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Sociodemographic Correlates of Hypertension in Apparently Healthy Secondary School Adolescents in Taraba State, Nigeria

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Abstract
Background: Although several interrelated socio-demographic factors, such as age, gender, and socioeconomic status, are associated with hypertension in adults, conflicting reports exist regarding the patterns of this relationship in children.
Objective: To determine the relationship between sociodemographic factors and hypertension among adolescents.
Methods: A cross-sectional study of blood pressure (BP) patterns in 1350 apparently healthy secondary school adolescents (10-19 years) was conducted over six months in Taraba State, Nigeria. The participants were selected from 56 secondary schools through a multistage random sampling technique.
Results: The overall mean systolic BP was 108.9±12.5mmHg while the mean diastolic BP was 68.3±8.2mmHg. The BP consistently increased with age (r = 0.30-0.35, p<0.001). The gender-related differences in BP showed mean systolic BP for boys and girls to be 108.1±13.3mmHg and 109.5±11.7mmHg (t = -2.054, p = 0.040) while the mean diastolic BP was 67.8±8.1mmHg and 68.7±8.2mmHg (t = -2.077, p = 0.038), respectively. Girls had a higher mean systolic BP than boys from early adolescence (t = 3.754, p = 0.001) through middle adolescence (t = -3.025, p = 0.003) but this was reversed during late adolescence with boys having higher mean systolic BP (t = 2.145, p = 0.033). Girls showed dominance in diastolic BP in early and middle adolescence (t = -3.517, p<0.001). Higher BP was common in low socioeconomic classes compared with those from upper socioeconomic classes (F = 1.650, p = 0.850) and diastolic BP (F = 0.193, p = 0.058).
Conclusions: The BP progressively increased with age. Females had greater BP in early to mid-adolescence, while males had higher BP in late adolescence. Higher BP was common in adolescents from low socioeconomic classes.

Keywords: Adolescence, Blood pressure, Hypertension, Socioeconomic status.

Introduction

Hypertension is associated with high morbidity affecting major organs of the body, such as the heart, kidneys and the brain and a mortality of up to 27.5-28.0%. [1,2] It is now diagnosed frequently in adolescents with a reported prevalence of 13.5-23.9%.[3] The younger the age of onset of hypertension, the greater the reduction in life expectancy, if left untreated.[1] This is because high blood pressure (BP) in childhood has been shown to track into adulthood.[3] It has also been shown that early identification and intervention may lead to a significant reduction in the complications of hypertension.[4]

Several interrelated socio-demographic factors, such as age, gender and socioeconomic status, are associated with and influence hypertension in adolescents. [3, 5] There are conflicting reports about the pattern of these factors and hypertension in children. Although a progressive BP elevation with age has been observed in several studies, the specific sex of children has been shown to influence the pattern of this progression.[3,6] Whereas some reports have demonstrated higher BP in males across all ages, particularly throughout adolescence, others have shown higher BP in females across all ages of adolescence.[6-8] Interestingly, some have reported higher BP in females in early- and mid-adolescence, with males having higher BP in late adolescence.[9] While socioeconomic status has been shown to have an inverse relationship with hypertension in some studies, others have reported a direct relationship between socioeconomic status and hypertension.[5,8,10-13] In contrast, a lack of significant relationship has been reported in a study from Trinidad and Tobago.[14] These conflicting reports about the relationship between blood pressure and sociodemographic characteristics of adolescents have necessitated this study, which aimed to describe the blood pressure patterns of adolescents aged 10-19 years in Northern Nigeria with age, gender, and socioeconomic status.

Methods

Study area

The study was conducted over six months in Jalingo, the capital of Taraba State, which lies between latitude 8^0 54’ north and longitude 11^0 21’ east and at an altitude of 360 meters above sea level, in North-eastern Nigeria and has a population of 118,198 people.[15] Jalingo has a tertiary health centre, the Federal Medical Centre Jalingo, and the state specialist hospital. It also has 15 private hospitals and many primary health care centres. There are also tertiary education institutions, including Taraba State University. There are 56 secondary schools (24 public and 32 private), all mixed schools except one, a girls-only school.

Study design

A cross-sectional, descriptive study.

Ethical approval

Ethical approval was obtained from the Scientific and Health Ethics Research Committee of Ahmadu Bello University Teaching Hospital, Zaria and the Taraba State Ministry of Education. Informed consent was given by the student’s parents or guardian. All students whose parents gave consent a day before the data collection voluntarily participated in the study. Assent was also obtained from the participants.

