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## **Pattern of paediatric blood pressure in rural, semi-urban and urban communities in Ilorin, Nigeria**

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### **Summary**

The blood pressures of 2,526 children aged between 1 and 14 years were measured in their home environments in rural, semi-urban and urban communities in Ilorin. Blood pressure increased with age, but there was no significant difference between the communities. Girls had higher blood pressures than boys between the ages of 9 and 13 years, in the semi-urban and rural communities. The prevalence of high blood pressure in the urban community (9.5%) was higher, though not significantly so, than the rural community (6.3%). It is concluded that the prevalence of paediatric high blood pressure in the African is higher than previously reported.

### **Résumé**

La tension artérielle sanguine de 2,526 enfants âgés de 1 à 14 ans a été mesurée chez eux dans les communautés rurales, semi-urbaine et urbaine d'Ilorin. La tension sanguine a augmenté par rapport à l'âge mais la différence entre les communautés était négligeable. Entre les âges de 9 à 13 ans les filles ont des tensions plus élevées que les garçons dans les communautés rurales et semi-urbaines. La prévalence de l'hypertension dans la communauté urbaine était plus élevée (soit 9.5% mais pas d'une façon significative) que celle de la communauté rurale (soit 6.3%).

En conclusion, la prévalence de la tension artérielle chez les enfants africains est plus élevée qu'on ne le rapportait auparavant.

### **Introduction**

Systemic blood pressure surveys in the African have usually been done in the adult [1,2], with very little information on patterns in children [3]. The few available reports on paediatric blood pressure were carried out in school children [3,4,5] mostly in urban communities. In adult blood pressure measurements, it is generally agreed that high blood pressure is more prevalent in urban communities. Furthermore, some of the reports are conflicting as is the case with the influence of sex on blood pressure [4,5], while most did not report on children in the 1-4 year (pre-school) age group, since the studies were done in the school premises. Thus, there is still a paucity of knowledge on the blood pressure pattern in children, particularly in Africa, despite the high prevalence of high blood pressure in these communities.

The purpose of this study was therefore to determine the blood pressure pattern of children, 1-14 years old in a relaxed atmosphere in rural, semi-urban and urban communities in Nigeria.

### **Methodology**

#### *Subjects:*

Blood pressure was randomly measured in 2,526 (male: 1,354; female: 1,172) children aged between 1 and 14 years at their homes. Their participation was voluntary and the parents and the Emir and/or Balogun gave consent. We excluded children whose parents indicated that they were on any form of medication — traditional or western. The measure-

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ments were done in an open air environment between 4.00 and 6.00pm in their homes/compounds. For each subject, we recorded the height (without shoes), weight (with minimal clothes on), and the systolic and diastolic blood pressures. Data were not collected if the child cried. All the measurements were done in the presence of the other children and the parent(s). There were no abnormal physical findings in the children.

#### Locality:

Three communities were chosen for this study: Okelele (urban), Opo-malu (semi-urban) and Shao (rural). The classification of the communities into urban, semi-urban or rural is based on size of population, availability of basic infrastructures, physical planning, amongst others [6].

#### Methods:

Blood pressure was recorded on the right arm with the child seated or carried by the mother where appropriate, and the mercury sphygmomanometer and arm approximately at heart level. Appropriately sized cuffs (1-8 years: 8cm and 9-14 years: 13cm in diameter) were used for the blood pressure measurements. The systolic pressure was taken as the first Korotkoff sound whilst the diastolic pressure was taken as the point of disappearance of the Korotkoff sounds (5th Korotkoff phase). Occasionally, the point of muffling (4th Korotkoff sound) was taken as the diastolic blood pressure if it did not disappear. The measurements were made to the nearest 5mmHg. One estimate of the blood pressure was made in each subject by one of the three of us. The measurements were done in the children's home/compound and in their normal environment. High blood pressure was taken as a value equal to or greater than 130/80mmHg [6] for all age groups.

Heights and weights were recorded in cm. and kg. respectively and to the nearest tenth of a unit.

#### Statistical analyses:

Values in text, table and figures are given as mean  $\pm$  SEM. The significance of the difference was analysed using student's *t*-test and ANOVA where appropriate. A P value equal to or less than 0.05 was considered significant.

