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Blood pressure percentiles in a group of Nigerian school age children

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Abstract: *Background:* Determination of abnormal blood pressure (BP) in children is dependent on comparison with normal percentile values. The commonly used National Institute of Health (NIH) standard is generated from children outside of Africa.
Objective: To develop BP percentile values for Nigerian children based on BP cuff width 40% to 50% of arm circumference.
Methods: Subjects were pupils from nine primary schools in Mid-western Nigeria recruited using a multi-stage sampling technique. Their BP was measured using a cuff width of 40 to 50% of arm circumference and cuff length of at least 80% of arm circumference respectively. The mean of two BP readings were taken. Hypertension was defined as systolic and or diastolic BP >95th percentile of the study population.
Results: There were 1549 subjects, aged 5 to 15 years, of which 757 (48.9%) were males. Prevalence of hypertension was 2.6%. Only age and weight were independent predictors of both elevated systolic and diastolic BP. The 5th, 10th, 50th, 90th and 95th percentiles of Systolic and diastolic BP were generated for both males and females pupils.
Conclusion: BP Percentiles have been generated using BP cuff width 40 to 50% of the arm circumference for Nigerian children.

Keyword: Blood pressure; hypertension; childhood; percentile

Introduction

Childhood blood pressure (BP) is an important clinical parameter of the wellbeing of the child thus, it is important to routinely measure BP of children in clinical settings[1]. Childhood BP has been shown by several workers to be strongly correlated with weight, height, body mass index and other anthropometric indices[1-4]. Higher BP has also been demonstrated in male compared to female children in previous works[1-4]. This has largely been related to the weight of the boys being higher than that of the girls. Some workers have shown higher BP in urban children compared to the rural children as well as differences in blood pressure based on socioeconomic classes in adolescent girls[5,6].

It is important to measure BP in children and identify those with elevated BP because BP tracks from childhood to adulthood[7,8]. Children with elevated BP tend to continue to have high BP into adulthood. Thus identification of these individuals is important for follow up and management.

Hypertension in children according to the Fourth Taskforce on hypertension in children and adolescents[1] is defined as elevated systolic blood pressure (SBP) and or diastolic blood pressure (DBP) > 95th percentile for the age and sex. Childhood hypertension is mostly secondary to underlying conditions while a smaller proportion is reported to be primary or essential hypertension[9]. Childhood essential hypertension is on the rise globally[9], it is reported to be associated with family history of essential hypertension and childhood overweight/ obesity[10]. Decreased physical activity, increase in sedentary life style including watching television and the large consumption of the fattening fast food are found to be contributors to childhood hypertension[11].

The increasing recognition of these facts should persuade health care worker as to the need to routinely measure the BP of children as they present in clinical and other settings. It is also important to be able to interpret the measured BP. Interpretation of measured BP is usually based on comparison of the measured value with what is considered normal or standard values. The BP standards generated by NIH and the National High Blood Pressure Education Program (NHBPEP) [1,12] from data obtained from Caucasian, African American, latino and Asian children would seem ideal for most children globally and it is currently being used. However negroid children from Africa were not included in the data base. The African American children may not adequately represent the African children since they may be exposed to different stressors as their environments are different. In addition, the method of measuring BP from which the NIH BP standards were derived is flawed. Cuff specification that include bladder width that is 40 - 50% of mid arm circumference and bladder length that is 80 – 100% of the mid arm circumference will produce a more accurate measurement of BP than the previous specification that included the cuff width of 2/3 or 3/4 of the arm's length, the specification with which the NIH standards were derived[10]. The cuff specification has been corrected by the steering committee of America Heart association (AHA) in recommending cuff size that included bladder width and length that is 40 - 50% and 80 – 100% respectively of mid arm circumference for children, in 1988[13]. This specification was also recommended by the 1996 update of the Task Force on Blood Pressure Control in Children[14] and the NHBPEP [12]. Previous Nigerian studies on childhood hypertension have relied on the NIH standards which are now considered flawed. This indicates the need for appropriate standards.

In this study, we set out to determine the BP pattern of a population of Nigerian primary school pupils aged 5 – 15 years and derive BP percentiles based on the new cuff specification.

Subjects and Methods

This cross sectional study was conducted in Egor Local Government Area (LGA), of Edo state of Nigeria as part of a larger study to evaluate cardiovascular risks in children. The LGA has an estimated total population of 339,899 of which 119,038 are aged less than 15 years[15]. It is predominantly urban with ten political wards of which two are rural. This study was conducted over a six months period (September 2011 to February 2012). This period included the times the schools were in session. Ethical approval for this study was obtained from the Ethics Committee of the University of Benin Teaching Hospital, Benin City.

