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High Blood Pressure amongst Adolescents in Lagos, South West Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Author IA conceptualized, designed and wrote the manuscript. Author IA did data collection and checking the data. Authors IA, JE, JCO and IFO participated in interpretation and manuscript writing. All the authors have read and agreed to the final manuscript.

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ABSTRACT

Adolescent high blood pressure (HBP), now a growing significant health problem with lasting consequences on cardiovascular health, was considered rare at a time. Several end-organ complications could occur if this asymptomatic condition is uncontrolled, and tracks into adulthood. The 2004 Fourth Report was developed to address the cumbersome challenges in the detection of adolescent hypertension.
Aims: This study sought to determine high blood pressure prevalence amongst adolescents in Mushin Local Government Area (LGA) using the 2004 Fourth report.

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Study Design: Cross-sectional study.
Place and Duration of Study: Fourteen secondary schools, in Mushin Local Government Area (LGA) between August 2020 and December 2020.
Methodology: A two-stage sampling method was utilized in selecting 14 secondary schools. Within selected schools; participants were recruited from each class by proportional allocation using the school's register. Students were stratified as males and females using the class register. Subjects were selected from each stratum by simple random sampling method. We included 1490, (744 male, 746 female), 10-19 years old students. A structured proforma was used to obtain socio-demographic information and relevant clinical data. The blood pressure measurements were taken according to standard protocol (elevated blood pressure is systolic and/or diastolic pressure ≥ 90th but ≤ 95th percentile for age, gender and height). Descriptive data was used to describe socio-demographic and anthropometric characteristics. Frequency, percentages, mean and standard deviation were used to summarize categorical and numerical variables. P-values of 0.5 was termed significant
Results: Among the 1490 subjects, 49.9% (744) were male and 50.1% (746) females (male: female ratio was 1: 1). Prevalence, of high blood pressure, elevated pressure and hypertension were 14.5% (number =216), 6.1% (number =92), and 8.4% (number =124). The prevalence of high blood pressure rose progressively with the age group in the early and mid adolescent age group, while the prevalence was lowest in the oldest age group.
Conclusions: Adolescent hypertension, elevated blood pressure, high blood pressure, prevalence, was high. Development of cardiovascular complications could be obviated by early detection, life style modification and treatment.

Keywords: Adolescent hypertension; high blood pressure; prevalence; pattern; 2004 fourth report.

1. INTRODUCTION

"Hypertension has been defined by levels of blood pressure (BP) above which lowering BP will reduce the cardiovascular risk associated with elevated BP and this level has been classically documented as 140/90 mmHg in adults" [1]. "High blood pressure, which begins in childhood or adolescents is associated with lifelong detrimental cardiac consequences" [2]. "HBP if left uncontrolled, could lead to development of complications such as left ventricular hypertrophy, myocardial infarction, cerebrovascular accident, and renal insufficiency" [3]. Based on this background information, it is worrisome to note that the prevalence of high blood pressure among adolescents has been increasing steadily in recent years, and this trend is attributed to the increasing prevalence of global childhood obesity [4], a potent risk factor for HBP.

"Risk factors for high blood pressure in adolescents include age, gender, obesity, physical inactivity, family history of hypertension in first degree relatives, socioeconomic status, cigarette smoking and alcohol intake" [5]. "Other risk factors include, birth weight, maturity during birth, heredity, and diet renal abnormalities, coarctation of the aorta, medications, neoplasm, etc" [6]. It is crucial to highlight the observation which examined only adolescents tended to reveal a higher prevalence of HBP, as compared with studies that included both children and adolescents. The growing prevalence of HBP amongst adolescents' calls for understanding of the condition, to ensure early detection and management, therefore regular assessment of adolescents with risk of HBP needs to be prioritized.

The assessment and detection of HBP is complex and fraught with many challenges and inconsistency [7], knowing that BP amongst adolescents is subject to several variables such as age, height, and gender which have to be accounted for when effort is made at describing "normal" and "abnormal" BP. However, the introduction of evidence based practice (which serves to help physicians in identifying symptoms and signs while making the best clinical decisions based on the most recent available evidence); led to the development of the 2004 Fourth report which aided HBP detection and treatment. The 2004 Fourth Report [8] included normative data and the adaptation of this data to the childhood growth charts from Center for Disease Control and Prevention for the year 2000. This 2004 Fourth report would therefore make evaluation, detection and treatment of HBP easier. Appraisal of persons with raised blood pressure, at risk for hypertension would assist

early detection, timely intervention (lifestyle modifications, weight reduction, exercise, dietary changes, drugs) and prevention of problems linked with hypertension. The need for targeted screening and interventions, particularly among adolescents is heightened when variable prevalence rates and risk factors are taken into consideration.