#### Results

Of the total 2,526 children examined, 53% were males while 47% were females. Approximately the same proportion was maintained in the three communities studied, except at ages 13 and 14 years when there were fewer females than males, particularly in the rural area. This may be related to migration of the females to urban centres and to other parts of the state.

The mean and standard error of the mean for the weights and heights of boys and girls are shown in the table. There was a steady increase in both these values in the sexes throughout the age range studied. There was no difference in these parameters between the communities.

#### (a) Pattern of systemic blood pressure in boys

Fig. 1 shows the mean systolic and diastolic blood pressures in boys, 1 to 14 years old. The mean systolic blood pressure at age 1 was  $98 \pm 4$ mmHg (Okelele),  $94 \pm 2$ mmHg (Opo-malu) and to  $96 \pm 2$ mmHg (Shao). These values rose steadily to  $115 \pm 3$ mmHg (Okelele),  $111 \pm 2$ mmHg (Opo-malu) and to  $109 \pm 2$ mmHg (Shao) at age 14 years. There is no statistically significant difference in these values between the communities. Similarly, the diastolic blood pressure rose from  $54 \pm 1$  to  $69 \pm 2$ mmHg (Okelele);  $52 \pm 2$  to  $66 \pm 2$ mmHg (Opo-malu) and  $51 \pm 2$  to  $70 \pm 2$ mmHg (Shao), with no difference between the communities.

#### (b) Pattern of systemic blood pressure in girls

The mean systolic and diastolic blood pressures are presented in fig. 2. The systolic blood pressure rose steadily from  $94 \pm 2$  to  $110 \pm 3$ mmHg (Okelele);  $94 \pm 2$  to  $106 \pm 3$ mmHg (Opo-malu) and from  $95 \pm 1$  to  $113 \pm 4$ mmHg (Shao) between the ages of 1 and 14 years respectively. These values are not statistically significantly different from one another. Similarly, the diastolic blood pressure rose from  $50 \pm 1$  to  $67 \pm 3$ mmHg (Okelele);  $51 \pm 1$  to  $64 \pm 2$ mmHg (Opo-malu) and from  $50 \pm 1$  to  $62 \pm 5$ mmHg (Shao). These values are again not statistically significantly different between the communities.

## Paediatric blood pressure in Nigeria

Table 1: Mean weights and heights of boys and girls in the communities

Age	Sex	Okelele (Urban)			Opo-Malu (Semi-urban)			Shoa (Rural)		
		N	Wt	Ht	N	Wt	Ht	N	Wt	Ht
1	M	14	8.7 ±0.3	74.0 ±0.6	15	9.1 ±0.5	73.3 ±0.9	9	7.8 ±0.9	73.3 ±0.9
	F	13	7.9 ±0.4	74.0 ±2.5	12	9.1 ±0.5	73.8 ±1.6	9	8.5 ±0.5	73.8 ±1.6
2	M	21	9.7 ±0.5	78.5 ±1.0	30	10.2 ±0.2	81.0 ±0.7	19	9.3 ±0.3	79.3 ±1.8
	F	36	9.7 ±0.3	78.4 ±0.9	27	10.0 ±0.4	80.0 ±1.1	13	9.8 ±0.2	80.5 ±1.2
3	M	27	11.9 ±0.4	88.7 ±1.3	34	12.5 ±0.3	92.4 ±1.2	27	12.2 ±0.5	90.5 ±1.2
	F	31	11.5 ±0.3	87.4 ±1.3	41	12.9 ±0.4	90.3 ±0.9	27	10.7 ±0.4	88.7 ±1.6
4	M	33	14.2 ±0.3	96.9 ±1.2	42	14.8 ±0.4	100.6 ±0.9	50	13.9 ±0.3	98.2 ±1.0
	F	49	13.7 ±0.5	95.4 ±1.2	50	14.6 ±0.3	100.1 ±1.0	34	13.7 ±0.4	97.7 ±1.0
5	M	28	16.1 ±0.4	103.4 ±1.3	46	16.4 ±0.3	105.2 ±0.9	34	16.9 ±0.5	105.0 ±1.0
	F	34	15.9 ±0.4	103.7 ±1.3	29	16.1 ±0.3	106.5 ±1.0	41	16.1 ±0.3	104.3 ±1.0
6	M	60	18.2 ±0.4	110.9 ±1.0	41	19.2 ±0.5	114.0 ±1.3	39	17.7 ±0.6	112.7 ±1.0
	F	40	17.0 ±0.4	108.7 ±1.1	39	18.3 ±0.5	113.7 ±1.3	54	18.5 ±0.5	114.1 ±0.9
7	M	35	19.3 ±0.4	114.1 ±1.1	48	20.7 ±0.4	118.8 ±1.0	30	18.5 ±0.5	114.6 ±1.2
	F	18	20.5 ±0.5	117.0 ±1.4	34	20.4 ±0.6	115.0 ±1.2	28	19.4 ±0.3	117.1 ±0.9
8	M	27	20.8 ±0.4	119.2 ±1.1	40	22.5 ±0.5	123.1 ±1.1	33	22.0 ±0.6	122.9 ±1.4
	F	31	21.7 ±0.7	120.4 ±1.5	37	23.4 ±0.7	124.0 ±1.1	39	22.3 ±0.6	122.2 ±1.5
9	M	18	23.4 ±0.9	127.4 ±1.4	40	24.0 ±0.4	128.3 ±1.0	22	23.5 ±1.3	129.0 ±1.7
	F	14	24.0 ±1.2	123.3 ±4.6	46	24.6 ±0.5	129.0 ±1.5	26	24.1 ±0.7	125.8 ±1.2
10	M	35	26.2 ±0.7	131.3 ±1.4	46	26.2 ±0.5	131.6 ±1.3	39	27.5 ±0.8	133.5 ±1.2
	F	21	27.5 ±1.0	131.4 ±2.8	43	26.8 ±0.6	132.4 ±0.9	30	26.4 ±0.6	130.5 ±1.4

