[15] was conducted in a mixture of semiurban and urban areas. Variability in anthropometric indices between geographical regions in Nigeria[16] may, therefore, imply that the findings may not be applicable to all regions of the country. In addition, blood pressure determination was by oscillometric rather than auscultatory methods as recommended by the United States Task Force on High Blood Pressure in Children and Adolescents.[4] The oscillometric method is based on the oscillations of pressure in a sphygmomanometer cuff recorded during gradual deflation, the point of maximal oscillation corresponding to the mean intra-arterial pressure. These oscillations, however, begin well above systolic pressure and continue below diastolic, so that actual pressures can only be estimated indirectly by empirically derived algorithms which vary between manufacturers. This accounts for variations in blood pressure readings between oscillometric in contrast to the mercury sphygmomanometer.[17,18] The objective of this study, therefore, was to evaluate the BPHR as a screening tool for high blood pressure in a large group of urban dwelling black adolescents using blood pressures derived by auscultation.

Materials and Methods

Study area and population

This cross-sectional, multi-centre study of apparently healthy adolescents aged 10–18 years was conducted in three secondary schools in the South-Western and South-Southern regions of Nigeria. The selection was done via a multi-stage technique. One of the educational districts in each of the states was randomly selected. The secondary schools in one educational zone each from the selected districts were further stratified into single gender and mixed schools. Three mixed gender schools were then selected by simple random methods. Ethical approval was obtained from the Health Research and Ethics Committees of the Lagos University Teaching Hospital, Lagos and the University of Port Harcourt Teaching Hospital, Rivers State, Nigeria. The school authorities gave formal approval while parental written informed consent and student assent were also obtained. Failure to obtain consent led to exclusion from the study. The study conformed to the ethical guidelines and principles of the Helsinki declaration of 2008.

Data collection

All eligible pupils were consecutively enrolled. Details of the nature of the study and its importance were explained to the subjects, and a brief demonstration of the measurement techniques was conducted before the commencement of the study. Data such as age, sex, weight, and height were entered into a study proforma.

Measurements

All measurements were carried out by the researchers and well-trained assistants. A calibrated digital scale was used to obtain the weights of subjects to the nearest 0.1 kg. Each subject was weighed barefoot in light clothing, (belts and other accessories were removed and pockets emptied) and standing still without any support. Height was measured to the nearest 0.5 cm using a stadiometer. Blood pressure was measured using a standard mercury sphygmomanometer and appropriately sized cuffs.[4] Subjects were quietly and comfortably seated with legs uncrossed and feet resting on a firm surface for at least 5 min before measurements were taken.[4] Systolic and diastolic BP readings were recorded at the first and fifth Korotkoff sounds respectively with readings taken to the nearest 2 mmHg during deflation. The average of at least two readings taken with a minimum of 5 min interval was taken as the subject's blood pressure.[4,19]

Hypertension based on age, sex and height was defined as follows: Prehypertension: - $\geq 90^{th}$–$<95^{th}$ percentile; hypertension $\geq 95^{th}$ percentile; Stage 1 hypertension: 95^{th}–99^{th} +5 mmHg; Stage 2 hypertension: $>99^{th}$ percentile +5 mmHg.[4,20] Blood pressure >120/80 mmHg but $<90^{th}$ centile was also defined as prehypertension. For adolescents aged 18 years, blood pressure <120/80 mmHg was considered normal and hypertension was defined as follows:[21] Prehypertension: 120–139/80–89 mmHg; Stage 1 hypertension: 140–159/90–99 mmHg; Stage 2 hypertension: >160/100 mmHg. Systolic blood pressure to height ratio (SBPHR) and diastolic blood pressure to height ratio (DBPHR) were calculated as follows: SBP (mmHg)/height (cm) and DBP (mmHg)/height (cm), respectively.