According to the World Health Organization, about 1.13 billion person are living with hypertension, and two-thirds of this number reside in low to middle income countries [9]. Song [10], attempted to collate figures for a worldwide prevalence of high blood pressure among children and adolescents and noted that the pooled prevalence of hypertension among children and adolescents was 4% and that of pre-hypertension 9.67%. A prevalence of hypertension of 13.7%, was reported in the Northeast of Brazil [11] which falls within the same range as what was found in Turkey (15.1%) [12]. Daniel [13], in India, reported a prevalence ranging between 2 to 20.5% among adolescents aged 10-19 years. Studies carried out in the Ashanti region of Ghana reported a prevalence of high blood pressure of 39.2%, and 28.3% as estimated by Amponsem-Boateng [14], and Gyamfi [15], respectively. A study conducted by Ezeudu [16], in South-Eastern Nigeria, recorded a prevalence of 11.3%. These studies from different continents of the world show varying results due to several factors including the heterogeneity in the conduction of analysis, larger sample sizes however, one factor remains constant; genetic and environmental factors have a crucial role to play in the incidence of high blood pressure amongst adolescents, hence statistics on this varies widely from region to region across the world. This increased prevalence is attributable to many factors, some of which include the differences in methods of estimating blood pressure as well as the rising trend of uncontrolled obesity coupled with fragile health systems, poor access to healthcare and harsh environmental conditions in these resource poor countries, exposing the children to higher risks of developing HBP.

Considering the risks, these adolescents face in a resource poor environment and the attendant risk of development of complications for undetected/untreated HBP, consequently, there is a necessity to carry out a cross-sectional study that would assess the existing burden of high blood pressure in the complete adolescent age range. This study therefore, sought to determine the prevalence and pattern of high blood pressure amongst adolescents in Mushin, Local Government Area using the 2004 Fourth report. It was hoped that findings from this study will provide accurate information on the current burden of high blood pressure amongst adolescents in Mushin; while providing useful material for health advocates and policy makers to commence/strengthen programme/call for screening of adolescents' high blood pressure.

2. MATERIALS AND METHODS

2.1 Study Design and Setting

A descriptive cross-sectional study, conducted in Mushin, Local Government Area of Lagos State South-western part of Nigeria from August 2020 through December 2020. It was conducted in 14 (12 private and 2 public) secondary schools in Mushin, which has one educational district; Educational District VI located in the Oshodi area of Lagos State. Study population was adolescents aged 10 to 19 years.

2.2 Inclusion and Exclusion Criteria

Subjects were consecutively enrolled following, consent from parents/ guardians and or from among eligible adolescents (aged 18 years and above) who gave assent to be enrolled in the study. Adolescents with renal conditions such as acute glomerulonephritis, reno-vascular and renal parenchymal diseases; and or those who were on antihypertensive medications were excluded.

2.3 Sampling Procedure

The sample size was determined using prevalence studies formula [8].

n = *Z2P/Qd2*

Where: n = minimum sample size when study, population is > 10,000;
z = Standard normal deviation corresponding to 95% confidence interval = 1.96;
p = prevalence rate of high blood pressure in adolescents from a previous study done in Lagos, Nigeria.

i.e. 16.5% (0.17) [17].
q = (1 - p) i.e. 0.83; d = precision level.

For this study, this was set at 2% (0.02) Substituting these figures into the formula:

n = 1.962 × 0.17 × 0.830.022 = 1355

The minimum sample size was 1355. An additional 10% (135 pupils) was added for non response. This brought the total calculated sample size for the study to 1490. Thus 1,490 adolescents were recruited into the study.