Table 1: Mean weights and heights of boys and girls in the communities

Age	Sex	Okelele (Urban)			Opo-Malu (Semi-urban)			Shoa (Rural)		
		N	Wt	Ht	N	Wt	Ht	N	Wt	Ht
11	M	15	27.5 ±0.9	133.2 ±1.6	43	28.0 ±0.5	153.5 ±0.9	16	28.5 ±0.9	136.7 ±1.2
	F	8	29.8 ±1.0	139.3 ±2.2	35	31.4 ±1.4	139.5 ±1.3	17	27.6 ±1.2	136.0 ±1.8
12	M	24	30.6 ±1.0	141.8 ±1.5	61	31.9 ±0.6	141.6 ±1.0	42	30.9 ±0.9	141.1 ±1.3
	F	20	30.5 ±1.5	138.9 ±2.3	52	37.3 ±1.1	146.4 ±1.5	16	30.1 ±0.8	139.1 ±1.8
13	M	26	33.4 ±1.2	143.3 ±1.8	44	33.2 ±0.8	144.3 ±1.3	26	35.8 ±1.5	146.1 ±2.3
	F	9	36.2 ±1.5	146.5 ±2.4	24	38.8 ±1.8	147.9 ±1.8	4	35.0 ±4.0	146.0 ±2.0
14	M	21	37.1 ±1.5	148.8 ±2.0	36	38.7 ±1.2	150.0 ±1.5	23	36.2 ±1.4	147.1 ±1.9
	F	10	39.2 ±2.0	150.0 ±2.2	21	39.0 ±1.5	148.7 ±2.3	6	42.3 ±2.4	150.7 ±1.6
Total		718			1056			752		

(N = number of subjects).

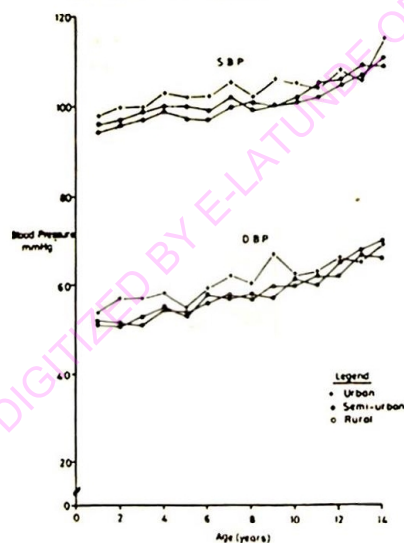


Fig. 1: Systemic blood pressure in boys. SBP = Systolic blood pressure; DBP = Diastolic blood pressure; + = urban; • = semi-urban; and o = rural.

