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Adolescent blood pressure pattern in Rivers State, Nigeria: A rural - urban comparison

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Abstract: *Background:* Childhood and adolescent blood pressure pattern have been known to predict adult blood pressure levels and development of hypertension. Hypertension, once rare in traditional African societies, is now the commonest non-communicable disease in Nigeria. There are few studies on adolescent blood pressure pattern, especially in adolescents living in rural areas. It is therefore important to identify blood pressure differences, if any, between adolescents living in rural areas compared to their urban counterparts.
Objective: To determine and compare the blood pressure pattern of apparently healthy adolescents in rural and urban areas, and to determine the association between blood pressure and body mass index in these children.
Subjects and Methods: A cross sectional population based blood pressure survey was carried out on 2,136 Nigerian school adolescents (1080 were resident in rural areas and 1056 in urban areas) aged 10-18 years, selected from 26 secondary schools using a multi-stage stratified sampling technique. Blood pressure measurements were taken by auscultatory method. An average of three readings was taken as the actual blood pressure.
Results: Systolic and diastolic blood pressure increased with age in both rural and urban subjects. The mean systolic blood pressure of the rural subjects (111.10 ± 14.72 mm Hg) was significantly (p= < 0.001) higher than that of the urban subjects (108.09 ±15.40 mm Hg), whilst the mean diastolic blood pressure of the urban subjects (66.88 ± 11.27 mmHg) was slightly higher than those of the rural subjects (66.32±11.71 mmHg. Urban subjects had a higher mean body mass index (19.82± 3.57kg/m^2) than their rural counterparts (19.59±2.78 kg/m^2).Systolic and diastolic blood pressure showed a positive significant (p= <0.001) correlation with BMI in subjects in rural and urban schools.
Conclusion: Significant differences in blood pressure were observed between rural and urban adolescents in Rivers State, with a positive significant correlation between BMI and blood pressure. We recommend blood pressure surveillance as part of the School Health Programme.

Key words: adolescent, blood pressure, rural-urban, Nigeria.

Introduction

Adolescence is a stage between childhood and adulthood, and a period of rapid biological, intellectual and psychosocial development largely initiated by and dependent on hormonal influences, but highly influenced by the environment.[1]Certain chronic diseases, including cardiovascular diseases, affecting adults have their origins during adolescence.[2]As a result adolescence is a unique and important developmental period requiring specific attention.

Childhood and adolescent blood pressure pattern have been shown to predict adult blood pressure pattern and thus the development of high blood pressure[3-5]. High blood pressure is a major public health problem in Nigeria and its prevalence is rapidly increasing among rural and urban populations[6,7]. Several factors have been shown to affect blood pressure pattern among adolescents including age, sex, environmental factors and obesity[8-11]. In Africa, Agyemang et al[12] reported an increase in blood pressure with age in rural, semi-urban and urban children in Ghana, which is similar to reports by Obika et al[13] in rural and urban children in Nigeria. Gender differences in blood pressure have been reported in adolescents irrespective of age and race[10,12,14]. Nur et al[14] reported significantly higher blood pressures in adolescent males than females in Turkey, while Akinkugbe et al[10] reported higher blood pressure levels in adolescent females in Nigeria. Several workers have alluded to the fact that environmental factors affect blood pressure in children[12,15-17]. Interestingly, studies in childhood have confirmed this rural-urban blood pressure disparity[12,16]. Blood pressures were reported to be higher in urban than in semi-urban and rural children in Ghana[12]. In Nigerian children, there have been varied reports by different researchers. Ejike et al[16] reported higher blood pressure levels in urban than in non-urban children in Kogi State, whilst Obika et al[13] reported no difference in blood pressure levels of rural and urban children in Ilorin. Oviasu et al[11] in Benin reported higher mean systolic BP levels in urban children aged 6-11years after which a reversal occurred at 11years with rural children having higher blood pressures than their urban counterparts. Since the ddifference in blood pressure could not be accounted for by body build as the BMI were not significantly different in the urban and rural subjects, they suggested that environmental factors could account for the differences observed even though these factors were not studied.[11]

In an attempt to study which environmental factors are responsible for the rural-urban difference in BP, Ekpo et al[18] studied rural and urban children aged 5-16years in Calabar and found that the systolic and diastolic blood pressures were higher in urban than in rural children until the age of 11-12years, after which this rural-urban difference disappears. They suggested that the rural-urban disparity in BP was multi-factorial, and may partly be dependent on BMI, electrolyte consumption (particularly salt) and salt/potassium ratio as well as an increase in exposure to western type of education.