Statistical analysis

Data were analyzed using the Statistical Package for Social Sciences version 20. (SPSS Inc., Chicago, IL, USA). Continuous data were represented as means and standard deviation while categorical data were represented as percentages. Statistical significance for discrete data was determined using the Chi-square test while comparison of means was done using the Student's *t*-test. Receiver operating curves (ROC) were generated to test the ability of the SBPHR and DBPHR to detect prehypertension and hypertension in males and females independently. The discriminatory ability was measured by the area under the curve (AUC) and classified as follows: 0.9 to < 1: Excellent, 0.8 *t* < 0.9: Good, 0.7 < 0.8: Worthless, and 0.6–< 0.7: Not good.[22] The ROC is a plot of sensitivity against 1-specificity for a range of cut-off points of SBPHR and DBPHR to the SBP and DBP. The optimal cut-off points were taken as the points where maximal sensitivity and specificity were achieved along the curve. $P < 0.05$ was considered statistically significant.

Results

A total of 2364 adolescents (M: F: 0.69:1), whose ages ranged from 10 to 18 years with mean age of 14.1 ± 2.1 years were studied. Subjects were divided into three age-groups for the purpose of analyzing descriptive characteristics as follows: (10–12 years, 13–15 years and 16–18 years) [Table 1]. Majority (46.6%) were aged between 13 and 15 years with the rest being almost equally split between the other age-groups. The mean weight, height, SBP and DBP increased with age in both sexes. The SBPHR and DBPHR, however, did not observe this trend being similar across all age groups and sexes, ranging between 0.69–0.72 and 0.42–0.45 respectively. Both SBPHR and DBPHR were generally higher in females across all age groups.

Comparison of overall mean variables between both sexes in Table 2 showed a trend to higher values in females for weight while mean height demonstrated a trend to higher values in males, although only the height difference was statistically significant. Overall prevalence rates of systolic and diastolic hypertension were 5.3% and 4%, respectively with corresponding prehypertension prevalence rates of 16.6% and 7.7%, respectively [Table 3]. Prevalence of systolic hypertension was higher in males while that of diastolic hypertension was higher in females though the differences did not reach statistical significance.

The AUC statistics of SBPHR and DBPHR for diagnosing prehypertension and hypertension by sex are shown in

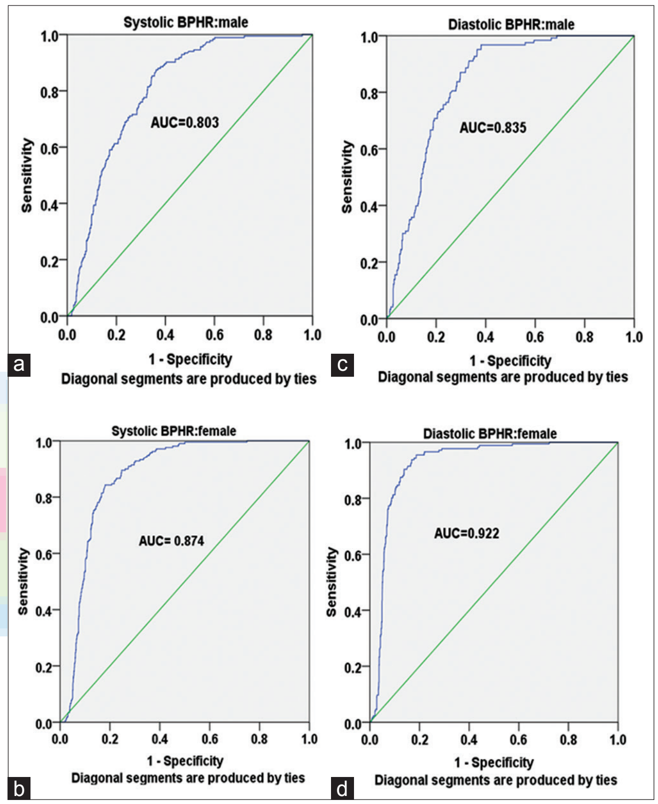

Figure 1: Receiver operating curves for systolic blood pressure to height ratio (a and b) and diastolic blood pressure to height ratio (c and d) for discrimination between children with and those without prehypertension by gender

Table 1: Descriptive characteristics of 2364 study participants by age and gender