Sample size determination

The minimum sample size was calculated using the formula: [16]

$$N = \frac{Z^2(pq)}{E^2}$$

Using a known prevalence of hypertension in adolescents (3.4% [17]), the calculated minimum sample size was 1262. With the allowance of 5% non-response rate, the final sample size became 1350.

Inclusion criteria

Students aged 10-19 years in the selected secondary schools who gave assent and whose parents gave consent to participate in the study.

Exclusion criteria

Students with known chronic diseases that could affect BP, such as sickle cell anaemia, chronic renal disease, thyroid disorder or a history of chronic drug ingestion, such as steroids or students already on antihypertensives were excluded.

Sampling method

A multistage, random sampling technique selected the student’s participants. The list of secondary schools obtained from the Taraba State Post Primary Schools Board served as the sampling frame for schools. There were 56 secondary schools (24 public and 32 privates, in a ratio of 1:1.3). Ten (10) schools were randomly selected by balloting, four (4) from public schools and six (6) from private schools, based on the number and approximately similar ratio of private to public schools of 1:1.5 (4:6). Ten schools were selected to ensure wider coverage and even distribution of students so that it could be truly representative of the community. All ten schools had a total enrolment of eight 8,107 students. The public schools had 5,940 with 989 students participating. The private schools had a total of 2,167 students, with 361 participating. These numbers (989 and 361) were arrived at based on the relative population of each school. Thereafter, the number of students to participate per school and per class were determined by proportionate sampling, in each case. Students in each class, from junior secondary school (JSS) 1-3 and senior secondary school (SSS) 1-3 were then randomly selected by balloting.

Data collection

The study was preceded by a pilot study. This pilot study was conducted in a school selected via a random sampling method one week prior to the commencement of the main study. The researcher and research assistants measured the BP and anthropometric parameters independently. There were no statistical differences in the results when compared using the Student's t-test.

The first contact, during the main study, with the students was a familiarisation exercise. On the second day, the students were selected as described above and those selected had general physical examination in the presence of a chaperone to identify those who did not fulfil the inclusion criteria. Each participant was given a proforma to retrieve information about their biodata and medical history. Other information obtained included the parents' medical history and the socioeconomic status using the format described by Olusanya *et al.* [18] The study was carried out in a relatively quiet and empty classroom to ensure privacy for both male and female students. After recruitment of the students, the measurements were taken in a selected classroom for both males and females as all the schools were mixed schools. The procedure for BP measurement was demonstrated by the researcher on one of the research assistants and sometimes on one of the teachers in the presence of the students to assure the students and allay their anxiety. BP and anthropometric values obtained were recorded in the study proforma. An average of 15-20 students per day were attended to over 3-4 hours (between 8 am and - 12noon daily), until the estimated sample size was reached.

BP measurement

The standard auscultatory method was employed using a mercury sphygmomanometer (Acosson®) and a standard classic Littman stethoscope according to the guidelines of the Fourth Report on the Diagnosis, Evaluation, and Treatment of Hypertension in Children and Adolescents.[19] Each student was rest-seated for five minutes before BP measurement. With the student seated, the right arm rested on a table at the level of the heart, and an appropriate cuff size, which covered two-thirds (2/3rd) of the arm, was applied about 2cm above the antecubital fossa. Two cuff sizes were used for this study, with dimensions of 10 x 24cm and 13 x 30cm, the smaller cuff for the smaller adolescents and vice versa. The bladder cuff was inflated rapidly to 20-30mmHg above the point where the brachial artery was no longer palpable. The bell of the stethoscope was then placed over the brachial artery, and the cuff was deflated slowly at 2-5mmHg while listening to the Korotkoff sounds. Phases one and five of the Korotkoff sounds were recorded as the systolic and diastolic BP, respectively. [20] Three recordings were taken at intervals of 3-5 minutes, and the average was the final BP in mmHg. BP was interpreted based on the standard protocol.[19]

Normal BP was defined as a BP value between the 5th and < 90th percentile for age, sex, and height. BP was described as elevated when the value lied between the 90th and the <95th percentile for age, sex, and height or a BP of >120/80mmHg, even if below 90th percentile. Hypertension was defined as BP value ≥95th percentile for age, sex and height.

Students found to have prehypertension were educated and counselled on lifestyle modifications such as regular exercise, avoidance of excessive eating of junk foods, reducing salt intake and the need to have their BP checked in six months and annually subsequently. Those with hypertension were educated on the implications of the findings and were referred to the Federal Medical Centre Jalingo for evaluation, management, and follow-up.