Body weight and body mass index have been shown to correlate strongly with blood pressure and thus the development of hypertension[8,19]. Sinaiko et al[20] reported that increases in weight and body mass index in childhood were significantly associated with an increased risk of high blood pressure and other cardiovascular diseases in adulthood. Moreover, adult blood pressure has been shown to correlate with childhood blood pressure and body size[3]. It is therefore important to study the characteristics of the blood pressure pattern of these rural and urban adolescents to find out disparities, if any, occurs, and if it begins in adolescence. Moreover, there is a dearth of information on adolescent blood pressure levels in Nigeria, especially in those living in rural areas. It is therefore expedient that the blood pressure of these rural adolescents is studied and compared with those of their urban counterparts to identify if any differences exist between them. The present study intends to determine and compare the blood pressure pattern in apparently healthy adolescents in rural and urban areas of Rivers State, and to determine the association between blood pressure and body mass index in these adolescents.

Subjects and methods

Rivers State is located in the South-South geo-political zone of Nigeria. There are 23 local government areas (LGAs) with 8 being mainly urban, and constitutes 28% of the State's population (according to the 1991 population census).[21] This translates to a rural- urban ratio of 2:1. Port Harcourt City LGA (PHALGA) was randomly selected to represent the urban LGA, while Emohua and Abua-Odual LGAs (EMOLGA and ABOLGA) were randomly selected to represent the rural LGAs. PHALGA has a population of 541,115 according to the population census of 1991.[21] Oil and gas exploration is the mainstay of the economy. Emohua and Abua-Odual LGAs have a population of 201,901 and 282,988 respectively.[18] Situated about 150km apart, subsistence farming and fishing dominates both areas. Ethical clearance was obtained from the Research and Ethics Committee of the University of Port Harcourt Teaching Hospital. Notification and permission to carry out the study was obtained from the Rivers State Ministry of Education, Local Government Council and from the Head teachers of the 26 selected schools and the parents or guardians and assent from the selected students.

The schools in each LGA were first stratified into public and private schools and further into co-educational (mixed), all boys and all girls schools respectively, and finally selected by simple random sampling. Eight schools (4private, 4public) were selected from PHALGA, 8 schools (3private, 5public) from EMOLGA and 10 schools (3private, 7public) from ABOLGA respectively. A total of 26 schools comprising of 18 rural schools and 8 urban schools were selected for this study. One thousand and eighty subjects were randomly selected from the 18 rural schools whilst 1056 subjects were from the 8 urban schools respectively. In each selected rural school, 60 students were recruited. Using simple random sampling, an arm was selected to represent the class from each of the 6 classes (JS1-3 and SS1-3). In each class selected, 10 students were randomly selected from the class register. In each selected urban school, 132 students were recruited. Using simple random sampling, an arm was selected to represent the class from each of the 6 classes. In each class selected, 22 students were randomly selected from the class register. A total of 2136 students were recruited for this study. Apparently healthy secondary school students aged 10 to 18 years in the selected schools, who gave assent for the study, and whose parents/ guardians gave consent made up the study population. Students on drugs known to affect blood pressure such as steroids or propanolol and those with histories or known chronic illnesses such as cardiac, renal and endocrine diseases were excluded. Each selected school was visited twice. Blood pressure (BP) was measured using the mercury sphygmomanometer (Accoson, London, England) with an appropriate cuff size in conjunction with the bell of the Littmann stethoscope (USA). The cuff size selected for each student had a bladder that covered at least 80% of the length of the right upper arm without obstructing the antecubital fossa and at least 40% of the circumference of the right arm. The students had been seated for at least 5minutes with their back supported on the chair and the upper arm bared without constrictive clothing. The right arm of each student was placed on a table with the cubital fossa supported at the level of the heart. The first Korotkoff sound was recorded as the systolic BP while the diastolic BP was recorded at the point of disappearance of the sounds (phase V). Three readings were taken with at least 1 minute in between them while making sure that the cuff was completely deflated between readings and approximated to the nearest 2 mm Hg.[22] The average of the three readings was taken as the BP and recorded for each student. Weight was measured using a well-calibrated, portable bathroom scale (Hana scale, model BR-9011) in kilograms. Height was measured using a portable stadiometer well calibrated up to 2 meters. The body mass index (BMI) for each student was calculated using the formula weight/height^2 (kg/m^2).

