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ABSTRACT

Objective: **To observe blood pressure (BP) pattern and its correlates in primary school children of northern Nigeria.**
Design: **Sitting BP and pulse were measured in quadruplicate, then repeated after four weeks in 1,721 healthy children aged five to 16 years. Body weight and height were also measured in their school environment.**
Setting: **Primary schools located in three communities in Zaria Local Government Area (LGA) of Kaduna State, Nigeria. The communities were Tudun Wada (University community of migrants with some indigenous Hausa settlers), Zaria City (traditional Hausa community) and Zaria Kewaye (a rural Hausa settlement).**
Results: **BP rose with age. However, BP levels particularly systolic was highest in children from Tudun Wada (TW) (urban), followed by those from Zaria city (ZC) (semi urban), and Zaria Kewaye (ZK) (rural). The mean systolic/diastolic BP (mmHg) were: 99/61, 94/62 and 89/60 in children aged five to ten years; and 112/69, 109/68 and 107/68 in those older than 10 years respectively. The differences in BP levels were evident even as early as the age of five years and appears largely independent of physical stature and gender.**
Conclusion: **These observations suggest that place of residence and ethnicity may be important factors in the progression of BP with age in some children in northern Nigeria.**

INTRODUCTION

Although hypertension is not a major issue in child health, there is some evidence(1-3) to suggest that most adult cases of this condition may have their origin in childhood. For this reason, it is no longer considered inappropriate to initiate primary preventive and promotive strategies against hypertension and other cardiovascular disorders in the paediatric years.

However, the success of such programmes is contingent on basic information concerning the blood pressure pattern and its correlates in the target population. Incidentally, existing data on the profile of BP in Nigerian children have been derived largely from studies conducted in the southern part of the country(3-6). Therefore, it is not entirely clear to what extent, if any, differences in geographic location and by extension, ethnicity may have on the pattern of paediatric BP in different parts of Nigeria. The present study was undertaken with this in view.

MATERIALS AND METHODS

*Study population and location***:** The study was designed to measure BP (in mmHg), heart rate (beats/minute) and selected indices of physical stature in healthy primary school children aged five to 16 years in Zaria Local Government Area (LGA) in Kaduna State, Nigeria.

Zaria LGA is in the savannah belt of northern Nigeria and the people are predominantly Hausa and Muslims. In the University community of Tudun Wada, Zaria, the local Hausa population is however mixed with migrants from the rain forest south of Nigeria, who are mainly Christians.

The Hausa rural community is mainly agrarian; with grains such as (millet, sorghum) and vegetables (for example lettuce, tomatoes) farming combined with cattle, sheep and goat rearing. Diet is typically Hausa: pounded grain paste for example *Tuwo Masa* taken with vegetable/palm oil sauce and meat. Fresh milk and other diary products are usually taken as snacks. Older children contribute to family income by working part-time on family farm as well as grazing the family animals. In some cases, children also hawk the family farm produce. Children usually go to and from school on foot. Early education is often dual - Islamic/Quranic and Western.

Within the metropolitan areas, the indigenous Hausa communities still live this traditional way of life modified in some cases by western influences. Some parents/guardians are government workers while others are in business. Children may walk to and from school or go in private or public automobiles depending on the economic fortunes of their parents or guardians.

On the other hand, in the university community of Tudun Wada, the staple food is derived from tubers such as *cassava* and supplemented with refined food items of western origin. Children usually go to school in buses or cars. The parents/guardians are either lecturers or other university workers; senior civil servants or business people.

Study protocol: Ethical consideration: Prior visits were made to the selected schools to assess co-operation and willingness to participate and to demonstrate sphygmomanometry and other measurement techniques.

Selection of subjects: A multi-staged sampling technique was employed. The list of all primary schools in Zaria LGA was obtained from Kaduna State Primary Schools Management Board. This constituted the sampling frame. Using table of random numbers, two schools were selected from each of the three areas: Zaria City, the traditional home of the indigenous Hausa population (Pada and Lemu Primary Schools), Tudun Wada, an urban area of mainly migrant population (Gyellesu and Tukur-Tukur Primary Schools). and Zaria Kewaye, a rural Hausa settlement (Taukarau and Tukur Kusa Primary Schools). The study population was then divided into strata according to age and sex. A sampling fraction (one out of every five children) was then allocated to each class. This procedure was used to select 1,721 children for the study. The children were asymptomatic and normal on physical examination.

