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Prevalence of Adolescent Hypertension in Zaria

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Summary

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Background: Although there are several epidemiological reports on the prevalence of hypertension in adult population, a dearth of information continues to exist on adolescent hypertension in many parts of the world.

Objective: To determine the blood pressure (BP) levels and the point prevalence of high blood pressure in healthy secondary school children in Zaria.

Subjects and Methods: A cross sectional prospective study of blood pressure levels of 2035 Nigerian school adolescents aged 10-19 years was conducted, using cluster multistage stratified sampling technique. All measurements were carried out, using standard techniques. Eight hundred and forty four of the subjects were males and 1191 were females.

Results: The mean systolic blood pressures (SBP) among males and females were 109 ± 10.5mmHg and 112 ± 10.9mmHg while the mean diastolic blood pressures (DBP) were 67 ± 8.3mmHg and 70 ± 9.7mmHg respectively. Adopting BP values greater than 140/90mmHg as elevated BP, only thirteen (0.6 percent) of this study population could be considered hypertensive. However, the prevalence rate rose to 3.7 percent, when high BP was defined as values >2 standard deviations above the mean BP for age. There was no difference in the prevalence of systolic hypertension between the two genders; however, diastolic hypertension was significantly higher in girls than in boys ($X^2 = 4.59$, $p < 0.03$).

Conclusion: Blood pressure levels in secondary school children in Zaria showed rapid rise in mid-adolescence. The overall prevalence rate of elevated BP [greater than mean + 2SD for age and sex] was 3.7 percent. School survey is effective for early detection of high blood pressure.

Introduction

THERE are several epidemiological reports on the prevalence of arterial hypertension in adult populations, but a dearth of information continues to exist on adolescent hypertension in many parts of the world.[1,2] In the northern parts of Nigeria, normal blood pressure levels have not been established. The "normals" obtained from countries which differ in environmental and racial factors cannot be interchangeable. The characterization of race-age-sex in the frequency distribution of BP in a particular community is vital to the detection of early hypertension. The exact prevalence of adolescent hypertension is unknown, with widely varying values being reported.[3-7] This variability may be accountable in part to the disparities in sample size, age composition and the use of arbitrary criteria for defining hypertension. The present study was undertaken to determine the BP levels in adolescents in guinea savannah region of northern Nigeria, and to find the prevalence rate of elevated BP in these age groups.

Subjects and Methods

The study was conducted in Zaria, Kaduna State of Nigeria. Zaria is located about 75km north of Kaduna, the state capital, and has an estimated population of 400,000 people.[8] Most of the inhabitants are engaged in farming and trading. Two thousand and thirty five secondary school students located within Zaria Local Government Area (LGA), comprising 844 males and 1191 females aged between 10 and 19 years made up the study population. The students were selected using cluster multistage stratified sampling technique.[9]

Initial visits were made to each school and the subjects were familiarized with the objective of the study, the equipment and investigators. Personal data including age, sex, social habits, socioeconomic status, family and past medical history were obtained. On

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subsequent visits, a quick physical examination was carried out on each subject prior to measuring the BP. All investigations were carried out between the hours of 8.30 and 14.00. The blood pressure was measured using a standard mercury sphygmomanometer with an appropriate cuff size (width measuring 10cm and 13cm). The technique of BP measurement adopted was as described by the 2nd task force on BP control in children of the United States.[7] All BP measurements were taken on the right arm, in the sitting position after the subject had rested for at least, 10minutes following physical examination. Three consecutive readings were taken and after an interval of 30 minutes, another three consecutive readings were again taken. The mean of the six readings was taken as the BP of the individual. The systolic blood pressure (SBP) was taken at the point of 1st appearance of Korotkoff sound (phase I), while the diastolic BP was taken at the level of muffling (phase IV), for uniformity. Weight and height were measured using standard procedures. Socioeconomic status (SES) was estimated using a modified scoring by Omran and Standley[10] based on the occupational and educational levels of fathers only. This scoring could be applicable to Nigeria as it is often difficult to determine actual income for most people.[11]

Data obtained were analyzed using SPSS for *MS Windows 6.0*. The mean, standard deviation and correlation coefficient were calculated. Student's t and Chi-square tests were used as appropriate, to test the significance of age and gender related differences. Statistical significance was set at $p < 0.05$.