Data analysis

Data entry and analysis was done using SPSS software version 15 and EPI-INFO version 6.04. Distributions were described as means and standard deviations. These results are presented a stables and charts in simple proportions. The Chi-square (c^2) test and Fisher's exact test were used where appropriate to test proportions. One-way analysis of variance (ANOVA) and student's t-test were used to compare the difference in means. In all cases, a probability value (p value) of < 0.05 was regarded as statistically significant.

Results

Two thousand one hundred and thirty six subjects participated in the present study. One thousand and eighty (50.6%) subjects were from schools in the rural areas while 1056 (49.4%) subjects were from schools in the urban area respectively, giving a rural-urban ratio of 1:1. The mean ages of the subjects in the rural and urban schools were 14.55 ± 2.1 years and 13.73 ± 2.2 years respectively. This difference was statistically significant (t = 7.872, p = <0.001).

Table 1 showed that the mean systolic BP increased with age in subjects in rural schools, from 99.17 ± 13.79 mm Hg at 10 years to 119.34 ± 14.91 mm Hg at 18 years. In urban subjects, the mean systolic BP increased from 94.62 ± 10.97 at 10 years to a peak at 16 years of 116.52 ± 14.31mm Hg. The subjects in rural schools had significantly higher systolic BP at 18 years (p= 0.049) compared with their urban counterparts. The systolic BP of the rural subjects ranged from 70 – 180 mmHg, with a mean systolic BP of 111.10 ± 14.72 mmHg, whilst in the urban subjects, the systolic BP ranged from 60 – 165 mm Hg with a mean systolic BP of 108.09±15.40 mmHg. This difference was statistically significant (p= 0.000).

Female subjects irrespective of location had a higher mean systolic BP than males. The mean systolic BP of the female subjects in the rural schools of 111.75 ± 13.91 mm Hg was significantly higher than the 109.30 ± 15.19 mm Hg in those of their urban counterparts (p= 0.007). Similarly, the mean systolic BP of male subjects in the rural schools of 110.48 ± 15.45 mm Hg was significantly (p = 0.000) higher than the 106.67 ± 15.54 mm Hg of their urban counterparts.

Table 1: Mean systolic blood pressure of the subjects according to age by school location

Age (years)	Rural Mean ± SD (mmHg)	Urban Mean ± SD (mmHg)	p value
10	99.17 ±13.79	94.62 ±10.97	0.208
11	102.12 ±12.10	100.10 ±14.59	0.303
12	104.09 ±13.25	102.40 ±13.31	0.358
13	105.61 ±11.60	107.12 ±14.06	0.310
14	111.79 ±15.06	110.73 ±14.66	0.545
15	112.66 ±12.21	112.80 ±13.11	0.920
16	115.05 ±15.40	116.52 ±14.31	0.447
17	117.04 ±14.88	114.68 ±17.20	0.303
18	119.34 ±14.91	114.05 ±11.63	0.049*
Total	111.10 ±14.72	108.09 ±15.40	0.000*

*significant

Table 2 showed that the mean diastolic BP of subjects in rural schools increased with age from 60.36 ± 10.55 mm Hg at 10 years to 72.20 ± 10.95 mm Hg at 18 years. However, in urban subjects, the mean diastolic BP increased from 61.81 ± 11.08 mm Hg at 10 years to 72.26 ± 9.49 mm Hg at 18 years with a slight drop at 17 years. The diastolic BP ranged from 40-110 mmHg with a mean diastolic BP of 66.32 ± 11.71 mm Hg in subjects in rural schools whilst in urban subjects, it ranged from 30 -100 mm Hg with a mean diastolic BP of 66.88 ± 11.27mmHg. This difference was however, not statistically significant (p=0.277). Diastolic BP differed significantly between rural and urban subjects at ages 12 and 15-17 years respectively as shown in Table 2

Table 2: Mean diastolic blood pressure of the subjects according to age by school location