Measurements: All measurements were taken before noon during which time pupils were encouraged to abstain from vigorous physical exercise. Prior to the measurement of BP, basic demographic information was gathered from each pupil using a standard questionnaire filled out by the observer. Thereafter, weight and height were measured in accordance with standard procedure(7).

Blood pressure: Blood pressure (BP) was recorded with a standard mercury sphygmomanometer using two sizes of cuff bladders a 20cm by 9.5cm for children 10 years old or younger and a 22.5cm by 15cm for children older than 10 years. BP was recorded in a large classroom with subject sitting comfortably on a chair and the arm rested at heart level on a table. Measurements were taken after a five-minute rest and in the morning before physical exercise(8). BP reading was taken by the same trained observer throughout the study. Systolic blood pressure (SBP) was determined by the first appearance of Korotkoff sound (Phase 1) and diastolic blood pressure (DBP) was recorded at the point of disappearance of Korotkoff sound (Phase V). Readings were made to the nearest 2mmHg. Before each set of BP readings, heart beat was determined by counting the pulse at the brachial artery for 15 seconds. Measurements of BP and pulse were made in quadruplicates. The BP and pulse for each subject is taken as the average of the four readings. BP recording and pulse was repeated for all the pupils after at least four weeks.

Analysis of data: For each subject, the BP and pulse rate, were the average of the two final readings at least four weeks apart. Statistical significance for analysis of difference was fixed at p = 0.05. Two tailed tests of statistical significance have been used throughout except otherwise stated. In addition, the strength of association between BP and selected variables was examined by Pearson's test of correlation.

RESULTS

BP levels according to age and sex: In both sexes, the mean SBP rose with increasing age (Table 1). In contrast, the mean DBP values were fairly uniform with the boys maintaining only a slightly higher mean DBP after the age of nine years. Specifically, there was no significant (p>0.05) gender difference in the distribution of both SBP and DBP levels in our study population. In addition, the pattern of resting pulse was similar in both sexes as no significant (p>0.05) change in the distribution of this variable by age or gender was evident (Table 1).

Table 1

Blood pressure and heart rate in children studied

la: Males (n = 906)

Age group (years)	No of children	Mean ± SD		
		Systolic mmHg	Diastolic mmHg	Heart rate Beats/min.
5-6	169	86 ± 6	56 ± 6	72 ± 4
7-8	147	92 ± 7	60 ± 8	70 ± 5
9-10	145	102 ± 6	64 ± 6	76 ± 3
11-12	139	102 ± 8	66 ± 7	72 ± 5
13-14	175	106 ± 7	67 ± 7	75 ± 6
15-16	133	115 ± 6	72 ± 7	74 ± 7

1b: Females (n = 815)

Age group (years)	No of children	Mean ± SD		
		Systolic mmHg	Diastolic mmHg	Heart rate Beats/min.
5-6	173	86 ± 6	97 ± 5	76 ± 7
7-8	140	92 ± 7	98 ± 7	74 ± 4
9-10	138	102 ± 6	106 ± 8	70 ± 8
11-12	134	102 ± 8	106 ± 7	80 ± 7
13-14	173	106 ± 7	114 ± 6	78 ± 5
15-16	107	115 ± 6	117 ± 5	82 ± 7

Comparison of anthropometric variables by age and gender in the three sub-groups of children from the three educational zones: The mean heights of the males were consistently higher than those of the females until at the age of eleven years, when the trend was reversed (Table 2). For all other parameters measured directly or derived for example Body Mass Index (BMI), the girls had higher mean values. The data summarised in Table 2 appear overall to show that while the children, particularly older adolescents in Zaria city were thinner, the children in Tudun Wada appear to have higher body weights.

Blood pressure levels by area of residence: Figure 1 shows the comparative levels of blood pressure by age and gender in children from the three sub-populations. BP levels particularly SBP were (p<0.05) significantly higher in children from Tudun Wada educational area, across most age groups, even as early as the age of five compared to those from the other two areas of Kewaye (rural) and Zaria city. This difference was still evident even after the age groups have been collapsed into three and the sexes combined (Table 3).