Data analysis

Data obtained were analysed using the Epi-Info statistical software package version 7. The BP values were summarized as means and standard deviations. The Chi-Squared test and Student's test were deployed to test associations as necessary. The probability level of statistical significance value was set at <0.05.

Results

A total of 1350 students were studied; they comprised 628 (46.5%) males and 722 (53.5%) females, with a male-to-female ratio of 1:1.1. There were 989 (73.3%) students from public schools and 361 (26.7%) from private schools. The mean age of the study subjects was 15.3±2.2 years with a range of 10-19 years. The age and sex distribution of the students are illustrated in Table I.

Table I: Age and sex distribution of study participants

Age	Male	Female	Total
	n (%)	n (%)	n (%)
10	9 (1.4)	13 (1.8)	22 (1.6)
11	20 (3.2)	31 (4.3)	51 (3.8)
12	36 (5.7)	52 (7.2)	88 (6.5)
13	96 (15.3)	85 (11.8)	181 (13.4)
14	92 (14.6)	115 (15.9)	207 (15.3)
15	92 (14.6)	111 (15.3)	203 (15.1)
16	66 (10.5)	116 (16.1)	182 (13.5)
17	78 (12.5)	91 (12.6)	169 (12.5)
18	79 (12.6)	70 (9.7)	149 (11.0)
19	60 (9.6)	38 (5.3)	98 (7.3)
Total	628 (100.0)	722 (100.0)	1350 (100.0)

Table II shows the mean BP distribution in relation to age and sex. The systolic and diastolic BP increased with age. The overall systolic and diastolic BP was significantly higher in females compared with males (p = 0.04). The systolic BP was significantly higher in females aged 11- 15 years (trend line1-pink) and in males aged 16 -19 years (trend line1 – blue) while the diastolic BP showed variable increase in male and female (trend line 2), as shown in Figure 1.

Considering the relationship between hypertension and stages of adolescence, Prehypertension and hypertension were more prevalent in late adolescence than early and middle adolescence ($\chi2$ = 49.054, p<0.001) and ($\chi2$ = 10.305, p = 0.006), respectively as shown in Table 3.

Table II: Age and sex distribution of BP pattern

Age (years)	Mean (±SD) Systolic BP (mmHg)		p-value	Mean (±SD) Diastolic BP (mmHg)		p-value
	Male (n = 628)	Female (n = 722)		Male (n = 628)	Female (n = 722)	
10	95.4±3.9	92.3±6.0	0.32	61.9±4.6	58.6±4.6	0.191
11	98.5±5.5	99.7±9.2	0.68	64.8±3.9	61.7±5.7	0.126
12	99.9±8.9	106.2±11.7	0.006	65.3±2.9	66.0±5.2	0.607
13	99.9±8.9	106.2±11.7	0.006	65.3±2.9	66.0±5.2	0.607
14	103.6±7.8	109.8±7.8	0.001	65.3±4.4	69.3±5.8	0.001
15	107.1±8.0	110.5±8.7	0.042	66.5±5.8	68.9±5.6	0.037
16	113.5±8.2	111.4±9.1	0.31	69.7±5.1	69.5±6.1	0.881
17	115.2±8.7	111.5±7.7	0.043	69.8±5.9	69.8±5.8	0.981
18	114.1±9.6	113.5±7.4	0.791	70.4±6.2	72.1±6.3	0.249
19	114.6±9.7	110.8±8.0	0.164	73.3±6.3	71.4±4.3	0.282
Total	108.1±13.3	109.5±11.7	0.040	67.8±8.1	68.7±8.2	0.038