Age (years)	*n*	Weight (kg)	Height (cm)	SBP (mmHg)	DBP (mmHg)	SBPHR	DBPHR
10-12	620						
Male	267	39.3±10.5	145±7.8	101.9±9.3	65.4±8.5	0.70±0.06	0.45±0.06
Female	353	42.3±9.6	147.5±8.1	104.6±10.8	64.2±8.8	0.71±0.07	0.44±0.06
13-15	1101						
Male	404	49.5±12.9	157.8±11	107.9±12	66.7±9.6	0.69±0.07	0.42±0.06
Female	697	50±9.7	154.6±7.9	108.2±10.7	67.7±9	0.70±0.07	0.44±0.06
16-18	643						
Male	292	57.3±9.3	165.9±8.4	114.8±11	70.9±8.9	0.69±0.07	0.43±0.05
Female	351	54.2±9.0	156±7.5	112.4±10.5	69.8±8.2	0.72±0.07	0.45±0.05
Total	2364	49.1±11.7	154.6±10.4	108.3±11.4	67.4±9.1	0.70±0.1	0.43±0.1

SBP=Systolic blood pressure; DBP=Diastolic blood pressure; SBPHR=Systolic blood pressure height ratio; DBPHR=Diastolic blood pressure height ratio

Table 2: Comparison of means of variables in 2364 study subjects between sexes

Variable	Mean±SD			*t*-test	*P*
	All (2364)	Male (963)	Female (1401)		
Age (years)	14.1±2.1	14.2±2.1	14.0±2.1	1.65	0.099
Weight (kg)	49.1±11.7	49.0±13.2	49.1±10.4	−0.130	0.897
Height (cm)	154.6±10.4	156.7±12.3	153.1±8.5	7.72	<0.001
SBP (mmHg)	108.3±11.4	108.3±12.0	108.3±1.0	−0.072	0.94
DBP (mmHg)	67.4±9.1	67.6±9.4	67.3±9.0	0.762	0.45
SBPHR (mmHg/cm)	0.70±0.1	0.69±0.1	0.71±0.1	5.21	<0.001
DBPHR (mmHg/cm)	0.43±0.1	0.43±0.1	0.44±0.1	−3.147	0.002

SBP=Systolic blood pressure; DBP=Diastolic blood pressure; SBPHR=Systolic blood pressure height ratio; DBPHR=Diastolic blood pressure height ratio; SD=Standard deviation

Table 3: Pattern of hypertension in study subjects

	All (2364) *n* (%)	Male (963) *n* (%)	Female (1401) *n* (%)	*P* Male:female
SBP				
Prehypertension	393 (16.6)	183 (19)	210 (15)	0.010
Hypertension	126 (5.3)	45 (4.7)	81 (5.8)	
Stage 1	107 (84.9)	40 (88.9)	67 (82.7)	0.238
Stage 2	19 (15.1)	5 (11.1)	14 (17.3)	
DBP				
Prehypertension	300 (12.7)	124 (12.9)	176 (12.6)	0.821
Hypertension	94 (4)	40 (4.2)	54 (3.9)	
Stage 1	88 (93.6)	37 (92.5)	51 (94.4)	0.714
Stage 2	6 (6.4)	3 (7.5)	3 (5.6)	

SBP=Systolic blood pressure; DBP=Diastolic blood pressure

Table 4: Gender-specific area under the curve of SBP and DBP to height ratios

	AUC	*P*	95% CI
Male			
SBP			
Prehypertension	0.803	<0.001	0.773-0.883
Hypertension	0.963	<0.001	0.945-0.982
DBP			
Prehypertension	0.835	<0.001	0.805-0.864
Hypertension	0.954	<0.001	0.930-0.978
Female			
SBP			
Prehypertension	0.874	<0.001	0.854-0.894
Hypertension	0.973	<0.001	0.963-0.982
DBP			
Prehypertension	0.922	<0.001	0.905-0.939
Hypertension	0.978	<0.001	0.967-0.989

SBP=Systolic blood pressure; DBP=Diastolic blood pressure; CI=Confidence interval; AUC=Area under the curve

Table 4 and Figures 1 and 2. The value was >0.95 for both diastolic and systolic hypertension in both sexes and ranged between 0.803 and 0.922 for prehypertension indicating greater accuracy for hypertension. Optimal cut-off points