Table 2

Comparison of mean anthropometric variables across age divisions in boys (A) and girls (B) in ZK (rural) TW (urban & ZC (Zaria city) (Hausa traditional)

Age	Area	Height (A)	Weight (A)	n (A)	Height (B)	Weight (B)	n (B)
5- 6 yrs	ZK	1.16 ± 0.11	18.0± 2.1	28	1.15 ± 0.20	19.4 ± 3.1	24
	TW	1.18 ± 0.13	17.6 ± 3.0	42	1.14 ± 0.10	19.6 ± 2.0	37
	ZC	1.17 ± 0.11	17.0 ± 3.4	49	1.12 ± 0.10	18.3 ± 2.3	49
7- 8 yrs	ZK	1.18 ± 0.14	17.9 ± 2.9	36	1.14 ± 0.72	19.6 ± 2.0	18
	TW	1.20 ± 0.11	18.9 ± 2.5	32	1.16 ± 0.16	19.2 ± 4.8	33
	ZC	1.22 ± 0.10	19.3 ± 2.6	29	1.16 ± 0.90	19.4 ± 2.1	25
9-10 yrs	ZK	1.22 ± 0.61	27.0 ± 3.4	29	1.29 ± 0.40	28.7 ± 5.3	26
	TW	1.30 ± 0.07	24.1 ± 3.1	30	1.27 ± 0.24	26.7 ± 6.8	26
	ZC	1.29 ± 0.08	25.7 ± 3.2	36	1.29 ± 0.14	28.0 ± 6.7	26
11-12 yrs	ZK	1.34 ± 0.08	29.0 ± 4.1	18	1.40 ± 0.17	29.2 ± 6.0	19
	TW	1.39 ± 0.59	29.0 ± 4.6	35	1.41 ± 0.71	34.0 ± 6.0	29
	ZC	1.37 ± 0.54	28.7 ± 5.0	38	1.40 ± 0.62	32.7 ± 6.2	32
13-14 yrs	ZK	1.40 ± 0.13	31 ± 3.9	27	1.44 ± 0.11	35.8 ± 5.1	18
	TW	1.41 ± 0.17	35.1 ± 5.3	48	1.43 ± 0.14	38.2 ± 5.9	34
	ZC	1.43 ± 0.11	34.1 ± 6.1	50	1.45 ± 0.12	36.0 ± 5.4	40
15-16 yrs	ZK	1.41 - ± 0.31	42 ± 6.3	18	1.49 ± 0.23	49.1 ± 5.8	9
	TW	1.50 ± 0.21	40.1 ± 9.0	30	1.42 ± 0.20	48.3 ± 4.4	12
	ZC	1.54 ± 0.19	34.8 ± 9.9	35	1.59 ± 0.07	47.9 ± 4.4	15

All values are mean + standard deviations for n determinations (n = number of pupils in the age group)

Table 3

Mean blood pressures in children in the three study areas: Kewaye (rural), Zaria City (Hausa), and T/Wada (urban) separately and combined

Age group (yrs)	Sex	Kewaye Area (Rural)			Zaria City Area (Hausa)			Tudun Wada Area (Urban)			Pooled BP for the Three areas		
		n	SBP mmHg	DBP mmHg	n	SBP mmHg	DBP mmHg	n	SBP mmHg	DBP mmHg	n	SBP mmHg	DBP mmHg
5-10	M	79	89	59	112	93	60	112	97	61	303	93	60
5-10	F	63	89	60	92	95	63	96	100	61	252	95	61
11-16	M	59	106	68	123	108	68	113	111	67	295	109	68
11-16	F	39	107	67	87	109	67	75	112	70	301	110	68
M + F													
5-10		142	89	60	204	94	62	208	99	61	555	94	62
11-16		98	107	68	210	109	68	188	112	69	596	110	68

All values are means for separate areas and pooled means (weighted) for all the three areas according to age and sex grouping.

Table 4

Correlation coefficients (r) between BP parameters and selected variables in subjects.