2.4 Data Collection

"Within selected schools, participants were recruited from each class determined by proportional allocation using the school´s register; and stratified along gender lines. Subjects were selected from each stratum by simple random sampling. Socio-demographic information and relevant clinical data were obtained using a structured questionnaire. Questions were asked to exclude symptoms of renal disease and history of hypertension in the participants. The anthropometry and blood pressure measurements were taken according to standard protocol. Anthropometry and blood pressure measurements were taken according to standard protocol. Body mass index Z score was determined using the WHO chart for children 5-19years" [18].The weight was measured to the nearest 0.1kg with minimal clothing using a standardized weighing scale (SECA model 756). Height was measured with the participant standing straight on bare feet, with both heels placed together, buttocks, shoulder blades and head without headgear in Frankfurt plan [19] in contact with the measuring rule, and readings recorded to the nearest 0.5cm using a stadiometer (SECA model 213). The blood pressure was measured after the subject must have rested in a seated position for 5 minutes legs uncrossed and flat on the floor; using Accoson's sphygmomanometer. The measurement was done as recommended in the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC-7) [20] with subjects sitting quietly and the right arm on a table at the level of the heart.

"An appropriately sized cuff was snuggly wrapped on the right upper arm after restricting clothing had been removed. The cuff was then inflated to a pressure of 30 mmHg above the level at which the radial pulse was no longer palpable. The stethoscope was placed over the brachial artery in the cubital fossa and the cuff pressure was deflated at 2 mmHg per second. The first audible sound (first Korotkoff sound) was recorded as the systolic blood pressure (SBP). The pressure in the cuff was further lowered until the sounds disappear completely. This was the fifth Korotkoff sound, and the corresponding pressure recorded as the diastolic blood pressure (DBP). Blood pressure was measured three times at an interval of 2 minutes and the mean recorded". The MSD manual calculator was the tool used in calculating the blood pressure percentiles based on the 2004 Fourth Report [21]. Social class was determined using the socioeconomic indices of parents as described by Oyedeji [22]. All children who were identified to have high blood pressure, were counseled on lifestyle modification, behavioral changes and referred to specialist clinics for further evaluation and follow up by Paediatrics cardiologist.

Normal blood pressure (NBP) was defined as systolic and diastolic blood pressure that is less than 90th percentile for gender, age and height [8]. Normal blood pressure is systolic and/or diastolic blood pressure less than the 90th percentile for age, gender and height of an individual [8].

"Pre-hypertension is defined as systolic blood pressure or diastolic blood pressure that is greater than or equal to the 90th percentile, but less than the 95th percentile for age, gender and height of an individual. OR systolic and/or diastolic blood pressure more than or equal to 120/80 mmHg but less than the 90th percentile" [8].

Stage 1 hypertension is systolic and/or diastolic blood pressure equal to or greater than the 95th percentile but less than the 99th percentile plus 5 mmHg for age, gender and height of an individual [8].

Stage 2 hypertension is systolic and/or diastolic blood pressure equal to or greater than the 99th percentile plus 5 mmHg for age, gender and height of an individual [8].Normal weight was BMI- for age between the 5th and 85th percentile.

Overweight was BMI-for-age between 85th and 95th percentile. Obesity was BMI-for-age above 95th percentile [23].

2.5 Data Analysis

The data was analyzed using Statistical Package for Social Science (SPSS) version 23, Armonk, NY: IBM Corp. Descriptive analysis was utilized to summarize the socio-demographic variables

using standard deviation and mean for quantitative variables. The prevalence of HBP, elevated BP, and HTN were summarized using frequency and percentages. Alpha wasset at 5%, with p-value of lessthan 0.05 regarded as statistically significant.

3. RESULTS AND DISCUSSION

Characteristics of Participants:

Of the initial 1500 adolescents invited into the study, complete responses were obtained from 1490, giving a response rate of 99.3%. There was about equal representation of boys and girls; mean age, of the participants was 14.39 ± 2.79 years. The highest proportion of participants (649: 43.6%) belonged to the upper socio-economic class. Majority, of the participants (83.5%), had normal nutritional status assessed by Body Mass Index, while 88 (5.9%) were thin. There were 132 (8.9%) overweight and 25 (1.7%) obese participants (Table 1).

Prevalence of High Blood Pressure among Participants Based on the 2004 Fourth Report:

The overall prevalence of high blood pressure was 14.5% (n = 216), while 1274 (85.5%) had normal blood pressure.