All subjects aged 19 years and below were included, while those with history of, or suffering from acute/chronic illness with signs of anaemia, cardiac and renal disorders on medical examination, were excluded. Informed consent was obtained from their parents. Ethical approval was obtained from the Ahmadu Bello University Teaching Hospital, Zaria, Ethical Committee.

Results

The mean age of the study population was 14.5 years, with a male to female ratio of 1:1.4.

Weight, Height and Pulse Rate (PR) according to age

The summary of weights, heights and pulse rates is shown in Table I. Weights and heights increased gradually with increasing age in both sexes. Females were heavier than males until the age of 17 years when the position reversed. Females were taller between the ages of 11-15 years; however, the position reversed at ages 16-19 years. The pulse rate generally decreased with advancing age, with a lower pulse rate in males compared to females, although this difference was not of statistical significance.

Blood pressure levels

Table II shows the mean BP levels according to age and sex. The mean BP increased gradually with age in both sexes with a more rapid increase in the age groups 12-14 years (101-113mmHg; $P < 0.02$). Mean SBP ±SD values were 109.0±10.5mmHg for males and 112.0± 10.0mmHg for females. Similarly, values for mean DBP were 67.0±8.3mmHg for males and 70.0±9.7mmHg for females.

Relationship between BP, Weight, Height and PR

The Pearson correlation coefficient between these parameters and BP are represented in Tables III and IV. There was a significant positive correlation between both SBP and DBP and weight as well as height in both sexes ($P < 0.05$) when these variables

Table I

Weight, Height and Pulse Rate according to Age in Zaria Adolescents (Mean ±SD)

Age	Boys	Girls	Boys	Girls	Boys	Girls
	Weight (kg)		Height (cm)		PR (b/min)	
11	30.1±4.2	32.6±0.5	138.9±6.6	142.1±4.6	84.2±8.5	91.0±12.8
12	32.1±5.2	34.7±8.1	142.0±6.4	144.7±8.9	87.412.4	90.4±12.0
13	34.2±5.5	37.9±5.9	145.9±11.3	150.2±6.7	85.8±9.7	94.9±14.7
14	37.3±3.0	42.9±6.7	149.8±11.7	153.2±9.4	87.2±11.3	90.3±4.8
15	41.8±8.4	46.3±6.2	155.2±11.7	156.4±5.6	85.9±12.7	89.3±11.3
16	47.7±8.3	48.7±7.3	161.3±7.3	157.3±5.7	84.0±4.2	86.8±4.0
17	51.0±7.2	50.5±7.4	164.3±8.5	158.6±5.5	82.1±11.9	86.7±10.5
18	55.3±6.6	51.5±7.0	168.7±5.5	158.9±5.5	79.7±10.5	86.5±11.2
19	57.5±6.2	55.1±9.0	168.4±6.6	160.0±6.5	75.5±10.3	83.8±9.7

PR + Pulse rate

SD = Standard deviation

Table II

Blood Pressue Levels acording to Age and Sex (Mean±SD)

	Blood Pressure (mmHg)					
	Boys			*Girls*		
Age	*No*	*SBP*	*DBP*	*No*	*SBP*	*DBP*
10	3	98.1±10.0	60.0	-	-	-
11	11	94.3±10.1	61.0±8.2	4	107.8±2.4	63.0±14.3
12	58	101.0±9.4	65.0±10.0	51	106.1±11.8	65.9±10.3
13	135	103.7±11.4	67.0±10.2	37	109.1±10.9	69.4±9.8
14	140	106.1±10.8	65.7±9.9	211	112.6±11.4	69.4±9.9
15	163	111.1±10.9	67.6±8.6	261	113.4±10.2	70.5±8.9
16	109	115.1±12.3	69.9±9.3	179	114.7±10.3	71.1±9.3
17	101	116.1±9.6	70.5±10.2	213	115.1±10.4	72.3±7.2
18	92	119.4±9.6	72.0±8.1	95	114.2±10.9	72.7±7.9
19	32	121.3±10.3	70.5±8.5	40	117.0±12.2	73.1±9.2