4a. Males (n = 578)

Age	Blood pressure	Weight	Height	BMI
5-6 yrs	SBP	0.19	0.25	0.56
(169)	DBP	0.44	0.45	0.39
7-8 yrs	SBP	0.38	0.48	0.60
(147)	DBP	0.22	0.50	0.31
9-10 yrs	SBP	0.21*	0.11	0.29
(145)	DBP	-0.17	0.27	-0.09
11-12 yrs	SBP	0.40	0.19*	0.37
(139)	DBP	0.26	0.07	0.19
13-14 yrs	SBP	0.53	-0.20	0.16
(175)	DBP	0.19	0.23	0.05
15-16 yrs	SBP	-0.20	0.38	0.02
(133)	DBP	0.17	0.10	0.06

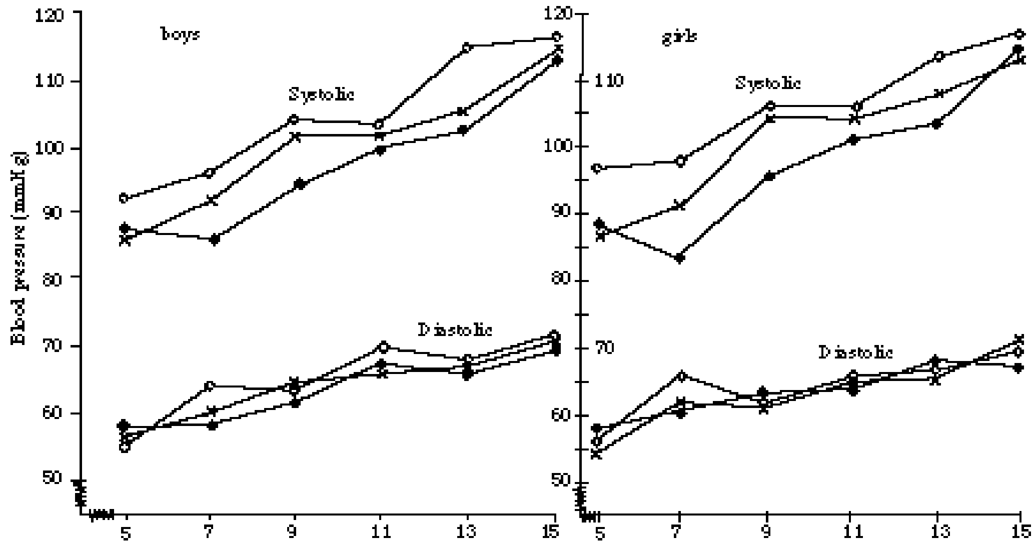
4b: Females (n = 452)

Age	Blood pressure	Weight	Height	BMI
5-6 yrs	SBP	0.18*	-0.21	0.37
(173)	DBP	0.20	-0.14	0.47*
7-8 yrs	SBP	0.22	0.09*	0.40
(140)	DBP	0.11*	0.26	0.21
9-10 yrs	SBP	0.24	0.11	-0.51
(138)	DBP	0.12	0.20*	0.31
11-12 yrs	SBP	0.21	0.29*	0.40
(134)	DBP	0.18	0.31	0.26
13-14 yrs	SBP	0.31*	0.12	0.38
(173)	DBP	0.17	0.16	0.41
15-16 yrs	SBP	0.20	0.31*	0.21
(107)	DBP	0.21	0.39	0.19

* Indicates significant r value at $p < 0.05$.

Figure 1

Distribution of mean systolic and diastolic blood pressure by age in boys and girls from Tudun Wada (urban o—o), Zaria City (Hausa traditional settlement area of indigenous population (x—x) and Zaria Kewaye (rural ǀ —ǀ)



Influence of body size and other variables on BP: Because of the variations in weight, height and other anthropometric variables in the three groups, and given reports(2,6,9-10) indicating that these parameters may influence the distribution of BP levels in children; the possible influence of selected indicators of body size or composition of BP was examined by test of correlation. Tables 4a and 4b summarise the correlation coefficients (r) and the level of significance so derived. The data showed that the degree of correlation was either extremely weak or was not statistically significant at the level of 95% confidence.

DISCUSSION

The present results show that BP, especially the systolic component increases with age consistent with earlier reports(2-6,9-10). However, there are a number of major differences between the findings of this study and previous ones.