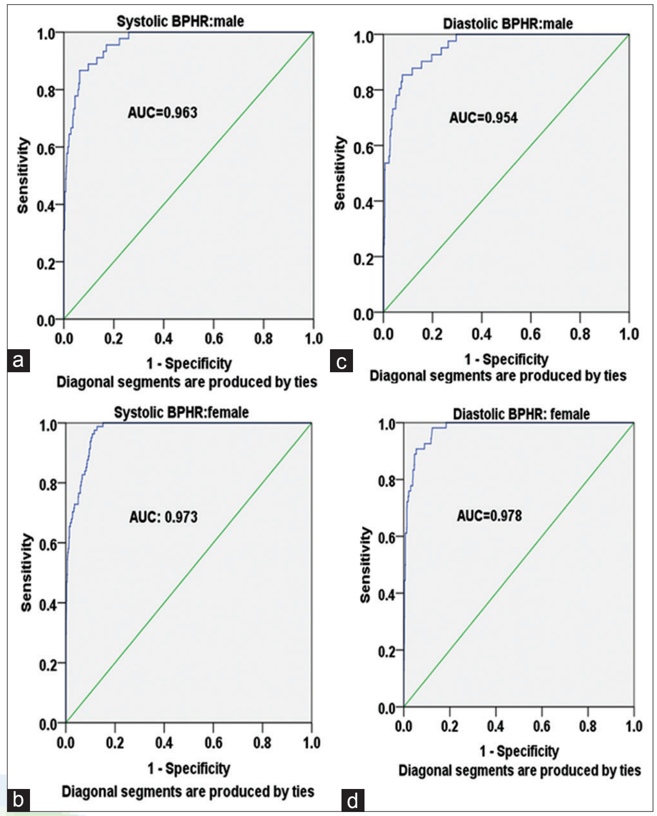

Figure 2: Receiver operating curves for systolic blood pressure to height ratio (a and b) and diastolic blood pressure to height ratio (c and d) for discrimination between children with and those without hypertension by gender

and corresponding sensitivities and specificities are shown in Table 5. Sensitivities for both systolic and diastolic hypertension ranged from 90% to 98% while that for prehypertension ranged from 87% to 98%. Sensitivities were also higher in females for all categories of hypertension. Specificity was lower than sensitivity across all categories of hypertension and prehypertension ranging from 0.64% to 0.88% but was higher for hypertension (0.75–0.88) compared with prehypertension (0.64–0.75).

Discussion

Childhood hypertension has reached epidemic proportions worldwide, largely associated with the rising prevalence of childhood obesity.[23-27] The prevalences of systolic and diastolic hypertension in the present study were 5.3% and 4%, respectively while those of systolic and diastolic preprehypertension were 16.7% and 7.7%, respectively supporting this trend. In another developing country, overall prevalences of 3.4% and 10.6% were reported for hypertension and prehypertension, respectively.[27] This supports the recent global attention on the need for routine blood pressure measurement in childhood to enable prompt diagnosis and intervention. The BPHR is a recently identified screening tool for childhood hypertension

Table 5: Optimal thresholds of SBP and DBP to height ratios for diagnosing prehypertension and hypertension and their corresponding sensitivities and specificities

	SBP				DBP			
	Prehypertension		Hypertension		Prehypertension		Hypertension	
	Male	Female	Male	Female	Male	Female	Male	Female
Cut-off points	0.70	0.73	0.76	0.78	0.45	0.46	0.48	0.50
Sensitivity	0.87	0.90	0.92	0.94	0.87	0.98	0.90	0.98
Specificity	0.64	0.75	0.87	0.75	0.70	0.71	0.85	0.88

SBP=Systolic blood pressure; DBP=Diastolic blood pressure

and prehypertension. It is proposed that this tool will significantly improve hypertension detection rates by simplifying diagnosis, in contrast to the current cumbersome process that requires referral to age and sex-specific charts for each child seen.[4]