SBP = Systolic blood pressure
DBP = Diastolic pressure

Table III

Correlation of Systolic and Diastolic Blood Pressures with Weight according to Age and Sex

	Boys			*Girls*		
		Systolic	*Diastolic*		*Systolic*	*Diastolic*
Age (yrs)	*No*	*r*	*r*	*No*	*r*	*r*
10	3	0.64	-	-	-	-
11	11	0.50	0.60	4	0.30	-0.06
12	58	0.40*	0.29*	51	0.30*	0.09
13	135	0.19*	0.11	137	0.35*	0.20*
14	140	0.41*	0.15	211	0.25*	0.21*
15	163	0.38*	0.19*	261	0.28*	0.21*
16	109	0.42*	0.21*	179	0.21*	0.06
17	101	0.31*	0.19	213	0.22*	0.13
18	92	0.26*	0.26*	95	-0.02	0.04
19	32	0.09	0.57*	40	0.41*	0.03
All ages	844	0.57*	0.30*	1191	0.31*	0.21*

r = Correlation coefficient
** Significant positive correlation ($p < 0.05$)*

were considered individually. Pulse rate showed a weak correlation with both SBP and DBP in both sexes. However, multiple regression analysis between measured BP and variables of age, weight, height and PR in both sexes combined, showed a significant positive association between both SBP and DBP with weight and PR only (Table V)

Prevalence rate of elevated BP

The number and percentages of adolescents with raised BP are summarized in Tables VI and VII. Defining hypertension as blood pressure values greater than 140/90mmHg, only 13 (0.6 percent) of the 2035 adolescents had raised blood pressure. However, when 2 standard deviations above the mean BP for each age group was considered, the prevalence rate of hypertension rose to 76 (3.7 percent). The BP remained elevated in all these subjects when repeated at six weeks intervals on two occasions. They were subsequently referred to the hospital for further evaluation. There were no significant sex related

Table IV

Correlation of Systolic and Diastolic Blood Pressures with Height according to Age and Sex

	Boys			Girls		
		Systolic	Diastolic		Systolic	Diastolic
Age (yrs)	No	r	r	No	r	r
10	3	0.86	-	-	-	-
11	11	0.43	0.47	4	0.84	-0.66
12	58	0.40*	0.28*	51	0.35*	0.04
13	135	0.06	0.09	137	0.40*	0.18*
14	140	0.23*	0.05	211	0.20*	0.05
15	163	0.23*	0.05	261	0.19*	0.11
16	109	0.32*	0.05	179	0.11	-0.07
17	101	0.28*	0.09	213	0.03	-0.05
18	92	0.34*	-0.07	95	-0.05	0.01
19	32	0.17	0.46*	40	0.14	-0.06
All ages	844	0.48*	0.21*	1191	0.25*	0.12

r = Correlation coefficient

** Significant positive correlation ($p < 0.05$)*

Table V

Multiple Regresion Analysis on Systolic and Diastolic Blood Pressures, Weight, Height, Pulse Rate and Age of 2035 secondary School Adolescents in Zaria

	SBP		DBP	
Variiable	ß	95% Cl	ß	95% Cl
Weight	0.50	0.43-0.56	0.25	0.19-0.30
Height	0.00	-0.01-0.01	-0.01	-0.01-0.01
Pulse rate	0.22	0.18-0.26	0.08	0.05-0.12
Age	0.79	0.47-1.10	0.26	-0.02-0.53

Table VI

Number and Percentage of Subjects with Blood Pressure > 2SD above the Mean for Age

Total Number of Subjects		Number with High BP	Percentage
		Systolic Blood Pressure	
Boys	844	19	2.25
Girls	1191	31	2.60
Total	2035	50	2.46
		Diastolic Blood Pressure	
Boys	844	7	0.83
Girls	1191	24	2.02
Total	2035	31	1.52