First, in children older than 10 years, the range of BP levels observed in this study is much lower than those reported in similar groups of children from the southern part of the country(4-6). It is possible that differences in measurement techniques may have contributed to this. For example, in this study, disappearance of Korotkoff (Phase V) was the end point used for reading DBP as against phase IV in the study of Akinkugbe *et al*(5). Nevertheless, it is doubtful whether this factor alone could have accounted for the lower BP readings noted in this population of children compared to their southern counterparts. A more recent study(6) in Nigerian children, mainly of Yoruba extraction and using similar techniques as in this study has also reported higher values in children of comparable age. This latter point suggests that the present findings in the older children are likely to reflect a true difference. This conclusion is reinforced by the comparable levels of BP in the younger groups of children in our study and those of the above cited investigators(5,6).

Second, the rise in DBP levels with age widely reported in studies from the southern part of Nigeria(4-6), appears steeper in comparison to the present observation where the rise in DBP with age was barely perceptible (Figure 1).

Third, in contrast to previous data(2,4-6,9) which indicate that BP were higher in girls compared to boys of similar age particularly during adolescence, we found no such gender difference consistent with the report of Abdulrahman and Ochoga(11) . In particular, BP levels were comparable in both sexes across most age divisions. This observation is at variance with findings in other Nigerian studies(4-6), as well as those from other parts of the world(2, 9) which indicate that the bigger body size of females was a major determinant of BP in older children. Therefore, our findings appear unique to this group of Nigerian children.

Of note in this regard is that those indicators of body sizes assessed in this study, for example weight, height and BMI were either comparable or higher in our study population compared to those in children of similar age reported in the southern parts of Nigeria(4-7). Thus, it seems unlikely that differences in physical stature was a major factor in the differences in BP observed. In support of this conclusion is the data summarised in Table 4 which show that none of the indicators of body dimensions evaluated was meaningfully correlated with BP. Thus, neither body weight nor height appears to be a critical determinant of BP in this population of children in contrast to reports from Ibadan(5) and more recently Ilorin(4,6), and elsewhere(2,5,12). Our findings, therefore, are consistent with a number of other reports(13,14) which indicate that at best body dimension only exerts a minor difference in BP in some paediatric population. Of note, the literature suggests that over-weight is not a common concomitant of elevated BP in adult Nigerians(15-17). Therefore, our findings reinforce the position(13,14) that in some populations, the influence of body size on BP in relation to other factors, such as age and heredity may have been overstated.

Apart from the foregoing, perhaps the most striking finding in this study is that area of residence was a major influence in the distribution of BP levels in the three groups of children. The children from the urban area of Tudun Wada had the highest level of BP, while the lowest level of BP was associated with the paediatric population of Hausa rural settlement of Zaria Kewaye.

This finding is at variance with recent observations(6) in Yoruba children from the llorin area which show that BP level was not influenced by area of residence whether rural, urban or semi-urban. It is possible, however, that the differences in the ethnic compositions of the two study populations may have accounted for this difference. However, our observation is consistent with many reports(17-19) which show differentiation of BP levels according to urban or rural settlement, especially in adult populations. It is striking that the present study shows that such differentiation of BP levels are evident in some paediatric populations of northern Nigeria even as early as the age of five years. This may therefore suggest that differences in diet and life style evident in the three populations of children studied may account for the disparities in BP levels observed. Thus, it appears that those adverse environmental factors that may interact with the cardiovascular system to encourage the progression of BP that manifest as hypertension in some adults may already have been in operation as early as the age of five years. In this regard, it is important to note that even within Zaria municipality, the traditional Hausa settlement (Zaria city) had much lower levels of BP compared to the predominantly migrant population of Tudun Wada, but higher than those observed in children from the rural Hausa settlement of Zaria Kewaye. This could well mean that even in urban areas, communities that are still able to preserve their traditional way of life are less likely to experience steep increases in BP that can be expected with ageing. Whether this observation in itself plays a key role in the progression of hypertension is not clear from this study but is consistent with recent observation in the adult population from the same part of Nigeria(20).

In conclusion, this study shows major differences in the profile of BP in this group of children in northern Nigeria and suggests that area of settlement may play a dominant role in the rise of blood pressure with age.

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