Age (years)	Rural Mean ± SD (mmHg)	Urban Mean ± SD (mmHg)	p value
10	60.36 ±10.55	61.81 ±11.08	0.351
11	61.67 ±11.93	63.18 ±10.06	0.643
12	61.87 ±10.20	64.88 ±11.06	0.043*
13	62.93 ±10.77	64.74 ±11.51	0.162
14	66.02 ±11.76	68.22 ±10.62	0.096
15	66.80 ±11.37	69.75 ±10.67	0.016*
16	68.12 ±11.67	71.51 ±11.00	0.022*
17	71.68 ±11.13	68.16 ±10.48	0.026*
18	72.20 ±10.95	72.26 ± 9.49	0.976
Total	66.32 ±11.71	66.88 ±11.27	0.277

*significant

The mean diastolic BP of the female subjects in rural schools was 67.07±11.98 mmHg compared to 66.87 ± 11.47 mmHg in those in urban schools. However, this difference was not statistically significant (p=0.785).

The mean diastolic BP of the male subjects in the urban schools of 66.90 ± 11.05mm Hg was higher than the 65.60 ± 11.42 mmHg of their rural counterparts. However, this difference was not statistically significant (p=0.072).
The mean weight of the subjects in rural and urban schools were 48.51 ± 10.14 kg (range 22 -110 kg) and 49.91 ± 11.78 kg (range 26 – 120 kg) respectively. This observed difference was statistically significant (p = 0.005).
The mean height of the subjects in the rural and urban schools were 1.56 ± 0.09 m (range 1.2-1.9 m) and 1.57± 0.10 m (range 1.3-1.9 m) respectively. This difference was not statistically significant (p=0.337).
Subjects in urban schools were significantly heavier and taller than their rural counterparts at ages 11-13, 15-16 years and 11-16years respectively as shown in Table 3 and Table 4.

Age (years)	Rural Mean ± SD (Kg)	Urban Mean ± SD (Kg)	p value
10	35.17 ± 5.44	37.76 ± 8.99	0.338
11	36.51 ± 6.59	40.86 ± 10.59	0.001*
12	39.99 ± 7.18	44.98 ± 8.78	0.000*
13	43.74 ± 8.03	49.98 ± 12.32	0.000*
14	49.13 ± 10.27	50.91 ± 8.86	0.118
15	49.29 ± 6.77	55.07 ± 8.02	0.000*
16	53.64 ± 7.22	56.90 ± 9.79	0.003*
17	55.10 ± 7.38	57.81 ± 13.13	0.065
18	58.64 ± 7.90	56.37 ± 6.71	0.116
Total	48.51 ± 10.14	49.91 ± 11.78	0.005*

Table 3: Mean weight- for- age of the subjects by school location
*significant

Age	Rural Mean ± SD(m)	Urban Mean ± SD(m)	
10	1.43± 0.07	1.45± 0.08	0.362
11	1.45± 0.08	1.49±0.07	0.000*
12	1.49± 0.07	1.53± 0.07	0.000*
13	1.53± 0.07	1.56± 0.09	0.000*
14	1.56± 0.08	1.60± 0.07	0.000*
15	1.57± 0.06	1.63± 0.08	0.000*
16	1.60± 0.07	1.63± 0.09	0.001*
17	1.62± 0.07	1.64± 0.09	0.293
18	1.64± 0.07	1.63± 0.09	0.398
Total	1.56± 0.09	1.57± 0.10	0.337

Table 4: Mean height for age of the subjects by school location
*significant

The mean BMI was 19.59 ± 2.78 kg/m^2 in subjects from rural schools (range 12.2-38.1 kg/m^2) and 19.82± 3.57 kg/m^2 (range 13.3-44.4kg/m^2) in subjects from urban schools. This observed difference was not statistically significant (p=0.097).The mean BMI showed a gradual increase with age as shown in Table 5, except at 17 years in subjects in rural schools and at 14 years in subjects in urban schools. Subjects in urban schools had higher mean BMI than their rural counterparts from 10 years to 17 years with significantly higher mean BMI

Table 5: Mean BMI- for-age of the subjects by school location

Age (years)	Rural Mean ± SD (kg/m^2)	Urban Mean ± SD (kg/m^2)	P value
10	16.84± 1.61	17.48± 2.84	0.306
11	17.22± 2.17	18.17± 4.25	0.066
12	17.67± 2.23	19.08± 3.10	0.000*
13	18.55± 2.24	20.26± 3.81	0.000*
14	18.85± 2.93	19.87± 2.97	0.956
15	19.75± 2.11	20.47± 2.78	0.009*
16	20.80± 2.69	20.96± 2.92	0.655
17	20.76± 2.39	21.33± 4.57	0.251
18	21.62± 2.44	21.16± 2.23	0.589
Total	19.59± 2.78	19.82± 3.57	0.097