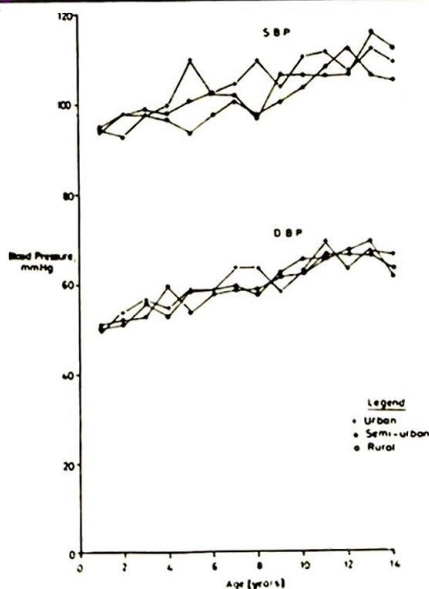


Fig. 2: Systemic blood pressure in girls. SBP = Systolic blood pressure; DBP = Diastolic blood pressure; + = urban; • = semi-urban; and o = Rural.

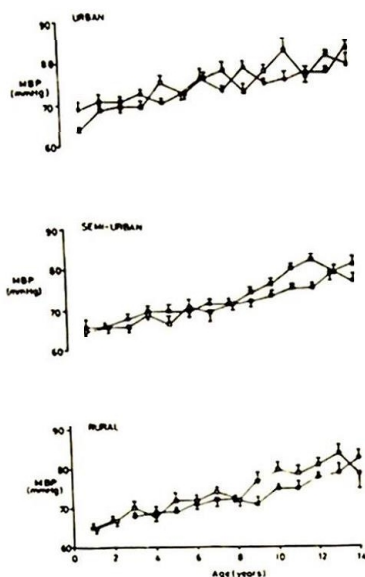


Fig. 3: A comparison of mean blood pressure (MBP) of boys (■) and girls (□).

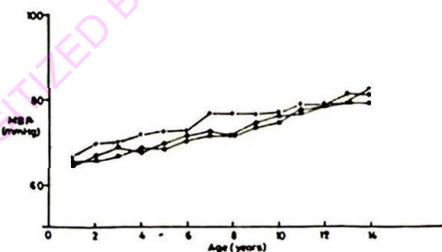


Fig. 4: Mean blood pressure in the three communities: urban (+), semi-urban (•), and rural (O).

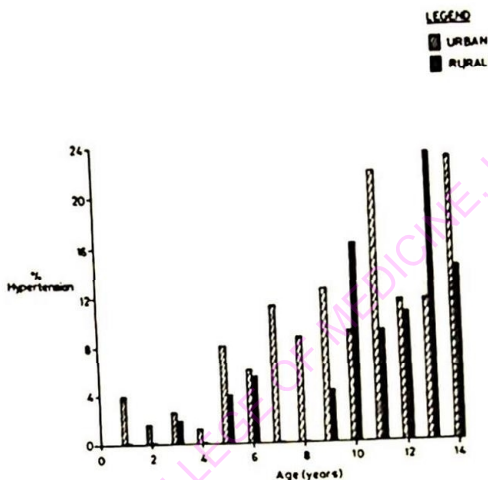


Fig. 5: Percentage high blood pressure (as defined by > 130/80mmHg) in urban (▨) and rural (■) communities.

(c) Comparison of mean blood pressure of boys and girls

Fig. 3 shows the mean blood pressure (MBP) of boys and girls in the three communities. The MBPs are similar in the three communities upto 8 years of age. In the rural and semi-urban communities, the girls had slightly but significantly ( $P < 0.05$ ) higher MBPs than boys between the ages of 9 and 12 years (semi-urban) and 9 and 13 years (rural). The urban values did not show similar trends.

(d) Mean blood pressure in the three communities

Fig. 4 shows the MBPs in the three communities. There was a steady increase in the MBPs with age, with no statistically significant difference between the communities.

(e) Prevalence of high blood pressure in children

Fig. 5 shows a gradual increase in percent high blood pressure with age. The mean prevalence values for all ages in the urban and rural communities were  $9.5 \pm 1.7\%$  and  $6.5 \pm 2.0\%$  respectively, but were not significantly different.

