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Blood pressure and anthropometric measurements in healthy primary school entrants in Jos, Nigeria

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Objectives. To describe blood pressure and its relationship to weight and height in healthy newly enrolled school entrants in Jos, Plateau State, Nigeria.

Methods. We measured the blood pressures of 650 healthy, randomly selected pupils after a complete physical examination at the start of school in the morning, using standard procedures.

Results. There were 301 male and 349 female children (male/female ratio 0.9:1). Their ages ranged from 5 to 12 years, with a mean of 6.6 (standard deviation (SD) 1.3) years. Mean systolic and diastolic blood pressures were 102.5 (SD 9.43) and 73.0 (SD 10.0) mmHg, respectively, and were significantly higher in private school pupils compared with public school pupils (97.1 (SD 9.17) and 70.1 (SD 9.65) mmHg, respectively, $p<0.05$). Blood pressure did not differ significantly between the genders. Mean systolic and diastolic blood pressures increased with age, weight and height in both genders. Anthropometric indices had a positive correlation with systolic and diastolic blood pressures (r=0.26 - 1.22, $p<0.05$). Two children (0.3%) had persistently elevated blood pressure.

Conclusion. Blood pressures were higher in private school pupils compared with public school pupils of the same age, while height and weight had a direct relationship to the systolic and diastolic blood pressures. Routine blood pressure monitoring of schoolchildren should be encouraged, starting at school entry to serve as a baseline assessment, with follow-up when indicated. In addition, blood pressure measurement should be a part of the routine clinical examination of children.

Regardless of patient age, measurement of the blood pressure should be part of routine physical examination. Its value as a screening tool for hypertension in adults has long been documented. It is currently firmly established as an important component of the routine paediatric physical examination[1] and should be done annually after 3 years of age, or earlier in children with a history of neonatal problems, renal disease or familial risk factors.[2]

The necessity for routine blood pressure screening in children was debated in the past, the main argument against it being that essential hypertension is an adult disease and there is no evidence that screening healthy children for hypertension is rewarding.[3] However, though long considered rare in children, hypertension is being diagnosed increasingly often and is known to exist in African children.[4] In the majority of cases it has some underlying cause, as demonstrated by Aderele and Seriki in their study at the University College Hospital, Ibadan, Western Nigeria, where renal abnormalities were the most common cause of elevated blood pressure in children.[4] They also showed that hypertension was commonest in children aged 5 - 10 years.[4]

On the basis of expert opinion, organisations such as the American Academy of Pediatrics now recommend routine screening of asymptomatic adolescents and children during preventive care visits, as treatable causes of secondary hypertension such as coarctation of the aorta can potentially be identified.[5] However, there are limited data on the benefits or risks of screening and treating such underlying causes of hypertension in children, and the decision whether or not to screen remains a matter of clinical judgement.[5]

Whether blood pressure is routinely measured in paediatric clinical practice in the Nigerian setting is uncertain. Moreover, healthy primary schoolchildren are unlikely to attend preventive care visits and therefore miss opportunities to have a baseline blood pressure screen. To diagnose hypertension in an individual child, the normal value for his or her age, gender and height needs to be known. There are limited reports on blood pressures of new primary school pupils in our setting, especially in the northern part of Nigeria. Since they form a sizeable proportion of the population,[6] measurement of blood pressure in healthy schoolchildren, especially during routine medical examination at school entry, presents an opportunity to obtain normative blood pressure data for our paediatric population through the school health programme.

Study design and methods

The data for this study were obtained from a previous cross-sectional survey of new primary school entrants in Jos, Plateau State, where 650 children (349 girls and 301 boys) were selected through a multi-stage proportionate random sampling of public and private schools. For the years 2002/2003, 8 380 and 3 872 children were newly enrolled into public and private schools, respectively, and 445 pupils from public and 205 pupils from private schools were selected. The study was approved by the Ethics Committee of Jos University Teaching Hospital and permission was obtained from the local education commission. Written informed consent was obtained from the parents or legal guardians of the pupils selected. A questionnaire for parents or guardians on personal data of the pupil, symptoms of renal disease, and medical and drug history was attached to the consent forms. The socio-economic status of the subjects was determined using the socio-economic indices of the parents as described by Olusanya *et al.*[7] The pupils underwent physical examination by two senior paediatric residents, including blood pressure, weight and height measurements, as described below.