In the current study, the SBPHR and DBPHR were similar across all age groups and sexes despite variations of blood pressure, weight, and height with age suggesting that the ratio should perform well across the adolescent age-group. It also implies that the performance of the tool may be unaffected by differences in these variables that may exist between different populations. This is an important characteristic that should promote its recommendation as an internationally accepted tool for blood pressure screening in children. The AUC for SBPHR and DBPHR in both sexes demonstrated excellent ability to predict blood pressure status. The predictive ability was however higher for hypertension being >0.90 in all categories compared to prehypertension which ranged from 0.803 to 0.922. This is similar to the findings of other workers from China and Nigeria[7,13,14] who reported AUC values that increased with the degree of hypertension in both young children aged 5–12 years old and adolescents. Galescu *et al.*[10] from the USA, however, reported higher AUC values of >0.95 for both SBP and DBP. In that study, there was no differentiation between prehypertension and hypertension as all children with blood pressure >90th centile for age and sex were analyzed as a group which could have accounted for their findings. In summary, BPHR as a screening tool for elevated blood pressure in children appears to perform better for hypertension than prehypertension. Repeated blood pressure measurements in childhood may, however, help circumvent this limitation as pre-hypertensive children who are initially missed may be diagnosed during future blood pressure measurements. This highlights the importance of the recommendation of the American National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents,[4] that all children above the age of 3 years admitted to a health facility should have their blood pressures checked.

The optimal thresholds of SBPHR and DBPHR for diagnosis of prehypertension and hypertension were similar to those from most previous studies. These range from 0.70 to 0.73 for systolic prehypertension, 0.75–0.79 for systolic hypertension, 0.45–0.48 for diastolic prehypertension and 0.48–0.51 for diastolic hypertension.[6-10,12-15,23] These striking similarities between studies in various populations is encouraging and again presupposes the general applicability of this novel screening tool.

Sensitivities and specificities derived from our study were generally higher for hypertension in comparison with prehypertension which aligns with most other reports, re-affirming the better performance of the test for hypertension versus prehypertension. In addition, the test demonstrated higher sensitivity than specificity across all ranges of blood pressures in all sexes in our study subjects. This was similar for most reported studies[6,7,10,14,15] except for that by Keliashi[9] from the Middle East where this pattern was only observed for predominantly prehypertension in both sexes. This is significant as with this type of screening tool; it is more desirable to have a higher rate of false positives (higher sensitivity) who can be subsequently excluded by further blood pressure measurements than false negatives (higher specificity) in which case hypertensive children may escape diagnosis.

The performance of the ratio is largely independent of race as has been reported.[7,8,10-14] This, in addition to promising studies in younger children[7,11-14] again demonstrates the potential for wide applicability of the BPHR as a screening tool for childhood hypertension. In the current study, blood pressure was derived from the average of two measurements obtained at a single visit similar to the study by Outdili *et al.*[12] This aligns with their claim that the use of this tool does not require repeated visits which is another potential advantage for its use. It should, however, be emphasized that it is only a screening tool, hence standard reference charts [4] should still be referred to confirmation of diagnosis.[4]

Totaro *et al.*[23] compared the BPHR with other previously described blood pressure screening tools (Somu's equations, Ardissino's table, and Kaelber's table) and found BPHR to be the best compromise between sensitivity (an important feature of a screening test) and accuracy. The authors concluded that that the BPHR is an easy-to-apply test that allows the identification of hypertensive children with only four thresholds and can, therefore, be used in any setting.

The findings of the present study lend credence to this observation.

Conclusion

This study adds to the increasing body of evidence that the BPHR performs well as a simple screening tool for prehypertension and hypertension in adolescents of all races. Larger studies in younger children and other populations as well as systematic reviews are recommended.

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Conflicts of interest

There are no conflicts of interest.