Sampling technique

One thousand, five hundred and forty nine pupils were selected using a multi stage sampling technique. Of the 10 political wards, 30% (3) of the wards were randomly selected from a list of the political wards as the first stage of the sampling process[16]. There were 8 public and 19 private schools in the three selected wards from which 30% each of private and public schools were selected from a list of alphabetically arranged schools. Thus, three public and six private schools were selected using a systematic sampling technique after randomly selecting the first school (second stage). The school sample size was determined as the ratio of the product of index school population and study sample size (1549) over the pooled population of the nine selected schools. The school sample size was thus determined in proportion to school population. A systematic sampling method was employed to select pupils from each school.

Evaluation of selected pupils

An informed written consent was obtained from the parents of each selected pupil. Any child whose parent declined to give consent was replaced by the next pupil on the sampling list selected using the sampling interval and whose parent gave consent. A socioeconomic class was ascribed to each selected pupil using the method described by Olusanya et al[17]. The selected pupil then had a thorough general and systemic examination with emphasis on the cardiovascular system. The weight was measured with the shoes, wrist watches, belts and other thick clothing taken off and the subject was in his or her school uniform only. The Omron body composition monitor (BF511Netherlands) was employed to measure the weight. The pupils were instructed to stand erect and looking straight ahead on the weighing machine. The weight once captured was displayed on the machine. The weight was read to the nearest 0.1 kg. The height was taken with the aid of a stadiometer with the pupils' shoes and stockings off, the pupils were instructed to stand against the stadiometer with the heels, buttocks and occiput resting against the stadiometer. The chin was raised so that the subject was looking ahead with the upper border of the ear canal in the same horizontal plane as the lower border of their eye socket (Frankfurt plane). The height was read to the nearest 0.1 cm. The Body Mass Index (BMI) for age was then computed for the pupils as the ratio of the weight in kg/ square of the height in metres (m^2).

The blood pressure was measured in the right upper arm, except where there was an injury to the arm (one pupil). The pupils were made to sit down and relax for about 3 minutes before the BP was measured.[1] An appropriate sized cuff, with bladder width of about 40 - 50% of the arm circumference and the bladder length of at least 80% of the arm circumference was utilised[1]. The cuff was smugly applied to the right upper arm and the cuff inflated to about 10 mmHg above the systolic BP by palpation. The bell of the stethoscope was then applied over the brachial artery as the cuff was slowly deflated at a rate of 2mm per second[1]. The first Korotkov sound was taken as the systolic BP while the fifth Korotkov sound represented the diastolic BP. Two BP readings were taken three minutes apart and the average was taken as the patient's BP. Hypertension was defined as elevated SBP or DBP >95th percentile for the age and sex of the percentiles derived in this study.

Statistical analysis

The data was entered into SPSS version 16 (Chicago IL) spread sheet and analysis done with the same tool. The prevalence of elevated blood pressure was presented in percentage. Differences in means of systolic and diastolic blood pressures were compared using student's t test. More than two means were compared using one-way ANOVA with Turkey-Kramer post hoc test when significant. Correlation between two continuous variables was tested using Pearson's correlation test. Multiple logistic models were made for predictors of elevated systolic and diastolic BP. Level of significance was set at $p = <0.05$.

Results

Characteristics of the study population

There were 1549 primary school pupils who were recruited for the study. They consisted of 757(48.9%) males and 792 (51.1%) females. The age range was 5 to15 years with a mean age of 8.8 ± 2.2 years. The mean age of the female pupils 8.8 ± 2.2 years was not significantly lower than the male pupils 9.1 ± 2.2 years, p =0.092. There were 850(54.9%) and 699(45.1%) pupils from the public and private schools respectively. 1510 pupils had information to compute their SEC. Of the 1510 pupils, most 740(49%) were in the low SEC. The characteristics of the study population are shown in table 1.

Table 1: The characteristics of the study population

Characteristics	Number	Percentage
Gender		
Male	757	48.9
Female	792	51.1
Type of school		
Public	850	54.9
Private	699	45.1
Socioeconomic class		
High	491	32.5
Middle	279	18.5
Low	740	49.0

The height percentiles of the study population

Table 2 shows the male and female 5^{th}, 10^{th}, 25^{th}, 50^{th}, 75^{th}, 90^{th}, and 95^{th} height percentiles of the study population.