The subjects' blood pressure was measured using a mercury sphygmomanometer (Accoson, hospital model BS 274, Accoson Works, Vale Road, London, N4 1PS). Measurement was done as recommended in the 7th Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure (JNC-7),[8] with the subjects sitting quietly and the right arm on a table at the level of the heart. An appropriately sized cuff, covering at least two-thirds of the upper arm with the lower border not less than 2.5 cm from the cubital fossa, was applied after restricting clothing had been removed. The manometer was at the level of the cuff. The brachial artery was palpated and its position noted. The cuff was then inflated to a pressure of 30 mmHg above the level at which the radial pulse was no longer palpable. The stethoscope was placed over the brachial artery in the cubital fossa and the pressure in the cuff was lowered at 2 mmHg every second until the first Korotkoff sound was heard. This was recorded as the systolic blood pressure (SBP). The pressure in the cuff continued to be lowered until the sounds completely disappeared. This was the fifth Korotkoff sound, and the pressure here was recorded as the diastolic blood pressure (DBP). The blood pressure was measured twice and the mean recorded.

The subjects' height was measured with an Accustat Ross stadiometer. The children stood erect with their heels, buttocks, shoulders and occiput against the stadiometer, so that the external auditory meatus and lower border of the eye sockets were in the same horizontal plane. The headboard was brought down to touch the head, and the height was read off the stadiometer.[9,10] The measurements were recorded to the nearest 0.1 cm.

The subjects were then weighed using a Weylux scale, which has an accuracy of 0.5 kg.[10] The scale was calibrated frequently to ensure its accuracy, using standard weights. Weight was measured to the nearest 0.1 kg with the subjects standing barefoot and wearing light underclothes only.

Data analysis

Data were analysed using EPI Info 2000 1.1.2a statistical software. Values were expressed as means (standard deviations (SD)) for age, weight, height, pulse rate and blood pressure. Pearson correlation statistics were used to determine correlation coefficients. A p-value <0.05 was considered significant.

Results

There were 301 males and 349 females (ratio 0.9:1). The mean age was 6.6 years (SD 1.3, range 5 - 12). The majority of the children in the public schools were from the lower socio-economic class (93%), while the children in the private schools were from the middle and upper socio-economic classes (55% and 40%, respectively). There was no difference in the mean weight of the pupils when stratified by type of school, but the children from the private schools were on average younger and taller than those from the public schools (Table I). The mean pulse rate was faster in girls than boys, but type of school was not associated with a difference in the pulse rate. The mean systolic and diastolic blood pressures were similar for male and female pupils. Mean SBP tended to increase with age among the female pupils (Fig. 1), but the DBP was significantly higher in boys than girls in the age group 9 and 10 years (p<0.05).

Fig. 2 shows that pupils at private schools had a higher SBP and DBP compared with those from public schools, with means of 102.5 (SD 9.43) and 73.0 (SD 10.0), respectively, in private school pupils and 97.1 (SD 9.17) and 70.1 (SD 9.65) in public school pupils (p<0.05). A higher proportion of private school pupils than public school pupils had a higher than normal blood pressure as defined by the JNC-7,[8] i.e. >95th percentile for age, gender and height; 9.8% (20) and 1.3% (6) of pupils from private and public schools, respectively, had an SBP >95th percentile, while 5.4% (11) and 1.1% (5) had a DBP >95th percentile. Two pupils had a persistently elevated blood pressure 2 weeks after review and were referred to the Paediatric Clinic of Jos University Teaching Hospital.

There was a positive correlation between age and the SBPs and DBPs of the subjects (r=1.22 and 0.60, respectively). Weight also had a positive correlation with blood pressure. These correlations of age and weight to blood pressure were significant (p<0.05). There was, however, low (r=0.26 and 0.30 for SBP and DBP, respectively) albeit a significant (p=0.001) correlation between blood pressure and height of the subjects (Table II).

Discussion

The key findings in this study were an increasing blood pressure with age in schoolchildren, a higher mean blood pressure in private schools than in public schools, and a positive correlation between anthropometric measurements and blood pressure. The finding of increasing blood pressure with age is not unusual; it has been documented in several studies and is known to almost always occur steadily throughout the first two decades of life.[1,11,12]

The increase in mean SBP and DBP was similar in both genders from 5 to 8 years of age, with boys having a higher SBP and DBP at 9 - 10 years. However, the pattern changed by 11 - 12 years of age, when girls were found to have a higher mean blood pressure than boys (Fig. 1), perhaps because of the onset of puberty, or because the girls were heavier than the boys at this age. This finding has been reported previously by Ayoola

Blood pressure increased with age and was higher in schoolchildren from private schools than in those from public schools.