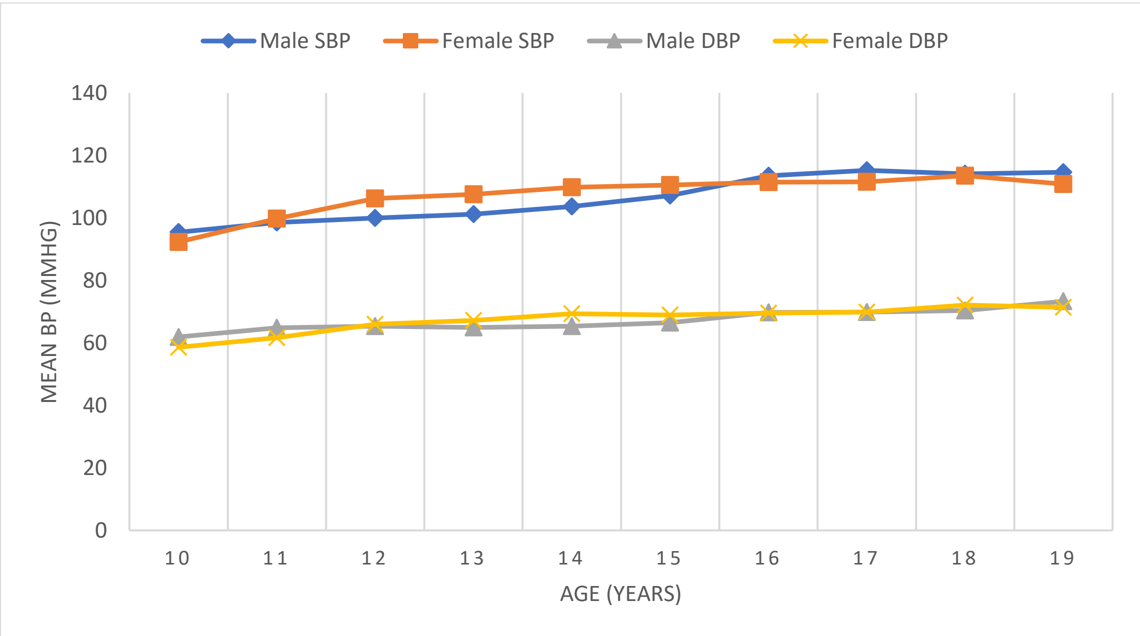

Figure 1: Line graph showing the trend of BP with age and sex

Table IV shows the relationship between the BP patterns and sex across the stages of adolescence. Females had a higher mean systolic BP (SBP) than boys from early adolescence (t = 3.754, p = 0.001) through middle adolescence (t = -3.025 p = 0.003). This dominance was also demonstrated in the diastolic BP (DBP) and was statistically significant in early (p = 0.050) and middle adolescence (t = - 3.517, p<0.001). Adolescents from private schools had higher mean SBP (t = -2.22, p<0.027) and mean DBP (t = -4.61, p<0.001) than those from public schools and these differences were statistically significant.
The mean BP according to the socio-economic class of the subjects is shown in Table V. Lower

social classes had higher mean SBP (t = 1.650, p = 2.850) and DBP (t = 0.193, p = 0.058) but these were not statistically significant.

Table III: Pattern of distribution of patterns of BP according to stages of adolescence

BP Category	Early Adolescence	Middle Adolescence	Late Adolescence	Total
	(10-13) years	(14-16) years	(17-19) years	(10-19) years
	[n = 342]	[n = 592]	[n = 416]	[n = 1350]
	n (%)	n (%)	n (%)	n (%)
Normal	290 (84.8)	428 (72.3)	275 (66.1)	993 (73.5)
Pre-Hypertension	43 (12.6)	135 (22.8)	120 (28.8)	298 (22.1)
Hypertension	9 (2.6)	29 (4.9)	21 **(5.1)**	59 (4.4)

Table IV: Mean BP according to sex and stages of adolescence

Stages of Adolescence	Mean (±SD) Systolic BP		p-value	Mean (±SD) Diastolic BP		p-value
	Male	Female		Male	Female	
Early (10-13)	100.0±9.6	104.0±11.8	0.001	64.8±5.6	65.3±8.2	0.050
Middle (14-16)	107.5± 12.9	110.5±11.3	0.003	67.0±8.1	69.4±7.7	0.001
Late (17-19)	114.0±12.8	112.1±11.1	0.033	71.7±8.5	71.0±8.3	0.945

Table V: Blood pressure pattern in relation to socioeconomic classes

Blood Pressure	Upper class (n = 184)	Middle class (n = 516)	Lower class (n = 650)	p-value
	Mean (±SD)	Mean (±SD)	Mean (±SD)	
Systolic BP	108.6±12.6	108.7±12.8	110.4±10.9	0.85
Diastolic BP	68.2±8.3	67.9±8.3	69.6±7.6	0.058

Discussion

This study found an increasing BP pattern across the stages of adolescence. However, there was no relationship observed between adolescence and socioeconomic status among Northern Nigerian adolescents.

Across the stages of adolescence, this study observed a progressive increase in BP with age. This is similar to the findings of other researchers in India and China.[3,5,20] The positive association between advancing age and elevated blood pressure is attributable to the increased inelasticity of the arteries and arterioles due to inflammation and endothelial dysfunction.[21] In consonance with the finding in the current study, it has been shown that for every one-year increase in the age of adolescents, the risk of prehypertension and hypertension rises by 1.28 times.[22] The peak age of elevated BP in this study occurred in late adolescence, between 16 and 19 years in boys, but earlier in girls aged 10 to 15 years where higher systolic and diastolic BP were recorded.