Table 2: The mean weight of the pupils by age and gender

Age (year)	FEMALE Weight (Kg)	MALE Weight (Kg)	P values	FEMALE Height (cm)	MALE Height (cm)	P value
5	20.1 ± 2.3	19.9 ± 3.0	0.71	116.2 4.0	115.7 4.9	0.91
6	22.1 ± 5.2	22.0 ± 4.3	0.94	120.7 6.2	119.7 6.9	0.30
7	24.1 ± 5.2	25.4 ± 6.4	0.16	124.6 7.9	126.7 6.9	0.052
8	25.4 ± 4.7	27.3 ± 6.7	0.002	127.2 12.7	129.6 8.0	0.08
9	30.4 ± 8.4	29.1 ± 6.1	0.15	131.2 8.4	131.3 8.7	0.92
10	31.8 ± 7.3	30.6 ± 7.9	0.23	134.1 8.4	132.1 8.5	0.07
11	34.1 ± 8.3	31.0 ± 5.3	0.01	136.7 7.8	133.6 7.1	0.01
12	36.5 ± 6.3	32.3 ± 5.6	0.001	139.7 9.6	136.6 7.7	0.04
13	41.7 ± 7.8	36.0 ± 6.6	0.003	146.4 7.8	142.2 9.8	0.06
14	42.3 ± 4.7	36.6 ± 2.2	0.006	147.8 6.0	142.9 5.6	0.10
15	49.9 ± 1.1	41.6 ± 8.5	0.04	150.5 5.2	149.8 11.5	0.89

Blood pressure of the study population

Table 3 shows the mean systolic blood pressure (MSBP) and mean diastolic blood pressure (MDBP) by gender of the pupils and by age. The MSBP of the male pupils rose with age from 92.1 ± 6.1 mmHg for the 5 year old to 113.1 ± 7.4 mmHg for the 15 year old. The difference in MSBP of the youngest and the oldest was statistically significant, $p = <0.0001$. Similarly, the MSBP of the females rose with age from 91.5 ± 11.2 mmHg in the five year olds to 119.0 ± 10.2 mmHg in the 15 year olds. The difference in MSBP between the youngest and oldest was significant, $p = <0.0001$. The Mean diastolic blood pressure (MDBP) of the males rose with age from 59.0 ± 9.2 mmHg at 5 year to 73.9 ± 10.4 mmHg in the 15 year old. The difference in MDBP of the youngest and oldest was significant, $P = 0.0001$. The females similarly showed a rise in MDBP with age, the difference was significant, $P = 0.001$.

There were 41pupils with elevated SBP and / DBP values >95^{th} percentile for age and sex. The prevalence of hypertension was thus 2.6%. Of the 41 pupils, 20 (48.78%) were female and 21(51.22%) males. The prevalence of hypertension among the male and female pupils were 20/792(2.5%) and 21/757(2.7%)

Table 3: The gender 5^{th}, 10^{th}, 25^{th}, 50^{th}, 75^{th}, 90^{th} and 95^{th} height percentiles of the study population

Age	Male Percentiles (in cm)							Female Percentile (in cm)						
(yr)	5^{th}	10^{th}	25^{th}	50^{th}	75^{th}	90^{th}	95^{th}	5^{th}	10^{th}	25^{th}	50^{th}	75^{th}	90^{th}	95^{th}
5	109	110	111	115	119	125	127	110	111	114	116	118	121	126
6	107	112	116	120	123	128	130	110	112	115	120	125	128	130
7	113	115	120	126	130	134	136	113	116	119	123	128	133	138
8	116	119	122	127	135	141	143	116	118	122	127	133	138	140
9	118	120	125	130	137	142	144	118	121	124	130	136	143	144
10	118	120	127	133	139	142	145	120	124	128	134	139	144	149
11	121	125	130	134	140	144	146	124	126	131	136	142	147	151
12	124	127	131	136	143	147	149	126	128	133	137	147	152	157
13	125	128	134	141	146	151	153	133	137	140	143	152	157	159
14	135	136	136	143	147	152	157	137	140	143	146	153	161	163
15	132	133	139	151	152	155	159	140	142	145	149	154	164	167