Pattern, of High Blood Pressure among Participants Based on 2004 Fourth Report:

Table 2 shows the pattern of high blood pressure using the 2004 Fourth Report. The prevalence rate of prehypertension, was 6.1% while the prevalence rate of stage 1 hypertension was 4.8% and the prevalence rate of stage 2 hypertension was 3.6%. With respect to the 216 participants that had high blood pressure, 42.6% had prehypertension, 32.9% stage 1 hypertension and 24.5% stage 2 hypertension. The mean systolic blood pressure and diastolic blood pressures increased steadily across the various blood pressure categories.

Blood Pressure Pattern According to the Age Group, Using the 2004 Fourth Report:

High blood pressure prevalence increased progressively from early adolescent to mid adolescent but dropped in the late adolescents' age group (17 to 19 years) as shown in Table 3.

Higher prevalence affected prehypertension and stage 1 hypertension, but not stage 2 hypertension, in the mid and late adolescents age group, while in the early adolescents the higher prevalence was noted in the stage 1 and stage 2 hypertension.

Table 1. Socio-demographic and BMI Status of participants

Variable	Frequency (n = 1490)	Percentage
Age (years)		
10 – 13 (early adolescence)	590	39.6
14 – 16 (middle adolescence)	504	33.8
17 – 19 (late adolescence)	396	26.6
Mean, age ± SD	14.39 ± 2.79	
Gender		
Male	744	49.9
Female	746	50.1
Socio-economic class		
Upper Class (I and II)	649	43.6
Middle Class (III)	545	36.6
Lower Class (IV and V)	296	19.8
Body Mass Index (BMI Z scores**)**		
Thin (< – 2 SD)	88	5.9
Normal (≥ – 2 SD – ≤ + 1 SD)	1245	83.5
Overweight (> + 1 SD – ≤ + 2 SD)	132	8.9
Obese (> + 2 SD)	25	1.7

Body Mass Index: BMI, Standard Deviation: SD

Table 2. Pattern of high blood pressure among participants based on the 2004 Fourth Report

Variable	Frequency	Percentage of study population	Percentage of high blood pressure	SBP(Mean±SD)	DBP(Mean±SD)
Prehypertension	92	6.1	42.6	127.95±4.34	75.82±7.47
Stage 1 HTN	71	4.8	32.9	133.21±3.22	81.03±7.48
Stage 2 HTN	53	3.6	24.5	140.58±8.89	94.00 ± 4.65
High BP	216	14.5	100	132.78±7.45	81.99±7.08

Systolic Blood Pressure: SBP, Diastolic Blood Pressure: DBP, Hypertension: HTN, Standard Deviation: SD, Confidence Interval: CI.

Table 3. Participants blood pressure pattern, according to age group using 2004 Fourth Report

		2004 4th Report
Age Group	**Blood Pressure**	N (%)
10 – 13	Normal BP	504 (85.4)
(n=590)	High BP	86 (14.6)
	High BP	
	Pre HTN	27 (4.6)
	Stage 1 HTN	30 (5.1)
	Stage 2 HTN	29 (4.9)
14 – 16		
(n=504)	Normal BP	425 (84.3)
	High BP	79 (15.7)
	High BP	
	Pre HTN	38 (7.5)
	Stage 1 HTN	27 (5.4)
	Stage 2 HTN	14 (2.8)
17 – 19		
(n=396)	Normal BP	345 (87.1)
	High BP	51 (12.9)
	High BP	
	Pre HTN	27 (6.8)
	Stage 1 HTN	14 (3.5)
	Stage 2 HTN	10 (2.5)

All p values calculated using Mcnemar Bowker's test of symmetry. ***** *Significant*
BP: Blood Pressure HTN: Hypertension

Table 4. Mean systolic and diastolic blood pressure by socio-demographic and BMI class of subjects

Variables	Frequency	SBP	DBP
	n	Mean ± SD	Mean ± SD
Body Mass Index			
Thin (<– 2 SD)	88	106.95±14.93	63.61±10.28
Normal (≥ – 2 SD – ≤ +1 SD)	1245	110.55±13.81	65.35±10.85
Overweight (> +1 SD – ≤ + 2 SD)	132	115.58±14.53	67.67±14.97
Obese (> + 2 SD)	25	115.60±14.43	68.08±10.82
F *(p-value)*		8.48 (0.001)	2.98 (0.030)
Socioeconomic Status			
Upper (I and II)	649	111.56±13.96	65.80±10.80
Middle (III)	545	110.98±13.75	65.38±11.76
Lower (IV and V)	296	109.16±14.74	65.06±11.35
F *(p-value)*		2.99 *(0.050)*	0.48 *(0.615)*