## Discussion

The main objective of this study was to document the blood pressure of children aged 1 - 14 years in their home environments in rural and urban communities.

It was hoped that measurement at home would allay apprehension and thus eliminate or reduce the effect of one major factor (unusual environment) that could affect the arterial blood pressure, particularly in children. Our results show that the systolic, diastolic and mean blood pressures increase with age. These observations are similar to earlier reports in Africans [4, 5] and in caucasians [7] and also in adult African populations [1, 8, 9, 10]. One major difference between these previous studies and the present report is that we determined the blood pressure of pre-school age children. Furthermore, we looked at the blood pressure in three different communities in apparently relaxed asymptomatic children.

In contrast to the studies in adult African population, the girls' MBP was higher than boys' between the ages of 9 and 12 years (semi-urban) and between 9 and 13 years (rural). On the other hand the boys' and girls' blood pressure in the urban community did not show this difference. This may explain why some workers have observed no difference in the blood pressure of boys and girls [1, 7] while others have noted a higher systolic blood pressure in girls in comparison to the boys [4]. Moss & Adams [12], and Zinner *et al.* [13] observed that the rise in systolic and diastolic blood pressures with age was more marked and more consistent in girls than in boys. This suggests that sex is a determining factor in paediatric blood pressure [4], but that this is modulated by the environment. In the rural and semi-urban communities, the systemic blood pressure of boys and girls tended to be lower than in the urban community, as observed in this study. Body weight and height also increased with age. We did not study the correlation of blood pressure with some indices of growth, but, it is pertinent to note that other workers have found a correlation between blood pressure and weight and height [13].

Studies of high blood pressure usually focus more on the adult African population than the paediatric population. A major reason for this is that it is difficult to define what paediatric high blood pressure is: One criterion for determining high blood pressure is that the blood pressure for that age is more than twice the standard deviation of the mean. Another method is to define the blood pressure as high if the blood pressure is persistently above 95th percentile for that age. In this study, we have chosen the value of 130/80mmHg and above as high blood pressure [6]. The prevalence of paediatric high blood pressure in the urban community was  $9.5 \pm 1.7\%$

while that in rural community was  $6.3 \pm 2.0\%$ . It is not immediately clear why the percent high blood pressure in the rural community was higher than in the urban community at ages 10 and 13 years. The two communities have roughly the same number of subjects. Our results show that up to the age of 8 years, high blood pressure was uncommon, with the rural community having much less prevalence. However, from the age of 9 years upwards, there was an increase in the prevalence of high blood pressure in both urban and rural communities, the rural community still having the generally lower prevalence. This suggests that high blood pressure does occur in the paediatric population and that the influence of environment (urban versus rural, as is the case in adult population studies) may already be evident in this age group. Indeed, in children aged 5-6 years, there is evidence that geographical factors which affect blood pressure independently of social class are already operating [14]. The reported prevalence of high blood pressure in adults is about 8 — 10% in the rural and 10 — 12% in the urban communities [6]. Indeed, Takeuchi [16] suggested that hypertension may start at an earlier age than was previously thought.

Our values of the incidence of paediatric high blood pressure are relatively high compared to other reported values. This is probably so because others have used the value of 140/90mmHg as the cutoff point for ages 10 and above [1]. Indeed, when we used twice the standard deviation as the criterion of high blood pressure the prevalence of high blood pressure was  $4.9 \pm 2.8\%$  (urban) and  $2.9 \pm 0.8\%$  (rural), values that are similar to the reports of other workers. We used 130/80mmHg for all age groups.

The aetiology of the high blood pressure was not investigated in this study. However, it is pertinent to note that the children were asymptomatic. There was no evidence of obesity, nor of physical abnormality. It is known that hypertension in children may be associated with a family history of hypertension. For example, Londe *et al* [17] reported that in 74 asymptomatic children with hypertension, 53% were overweight and 44% had one parent with hypertension.

In conclusion, this study shows an increase in paediatric blood pressure with age. Furthermore, the incidence of high blood pressure increases with age. It also suggests that paediatric high blood pressure may be more common in Nigeria than previously reported, perhaps because of the changing life style of the Nigerian communities.

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