yr = years; cm = centimeters

The 5^{th}, 10^{th}, 50^{th}, 90^{th} and 95^{th} percentiles of the SBP and DBP of the pupils according to age and gender are shown in figures 1, 2, 3 and 4. The age, weight, height, BMI were positively correlated with the SBP $r = 0.32$; $P = 0.0001$, $r = 0.4$; $P = 0.0001$, $r = 0.36$; $P = 0.0001$ and $r = 0.3$; $P = 0.0001$ respectively. Multiple linear regressions models showed that only age and weight were independent predictors of elevated SBP; $P = 0.0001$ and 0.013 respectively. (Table 4) Similarly only age and weight were independent predictors of elevated DBP; $P = 0.01$ and 0.006 respectively. (Table 5) The age, weight, height and BMI were positively correlated with DBP $r = 0.29$; $P = 0.002$, $r = 0.36$; $P = 0.0001$, $r = 0.030$ and $P = 0.0001$, $r = 0.26$; $P = 0.0001$ respectively.

Table 4: Multiple linear regression model showing independent predictors of elevated systolic blood pressure

Variable	Beta	Std Error	t value	P value	Confidence Interval
Constant	65.15	9.2	7.09	0.0001	47.10 – 83.20
Age	0.59	0.16	3.68	0.0001	0.27 – 0.9
Weight	0.39	0.16	2.74	0.013	0.08 – 0.70
Height	0.09	0.071	1.22	0.22	-0.05 – 0.23
BMI	0.18	0.30	0.63	0.53	-0.39 – 0.76

Table 5: Multiple linear regression model showing independent predictors of elevated diastolic blood pressure

Variable	Beta	Std Error	t	P value	Confidence Interval
Constant	46.7	7.61	6.14	0.0001	31.78 - 61.64
Age	0.45	0.13	3.40	0.01	0.19 – 0.71
Weight	0.36	0.13	2.74	0.006	0.10 – 0.62
Height	0.012	0.06	0.20	0.84	-0.10 – 0.13
BMI	-0.91	0.24	-0.38	0.71	-0.57 – 0.39

Fig 1: The 5th, 10th, 50th, 90th and 95th percentiles of the male systolic blood pressure

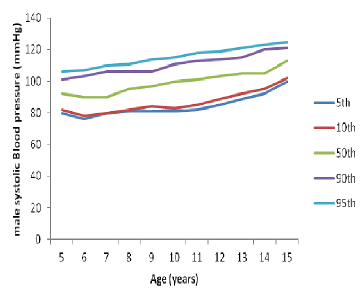


Fig 2: The 5th, 10th, 50th, 90th and 95th percentiles of the female systolic blood pressure

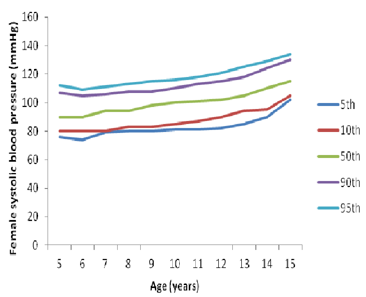


Fig 3: The 5th, 10th, 50th, 90th and 95th percentiles of the male diastolic blood pressure

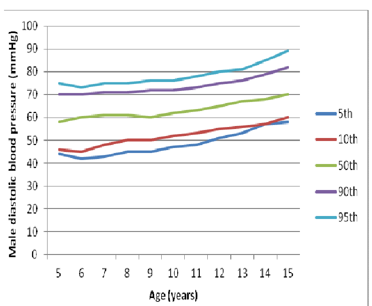
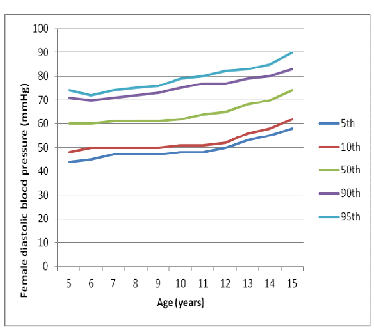


Fig 4: The 5th, 10th, 50th, 90th and 95th percentiles of the female diastolic blood pressure



Discussion

The BP percentile generated in this study was from BP values obtained as the means of at least two BP readings using an appropriate cuff based on the circumference of the arm rather than the length of the arm as recommended by the working Group, NHBPEP[1].