One-way analysis of variance (ANOVA) test: F, students t-test: t, Systolic Blood Pressure: SBP, Diastolic Blood Pressure: DBP, Standard deviation: SD

Mean Systolic and Diastolic Blood Pressures by Socio-demographic and BMI Status of Subjects:

The mean systolic and diastolic blood pressures differed according to the BMI status with obese participants having the highest systolic and diastolic blood pressure readings, the differences being statistically significant (p = 0.001 and p = 0.030, for SBP and DBP respectively). Participants from the upper socio-economic class had the highest mean systolic and diastolic blood pressures. The differences were not, however, statistically significant (p = 0.050 and 0.615) (Table 4).

3.1 Discussion

The current study demonstrates that there is a high burden of high blood pressure in Lagos Nigeria, a low-income country. It confirms pre-hypertension and elevated blood pressure as the common pattern using the 2004 Fourth Report. In each age group, the prevalence of high blood pressure was significantly higher among the mid and late adolescents, in contrast to the early adolescent cluster. This accentuates the need for regular checks of BP and detection of high blood pressure amongst adolescents.

The first significant finding of this study is the establishment of the fact that the prevalence of high blood pressure (HBP) amongst adolescents in the current study is 14.5% using the 2004 Fourth Report. This is comparable to 14.2% observed by Odey [24], in Calabar, Cross River State in a population of adolescents aged 10 to 18 years with a similar obesity rate of 1.9% using the Fourth Report. Several earlier studies had established higher, prevalence of HBP of 27.5% [17] and 22.7% [25] among adolescents using the 2004 Fourth Report. This disparity may be attributable to the remarkably lower prevalence of overweight subjects in the current study (1.7%) than 5.6% and 12.6% in the earlier Awka and Enugu studies [16,25].

However, the HBP prevalence rate of 4.1% reported by Omisore [26], in Osun state was lower than the rate obtained in our study; despite subjects being in comparable age cluster and a seemingly low obesity prevalence of 3%. This difference may be attributable to sedentary lifestyle and unhealthy dietary changes common in cosmopolitan urban areas like Lagos (our study area); which predisposes to cardiovascular risk factors, including high blood pressure [27].

An additional striking finding linked to age in the our study, was that the prevalence of high blood pressure soared progressively with age group when the 2004 Fourth report was applied in early and mid adolescent age group, while the prevalence was lowest in the oldest age group. This finding with the 2004 Fourth Report was unusual because blood pressure is known to progressively increase with age.

We established association between higher blood pressure and elevated BMI in this study. This corroborates findings by Oduwole [17], Abiodun [28], Sharma [29], Khoury [30] and Dong [31]. “Obesity is implicated in the development of metabolic syndrome. The high number of children living with metabolic syndrome globally highlights the urgent need for

multi-sectorial intervention to reduce the global burden of metabolic syndrome and conditions that predispose to it, including childhood overweight and obesity" [32]. This is more so, because of its (obesity) increasing incidence amongst low- and middle-income countries, particularly in urban settings [33].

4. LIMITATION OF STUDY

Limited resources may have excluded children not in school, therefore necessitating the need for multi setting study to be carried out, because social factors that influence HBP may differ amongst children in the two settings.

5. CONCLUSION

Hypertension in adolescents remains an important public health concern. That, more than one eighth of subjects were hypertensive underscores the need for regular screening for HBP amongst adolescents. Preventing and controlling hypertension can be achieved when risk factors are recognized and appropriate lifestyle modifications implemented. This is because high blood pressure if left undetected and untreated tracks into adulthood with its attendant end organ complications.

CONSENT

As per international standards, parental written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

Ethical approval: ethical approval was obtained from the health research ethics committee of the Lagos University Teaching Hospital with number NHREC/DCST/HERC/2659. Lagos State Ministry of Education also gave approval with number LG/C530/VI/122.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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