*significant

The mean BMI of the female subjects in the urban schools of 20.57 ± 3.74 kg/m^2 was significantly (p = 0.002) higher than the 19.91 ± 3.01 kg/m^{2}in their rural counterparts. However, the mean BMI of the male subjects in the rural schools of 19.27 ± 2.50 kg/m^{2}was higher than the 18.96 ± 3.15 kg/m^2 in those in urban schools. This difference was not statistically significant (p=0.087). Figures 1- 4 show the correlation between systolic and diastolic BP and BMI in rural and urban subjects. Both systolic and diastolic BP showed a positive significant correlation with BMI in rural subjects (R= 0.386, p= <0.001 and R= 0.314, p= <0.001) and urban subjects (R= 0.316, p= <0.001 and R= 0.228, p= <0.001) respectively.

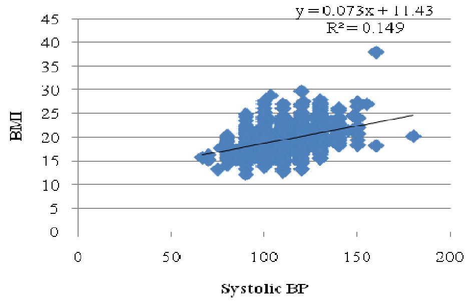

Fig 1: Correlation between BMI and systolic BP in rural subjects

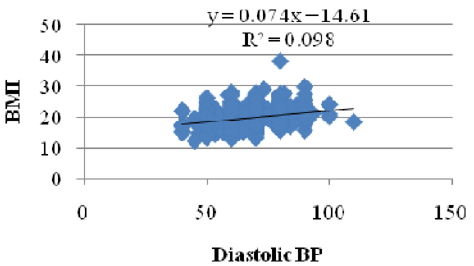

Fig 2: Correlation between BMI and diastolic BP in rural subjects

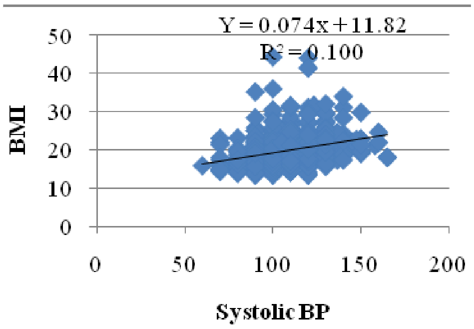

Fig 3: Correlation between BMI and systolic BP in urban subjects

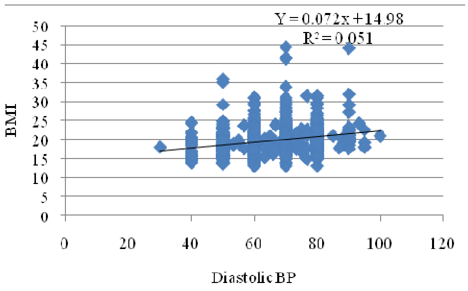

Fig 4: Correlation between BMI and diastolic BP in urban subjects

Discussion

The finding in the present study that blood pressure increased with age in both rural and urban subjects is consistent with earlier reports by Bugage *et al*[9] and Akinkugbe *et al*[10] in urban adolescents in Zaria and Ibadan respectively. Other studies in rural and urban children in Nigeria[11,13] and Ghana[12] reported a similar pattern. The more rapid increase in blood pressure noted at mid-adolescence in the present study has also been noted by other researchers[9,10,12,23]. It seems to coincide with periods of rapid physical development and hormonal changes in children.[9]Several studies attest to the rural-urban difference in blood pressure levels throughout Sub-Saharan Africa[24,25]. Previous studies in adults have reported higher blood pressure levels in urban than in rural subjects, and the higher blood pressure levels in adults in urban subjects have been attributed to the stress of acculturation[26-28]. Studies in childhood have reported similar rural-urban blood pressure disparity with urban children having higher blood pressure levels than rural children.[11,12]In the present study, there were marked differences in blood pressure especially in systolic BP of rural and urban adolescents. Rural adolescents had significantly higher mean systolic BP than their urban counterparts. This could be attributed to the fact that the mean age of the rural children was significantly higher than that of the urban children, as age positively correlates with blood pressure. However, the difference in mean systolic BP between rural and urban adolescents was not significant for most ages. This is similar to findings by Okonofua[29] who reported higher mean systolic blood pressures in rural than in urban children and adolescents aged 3-20 years in Benin City, Nigeria. In contrasts, Ejike *et al*[16] and Agyemang *et al*[12] reported significantly higher systolic BP in urban adolescents compared to non-urban adolescents in Kogi State, Nigeria, and in Ashanti, Ghana respectively. The reasons for these differences are unclear, however, further studies are needed to identify the factors that may contribute to these rural-urban disparities, as the present study and the Benin[29] study were done in the same South-South geo-political zone whilst the Kogi[12] study was done in the North Central region of Nigeria.