The percentile values generated in this study were based on only the age of the child which makes it easy to use in a busy paediatric clinic. The NIH percentiles which is based on age and the height percentiles of the children is rather difficult to use, besides in the San Anthonio blood pressure study, it was shown that the contribution of height to BP is negligible when weight and age are controlled for. Thus the rationale for the inclusion of height percentiles to childhood BP measurement was queried[18]. The current NIH BP standard that is in use is limited in that some of the data used were single BP readings, obtained by using cuff measurement based on the length of the arm (two thirds or three quarters) which are considered incorrect by American Heart Academy and the working group NHBPEP[1]. This study thus provides normative BP percentiles using currently agreed methods by NHBPEP[1], the AHA[13] and 1996 update of Task Force on Blood Pressure Control in Children[14] for Nigerian children age 5 to 15 years. In the absence of BP standards using currently agreed methods for BP determination internationally and the non-representation of African children living in Africa, the normative BP percentiles derived in this study would be suitable for use in Nigerian children. Although there is another Nigerian study that used at least 40% of cuff width; the study was on adolescents aged 10 to 18 years and BP percentiles were not generated[6].

The prevalence of hypertension in this study is similar to an earlier Nigerian study on adolescents aged 10 – 18 years in Calabar[6] but lower than some other previous studies in Nigeria[19,20]. The higher values obtained in the previous studies may reflect the differences in the environment stressors, weight and parameters affecting BP. The influence of environment on the casual BP of children was demonstrated in a study by Hamidu et al[21], in Kaduna State, Nigeria where the place of residence significantly influenced the BP of the children from three different communities[3]. The prevalence of hypertension in this study and most other Nigerian studies is higher than the 1-2% quoted among Caucasian children[22]. This suggests that the prevalence of childhood hypertension in Nigeria is higher than that reported amongst Caucasians. It is not clear why this is so. It may be related to differences in environmental stressors, or genetics.

However, childhood essential hypertension is reported to be on the rise globally and besides the possibility of inheriting essential hypertension from their affected parents, another important associated factor is obesity and overweight whose prevalence is also on the rise[1,23]. Overweight/ obesity are caused by the sedentary lifestyle that includes television watching, video gaming and less physical exercise. This is further compounded by increased consumption of fast food[24]. Studies have demonstrated similar lifestyle among Nigerian children who are overweight and obese[9].

It is important to initiate programmes to stop this trend in Nigeria as this lifestyle among children portends a potential for higher prevalence of hypertension and other cardiovascular and metabolic abnormalities if the trend is not checked. Lessons can be learned from the United States experience in which a study done in 1994 by Arar et al[25], found that 23% of the hypertensive children had essential hypertension. By 2001 in another study by Flynn et al[26] the proportion of children with essential hypertension was 48.6%. This rising trend of the burden of childhood essential hypertension is being attributed to the rising prevalence of overweight and obesity[10,11].

The MSBP and MDBP of the male pupils were lower than that for the females for most ages; this is at variance with previous studies that showed a higher BP for the male compared to the females until adolescence when the females now had higher BP[2-6]. The lower male BP in our study may be due to the similarly higher mean weight for the female than the males for most ages, showing the pivotal role that weight plays in the prediction of BP as also has been demonstrated by previous studies[2-6]. The height did not show similar strength of association also indicating the less important role height plays in prediction of BP[11]. This fact is further buttressed by the finding of weight and age as the only independent predictors of BP in this study.

It is not clear why the older males were lighter than the females in this study. Perhaps because females are encouraged to stay at home and engage in indoor activities like cooking while the males engage in more physical activities like playing football and other outdoor games. The 90[th] and 95[th] percentiles for blood pressure in the males aged ten years and older was lower than those of the females, this is also due to the fact that the females were heavier than the males in this study.

Conclusion

In conclusion, BP percentiles were derived for Nigerian children using cuff sizes based on the arm circumference in this study. The older females tend to have higher BP values compared to the males, a reversal of previous trend involving younger age group. These percentiles will be appropriate for use in Nigerian children pending the development of a National BP standard for children derived using recently agreed cuff specification and from the different zones of the country and pending when the BP values of African children resident in Africa are included in a new global BP standard like that of the NIH. Furthermore, there is a need to initiate a programme to address weight reduction in school children, especially the older girls who are heavier than their male colleagues.