TABLE I. PHYSICAL AND ANTHROPOMETRIC MEASUREMENTS IN SCHOOLCHILDREN (MEAN (SD))

	Gender			School		
	Female	Male	*p*-value	Private	Public	*p*-value
Age (yrs)	6.7 (1.38)	6.6 (1.38)	0.1	6.3 (0.98)	6.8 (1.43)	0.01
Weight (kg)	20.1 (3.82)	20.2 (3.27)	0.9	20.4 (3.24)	20.1 (3.71)	0.2
Height (cm)	116.6 (8.03)	116.4 (7.96)	0.8	118.2 (6.52)	115.7 (8.44)	0.001
Pulse rate (/min)	99.7 (12.13)	97.8 (12.31)	0.05	98.6 (12.07)	98.9 (12.33)	0.7
SBP (mmHg)	98.8 (9.34)	98.6 (9.88)	0.7	102.5 (9.43)	97.1 (9.17)	0.001
DBP (mmHg)	71.3 (9.84)	70.7 (9.86)	0.5	73.0 (10.00)	70.1 (9.65)	0.001

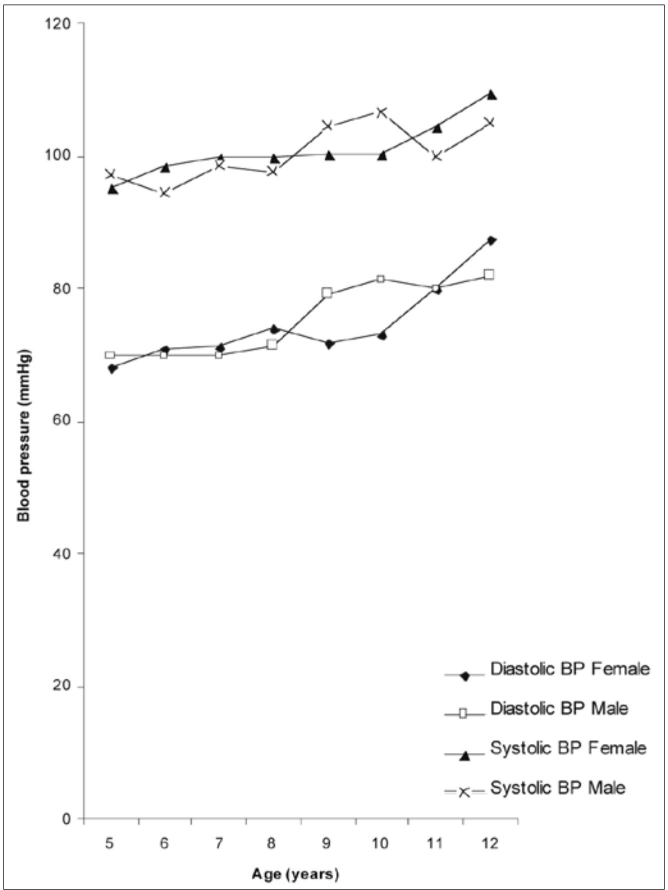

Fig. 1. Mean SBP and DBP according to gender.

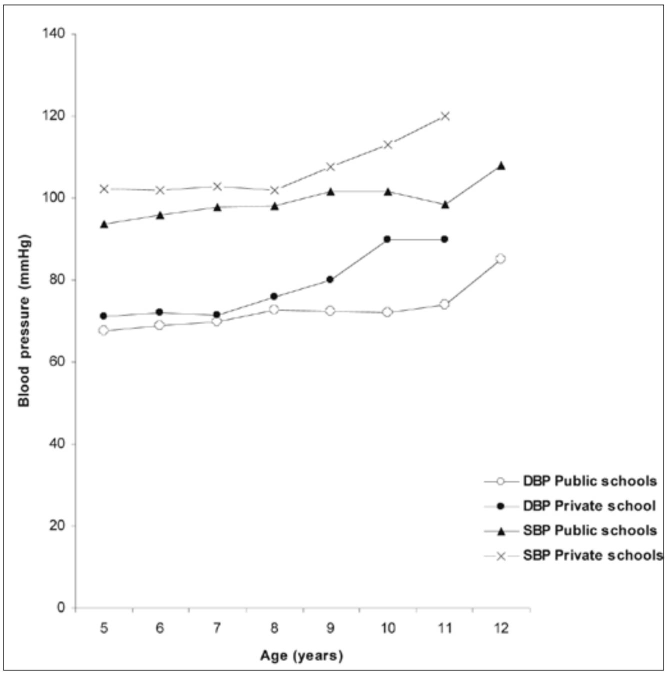

Fig. 2. Mean systolic and diastolic blood pressure according to type of school.