However, the findings in the present study may be a pointer that the seeming protection from blood pressure elevations which rural subjects enjoyed may be fading away, and indeed adolescents living in the rural areas of Rivers State may be exposed to more stressful life events than their urban counterparts. However, further studies are needed to identify the factors that may contribute to these rural-urban disparities.

In the present study, female subjects had higher blood pressure profiles than males in both rural and urban areas. This finding compares favourably with reports by Okonofua[29] in children and adolescents aged 3-20 years in Benin City and Akinkugbe *et al*[10] in adolescents aged 11-19 years in Ibadan. The higher blood pressure profiles in females in the present study may be due to the fact that females had higher BMI (19.91 ± 3.01kg/m^{2}and 20.57 ± 3.74kg/m^2) than their male counterparts (19.27 ± 2.50 kg/m^{2}and 18.96 ± 3.15 kg/m^2) in both rural and urban areas respectively. It however contrasts with reports by Balogun *et al*[30] who reported higher BP profiles in males than females aged 8-20 years in Ile-Ife. However, Hamidu *et al*[17] and Obika *et al*[13] studied Nigerian school children aged 5-16 years and 1-14 years in rural, semi-urban and urban areas of Zaria and Ilorin respectively and found no significant gender difference in BP. Subjects of different age range and therefore of different body sizes and sexual maturation were studied by these researchers and this may explain the disparities in their reports. In explaining the inconsistent findings in different studies, Szklo[31] attributed the findings to the varying pattern of growth in boys and girls amongst various populations. Nonetheless gender differences in blood pressure have been reported by different researchers in different populations[12,13,31].

In the present study, blood pressure increased with increasing BMI in both rural and urban subjects. This is similar to findings by other researchers in Nigeria,[32] Ghana[12] and United States of America[8]. The relationship between blood pressure and increasing BMI in children and adolescents have been demonstrated in several studies[8,13,28]. Alabi et al[32] in Port Harcourt, Nigeria reported a positive significant relationship between BP and BMI in adolescents aged 10-19 years. Similar findings were reported by Agyemang et al[12] in Ghanian children aged 8-16 years in rural, semi-urban and urban areas of Ashanti region of Ghana and by Sorof et al[8] in American children aged 11-15 years. However, Antia-Obong and Antia-Obong[15] in their study of younger urban and rural children aged 6-14 years found no relationship between blood pressure and BMI. This finding gives credence to the observation by Lauer *et al*[3] that the correlation between BMI and blood pressure is stronger in adolescence than in childhood. There is strong evidence that high adult blood pressure levels correlate significantly with an increase in adiposity from childhood to adulthood, and that there is a moderate risk that excess body fat acquired during childhood will persist into adult life[3,33]. Therefore, efforts should be made at educating these young ones on the risks of overweight status irrespective of location (rural or urban) as westernization and adoption of unhealthy lifestyle habits may further lead to an increase in the prevalence of high blood pressure levels in adult Nigerians in the future.

Conclusion

In conclusion, the present study showed an increase in blood pressure with age with marked differences in blood pressure of rural and urban adolescents in Rivers State. Also, blood pressure showed a significant positive correlation with BMI among these adolescents. However, more work needs to be done to investigate the factors responsible for the rural-urban disparities found in the present study.

We recommend that blood pressure measurement should form part of the medical evaluation for School Health Programme for all secondary school students in both rural and urban areas, and health education on lifestyle modification to avoid overweight and obesity should be incorporated into the school curriculum in secondary schools in Nigeria.

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