Reports on the relationship between BP and sex in adolescents have been inconsistent, with different studies variably reporting higher mean BP in males and females, and no sex-related differences. The higher BP recorded in females at early and mid-adolescence stages in the index study is similar to Ji *et al.* [9] The progressive increase in the body size of adolescents may be a contributory factor responsible for the differential rise in BP in male and female adolescents in favour of female adolescents in early- and mid-adolescence stage and in favour of males at late adolescence stage. This is because the growth and maturity of organs are associated with physical changes during puberty, such as increased height, body size and associated increased vascularity, which have been shown to be a significant contributor to the elevated blood pressure characteristic of this phase of growth.[8, 9] These peripubertal changes usually manifest earlier in female adolescents.[8, 9] In addition, menarche, which occurs peripubertal in female adolescents, is associated with psychosocial stress occurring at that age, leading to increased blood pressure in early and mid-adolescent stage in females compared with male adolescents.[23] However, some studies have reported that male adolescents have higher blood pressure throughout adolescence stages and not just in late adolescence stages, as reported in this study.[6-7,24]

Although the findings in these studies have been explained by the indirect vasoconstrictive effects of testosterone and vasodilatory (relaxation) effects of female oestrogen on the blood vessels, the drawback of some of these studies is that the study either did not include early adolescents or mid adolescents unlike the index study that recruited adolescents aged 10-19 years.[7, 24] In addition, this hormonal effect cannot completely explain these observations, as oestrogen, oestradiol, and progesterone that herald puberty in females have been shown to have vasoconstrictive effects.[25]

The BP distribution with the parental socio-economic class in this study showed that students from low socioeconomic classes had higher mean BP than those from upper socioeconomic classes, although this was not statistically significant. This is similar to the findings of Tao *et al.* and Rosengren *et al.*, who reported a negative relationship between BP and parental socio-economic status. [5, 8] The reasons for the inverse relationship between BP and socioeconomic status may include exposure to chronic environmental stress with sustained sympathetic nervous system stimulation.

Other factors that might have contributed to the inverse relationship found in this study between BP and parental socioeconomic class include poor health-seeking behaviours due to low income and/or inadequate health knowledge. It has been shown that, of all the social determinants of health (SDOH), poverty level and low level of education are key indicators of health disparities and indeed, have a significant positive relationship with the development of hypertension and cardiovascular diseases.[25] This is because the adolescents of parents with high incomes have easy access to health education and awareness about hypertension prevention and control, and better accessibility and adherence to medical treatment.[26] In contrast, adolescents from low socioeconomic classes may have increased exposure to psycho-socioeconomic stressors and discrimination that can worsen the prevention and control of hypertension.[27] These may be responsible for the findings in the present study as Jalingo is a semi-urban community, the inhabitants of which are mostly subsistent farmers, civil servants and traders with low income. The high number of students in the lower socioeconomic class in this study lends credence to that fact. In contrast to the current study, other studies have reported a direct relationship between socioeconomic status and blood pressure.[11-13] It appears that high socioeconomic status is generally associated with hypertension in high-income countries.[5,8,10] On the contrary, the relationship in low-to-middle income countries (LMIC) is complex. [11-13] While the relationship is direct in some LMICs in which high-income earners have hypertension, probably due to increasing sedentary lifestyle, [11, 12] the reverse is the case in other LMIC, similar to the current study, due to psycho-socioeconomic stressors.

[13] It may thus be stated that whereas hypertension is associated with low socioeconomic status in high-income countries, the relationship in LMIC is complex and not always inverse as was believed. This complex relationship between socioeconomic status and hypertension in LMIC is influenced by other factors such as anthropometry, genetics, social lifestyles, and globalisation, in addition to income-based classification. [28]

Conclusion

The BP progressively increased with age, with females having higher BP measurements in early to mid-adolescence and males having higher BP values in late adolescence. Higher BP is seen in adolescents from low socioeconomic class in Northern Nigeria. The school health programmes should be strengthened in secondary schools across Nigeria to include routine BP screening measurements to detect early elevated BP and hypertension in the adolescent age group. This is to allow for monitoring of trends and potentially reduce morbidity and mortality in adult life.

Authors' Contributions: AR and PTY conceived and designed the study. AR, PTY, UJA, and IH analysed the data while BAA, ALO and BDC interpreted the data. AR, PTY, UJA, IH BAA, BAA, ALO and BDC drafted the manuscript. All the authors revised and approved the final version of the manuscript.
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