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References

1. 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 on children and adolescents. *Pediatrics 2004; 114: 555 – 76*
2. Balogun JA, Obajuluwa VA, Abereoje OK, Olaogun MO, Oyeyemi AY, Balogun MO, Adeodu OO. Anthropometric determinants of resting blood pressure and heart rate of Nigerian school children. *Ann Trop Paediatr 1990; 10: 425 – 431*
3. Hamidu LI, Okoro EO, Ali MA. Blood pressure profile in Nigerian children. *East Afri Med J 2000; 77: 180 – 4*
4. Adams-Campbell LL, Ukoli F, Young MP, Omene J, Nwankwo M, Haile GT, Kuller LH. An epidemiological assessment of blood pressure determinants in an adolescent population of Nigerians *J Hypertens 1987; 5: 575 - 80*
5. Balogun JA, Obajuluwa VA, Olaogun MO, Abereoje OK, Oyeyemi AY, Adeodu OO, Balogun MO. Influence of parental socioeconomic status on casual blood pressure Nigerian school children. *Intl J Cardiol 1990; 29: 63 – 9*
6. Ansa VO, Anah MU, Ody FA, Mbu PN, Agbor EI. Relationship between parental socioeconomic status and casual blood pressure in coastal Nigerian adolescents. *West Afr J Med 2010; 29: 149 – 52*
7. Adams-Campbell LL, Ukoli FA, Silverman JA, Omene JA, Nwankwo MU, Kuller LH. Tracking of blood pressure and anthropometric measures in Nigerian children. *J Hum Hypertens 1992; 6: 47 – 51*
8. Bao W, Threefoot SA, Srinivasan SR, Berenson GS. Essential hypertension predicted by tracking of elevated blood pressure from childhood to adulthood: *the Bogalosa Heart Study. Am J Hypertens 1995; 8: 657 - 65*
9. Moel DI. Hypertension In. Essential Pediatric cardiology. Eds: Koenig P, Hijazi ZM, Zimmerman F. The McGraw-Hill companies, *Inc. 2004; 67 – 76*
10. Park MK. Physical examination. In. Pediatric cardiology for practitioners. *Mosby Elsevier. 2008; 17 – 23*
11. Omuemu VO, Omuemu CE. The prevalence of overweight and its risk factors among adolescents in an urban city in Edo State. *Nig J Clin Pract 2010; 13: 128 – 33*
12. Task force on blood pressure control in children: Report of the second task force on blood pressure control in children. *Pediatrics 1987; 79: 1 - 25*
13. Frolich ED, Labarth DR, Maxwell MH et al. Recommendations for human blood pressure determination by sphygmomanometers: Report of a special task force appointed by the steering committee, America Heart Association. *Circulation 1988: 77: 501A – 514A*

14. National High Blood Pressure Education Working Group on Hypertension Control in Children and Adolescents: Update on the 1987 Task Force on high blood pressure in children: a working group report from the National High Blood Pressure Education Program. *Pediatrics 1996; 98: 649 - 658*
15. Federal Republic of Nigeria. 2006 population and housing census of Nigeria. *Federal Republic of Nigeria official gazette, Lagos 2007; 94.*
16. Lwanga SK, Lemshow S. Sample size determination in health studies. Wld Hlth org. 1991; Pg 12
17. Olusanya O, Okpere E, Ezimokhai M. the importance of socio-economic class in voluntary infertility control in a developing country. *West Afr J Med 1985; 4: 205 – 221*
18. Menard SW, Park MK, Yuan CH. The San Antonio biethnic blood pressure study: auscultatory findings. *J Pediatr Health Care 1999; 13: 237 - 44*
19. Olaitan OO. Evidence of elevated blood pressure among secondary school students. *Health fitness J International. 2001; 2: 14 -9*
20. Obika LF, Adedoyin MA, Olowoeye JO. Pattern of Paediatric blood pressure in rural, semi-urban and urban communities in Ilorin, Nigeria. *Afr J Med Med Sci 1995; 24: 371 – 4*
21. Hamidu LJ, Okoro EO, Ali MA. Blood pressure profile in Nigerian children. *East Afr Med J 2000; 77: 180 – 4*
22. Moel DI. Hypertension. In. Essential pediatric cardiology. Koenig P, Higazi ZM, Zimmerman F. Eds. McGraw-Hills publishers. New York. 2004; p 67 - 76
23. Braunschweig CL, Gomez S, Liang H, Tomey K, Doerfler B, Wang Y et al. Obesity and risk factor for the metabolic syndrome among low income urban African American school children: the rule rather than the exception? *Am J Clin Nutr 2005; 81: 970 – 5*
24. Amstrong MEG, Lambert MI, Sharwood KA, Lambert EV. Obesity and overweight in South African primary school children the health of the nation study. *S Afr Med J 1996; 486 - 494*
25. Arar MY, Hogg RJ, Arant BS, Seikaly MG. Etiology of sustained hypertension in children in the south-western United States. *Pediatr Nephrol 1994; 8: 189 – 9*
26. Flynn JT. Characteristics of children with primary hypertension referred to a tertiary centre. *Am J Hypertens 2001; 239A*