**Some subjects had both pressures elevated*

Table VII

Age and Sex Distribution of Subjects with Systolic &/or Diastolic BP > 2SD Above the Mean for Age

Age (yrs)	Number of Subjects SBP			Number of Subjects DBP		
	Males	Females	Total	Males	Females	Total
10	-	-	-	-	-	-
11	1	-	1	-	-	-
12	1	1	2	-	-	-
13	4	3	7	-	1	1
14*	5	6	11	-	2	2
15*	2	8	10	3	9	12
16*	5	3	8	3	6	9
17	-	5	5	1	2	3
18	1	3	4	-	3	3
19*	-	2	2	-	1	1
Total	19	31	50	7	24	31

**Age of those with both pressures elevated. SBP = Systolic blood pressure. DBP = Diastolic blood pressure*

differences in the prevalence rate of systolic high BP, but diastolic high blood pressure was more prevalent in females than males ($X^2 = 4.59, p < 0.03$).

Discussion

In the present study, the mean systolic and diastolic BP rose gradually with age in both sexes, with a more rapid increase during mid-adolescence. This finding has been documented in earlier reports.[7,12-14] The more rapid rise in BP in those aged 14-16 years may be due to hormonal changes associated with pubertal growth spurt.

Similar to the findings of Ayoola,[4] the present study showed definite relationship between blood pressure, height and weight with a weak positive correlation with PR in both sexes. However, multiple regression analysis showed that only variables of weight and pulse rate were the most important determinants of BP in both genders. This is similar to the findings of Ayoola[4] in Ibadan and a report from USA[15] but in contrast to the findings of Sharma *et al* [16] in Indian children. The differences in the relationship of weight, height and PR to BP in the various studies could be attributable to varying age composition, socioeconomic factors and methodology. For instance, in the present study, the fourth phase Korotkoff sound which was used, is known to give a higher DBP reading. Sharma *et al* [16] on the other hand, used the fifth phase which gives a lower DBP value. There is paucity of reports on the relationship between PR and BP in Africans. In the present study, a weak but significant correlation between PR and BP in girls was noted, similar to the findings in white children in the USA by Gilium[17] and Voors *et al*.[18] It is however in contrast to the findings by Sharma *et al* [16] among Indian children where there was no significant correlation between PR and BP. The differences in the relationship of PR to BP in the various studies cannot be easily explained. However, it may be postulated that the variability in duration of taking the PR and varying environmental factors might among others, have influenced the values obtained by different workers.

There have been variable reports on the prevalence of adolescent hypertension ranging from 0 percent to 36 percent.[3,19-21] Varying methodology, sample size, sex, age, environmental and social factors could have contributed to this wide disparity. The use of arbitrary or adult criteria in defining hypertension in children may underestimate the real prevalence of adolescent hypertension. This has been demonstrated in the present study, where the prevalence rate of elevated BP increased significantly when group reference level was used. Cross-sectional studies which demonstrate individuals with significant hypertension on a casual observation deserve further evaluation. Long term follow up is desirable. Such repeated screening may provide further information on the evolution of hypertension which may have its onset in childhood and/or adolescence. Early detection and control of hypertension in early life will reduce the likelihood of complications of the disease, not only in childhood but later in adulthood. Limitations of this study include the lack of urinalysis to exclude renal causes of elevated BP. Follow up period was short; ideally, they should have been followed up for a year to exclude

those with labile hypertension. However, it is hoped that the determination of the BP on several and different occasions in the present study would have minimized this effect.

In conclusion, BP levels in secondary school children in Zaria increased with increasing age with a more rapid rise in mid-adolescence. The point prevalence of high BP in this study population was 3.7 percent using values that were 2SD above the mean for age and sex. It is recommended that routine BP measurements should be encouraged in children and adolescents within the school system for early detection of hypertension. This screening method should be adopted in all schools within the region using group reference levels to determine elevated BP.

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