References

1. Falkner B. Hypertension in children and adolescents: Epidemiology and natural history. Pediatr Nephrol 2010;25:1219-24.
2. Falkner B, Lurbe E, Schaefer F. High blood pressure in children: Clinical and health policy implications. J Clin Hypertens (Greenwich) 2010;12:261-76.
3. Chen X, Wang Y. Tracking of blood pressure from childhood to adulthood: A systematic review and meta-regression analysis. Circulation 2008;117:3171-80.
4. National High Blood Pressure Education Program 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. Pediatrics 2004;114:555-76.
5. Hansen ML, Gunn PW, Kaelber DC. Underdiagnosis of hypertension in children and adolescents. JAMA 2007;298:874-9.
6. Lu Q, Ma CM, Yin FZ, Liu BW, Lou DH, Liu XL. How to simplify the diagnostic criteria of hypertension in adolescents. J Hum Hypertens 2011;25:159-63.
7. Guo X, Zheng L, Li Y, Zhang X, Yu S, Sun Y. Blood pressure to height ratio: A novel method for detecting hypertension in paediatric age groups. Paediatr Child Health 2013;18:65-9.
8. Rabbia F, Rabbone I, Totaro S, Testa E, Covella M, Berra E, *et al.* Evaluation of blood pressure/height ratio as an index to simplify diagnostic criteria of hypertension in Caucasian adolescents. J Hum Hypertens 2011;25:623-4.
9. Kelishadi R, Heshmat R, Ardalan G, Qorbani M, Taslimi M, Poursafa P, *et al.* First report on simplified diagnostic criteria for pre-hypertension and hypertension in a national sample of adolescents from the Middle East and North Africa: The CASPIAN-III study. J Pediatr (Rio J) 2014;90:85-91.
10. Galescu O, George M, Basetty S, Predescu I, Mongia A, Ten S, *et al.* Blood pressure over height ratios: Simple and accurate method of detecting elevated blood pressure in children. Int J Pediatr 2012;2012:253497.
11. Lu Q, Ma C, Yin F, Wang R, Lou D, Liu X. Blood pressure-to-height ratio as a screening measure for identifying children with hypertension. Eur J Pediatr 2013;172:99-105.
12. Outdili Z, Marti-Soler H, Simonetti GD, Bovet P, Paccaud F, Burnier M, *et al.* Performance of blood pressure-to-height ratio at a single screening visit for the identification of hypertension in children. J Hum Hypertens 2014;32:1068-74.
13. Xi B, Zhang M, Zhang T, Liang Y, Li S, Steffen LM. Hypertension screening using blood pressure to height ratio. Pediatrics 2014;134:e106-11.
14. Ejike CE, Yin FZ. Blood pressure-to-height ratio simplifies the diagnosis of hypertension in Nigerian children. J Trop Pediatr 2013;59:160-1.
15. Ejike CE. Blood pressure to height ratios as simple, sensitive and specific diagnostic tools for adolescent (pre) hypertension in Nigeria. Ital J Pediatr 2011;37:30.
16. Ejike CE, Ugwu CE, Ezeanyika LU, Olayemi AT. Blood pressure patterns in relation to geographic area of residence: A cross-sectional study of adolescents in Kogi state, Nigeria. BMC Public Health 2008;8:411.
17. Ogedegbe G, Pickering T. Principles and techniques of blood pressure measurement. Cardiol Clin 2010;28:571-86.
18. Skirton H, Chamberlain W, Lawson C, Ryan H, Young E. A systematic review of variability and reliability of manual and automated blood pressure readings. J Clin Nurs 2011;20:602-14.
19. Williams JS, Brown SM, Conlin PR. Blood pressure measurement. N Engl J Med 2009;360:2034-5.
20. Centers for Disease Control and Prevention, National Center for Health Statistics. 2000 CDC Growth Charts; 2000. Available from: http://www.cdc.gov/growthcharts. [Last accessed on 2015 Sep 08].
21. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL Jr, *et al.* Seventh report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure. Hypertension 2003;42:1206-52.
22. Zhu W, Zeng N, Wang N. Sensitivity, Specificity, Accuracy, Associated Confidence Interval and ROC Analysis with Practical SAS Implementations. In Proceedings, North East SAS Users Group; 2010.
23. Totaro S, Rabbia F, Rabbone I, Covella M, Berra E, Fulcheri C, *et al.* Comparison among different screening tests for diagnosis of adolescent hypertension. ISRN Hypertens 2013;2013:1-3.
24. Assadi F. Childhood hypertension: A problem of epidemic proportion. Int J Prev Med 2014;5 Suppl 1:S1-3.
25. Flynn J. The changing face of pediatric hypertension in the era of the childhood obesity epidemic. Pediatr Nephrol 2013;28:1059-66.
26. Lee CG. The emerging epidemic of hypertension in Asian children and adolescents. Curr Hypertens Rep 2014;16:495.
27. Kumar J, Deshmukh PR, Garg BS. Prevalence and correlates of sustained hypertension in adolescents of rural Wardha, Central India. Indian J Pediatr 2012;79:1206-12.