TABLE II. CORRELATION COEFFICIENTS BETWEEN ANTHROPOMETRIC VARIABLES AND BLOOD PRESSURE IN SCHOOLCHILDREN

	SBP	DBP
Age		
Correlation coefficient (Pearson's r)	1.22	0.60
p-value	0.001	0.001
Weight		
Correlation coefficient (Pearson's r)	0.74	0.66
p-value	0.001	0.001
Height		
Correlation coefficient (Pearson's r)	0.26	0.30
p-value	0.001	0.001

in his study of adolescent hypertension in Western Nigeria.[13] Similarly, other studies on blood pressures of schoolchildren in Western Nigeria found that females who were heavier than their male counterparts had higher blood pressures.[14,15]

The mean blood pressures in our study were higher than those recorded by Asani and Bode-Thomas in the same setting.[16] This difference could have been due to their larger sample size.

When our results were analysed by type of school attended, the children from private schools were found to have higher blood pressures than those from public schools. This difference was statistically significant and could be attributed to variations in environment, lifestyle and diet, as the private school pupils were mostly from the middle- and high-income groups. Primary hypertension in children and adolescents is associated with excess weight, reduced physical activity, inadequate fruit and vegetable intake and excessive sodium and alcohol intake.[8] Furthermore, since blood pressure is closely related to height and weight,[17] subjects from private schools could be expected to have higher blood pressure given their bigger stature. The finding of higher blood pressure in pupils from private schools and more affluent backgrounds is similar to that of Hamidu *et al.* in Zaria, northern Nigeria.[11] It should be noted, however, that the blood pressure readings in both studies were single-point cross-sectional measurements, which are insufficient to determine high or high-normal blood pressures for age,[18] particularly in children, who may exhibit high blood pressure from anxiety/excitement and are more prone than adults to 'white coat' hypertension.[19]

Blood pressures in relation to anthropometric measurements in this study are similar to findings of several other studies in Nigeria.[13-16,20] The positive correlation between SBP and DBP with weight and height has been documented in children as young as 5 years of age.[12] Gender and race do not have the same impact on blood pressure in children as in adults.[1] Our study site is a diverse multi-ethnic, multicultural urban area, and our sample size took this into account, so race/ethnicity was unlikely to have impacted on the blood pressure of the children to as great a degree as their socio-economic circumstances.

Conclusion

Blood pressure increased with age and was higher in healthy schoolchildren from private schools than in those from public schools, while height and weight had a direct relationship to both SBP and DBP. Two children in this study had persistent hypertension requiring referral for further investigation. Routine blood pressure monitoring in schoolchildren should be encouraged, starting at school entry to serve as a baseline assessment, and follow-up should be done where indicated. In addition, blood pressure measurement should be incorporated as part of the routine clinical examination of children. Large multicentre epidemiological surveys with a uniform protocol are required in our setting to develop our own ranges of normal blood pressure values for children.

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Conflict of interest. None declared.

References

1. Sinaiko AR. Hypertension in children. *N Engl J Med* 1996; 335(26): 1968-1973.
2. da Silva IRR, de Souza MDG, de Camargo Carvalho AC. Blood pressure measurement in children and adolescents: Guidelines of high blood pressure recommendations and current clinical practice. *Arq Bras Cardiol* 2007; 88(4): 434-437.
3. Hypertension in children. http://www.gp-training.net/protocol/paediatrics/bp (accessed 7 October 2009).
4. Aderele WI, Seriki O. Hypertension in Nigerian children. *Arch Dis Child* 1974; 49: 313-317.
5. US Preventive Services Task Force. Screening for high blood pressure: recommendations and rationale. *Am J Prev Med* 2003; 25(2): 159-164.
6. Federal Ministry of Health, Nigeria. *Expanded Programme on Immunisation: The National Coverage Survey, Preliminary Report*. Lagos: Federal Ministry of Health, 1991.
7. Olusanya O, Okpere E, Ezimokhai M. The importance of social class in fertility control in a developing country. *West Afr J Med* 1985; 4: 205-212.
8. Chobanian AV, Bakris GL, Black HR, *et al*. Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure. *Hypertension* 2003; 42(6): 1206-1252.
9. Kliegman RB, Berhman RE. Assessment of growth. In: Berhman RE, Vaughn VC, eds. *Nelson Textbook of Paediatrics*. Philadelphia: WB Saunders, 1996: 63-67.
10. Paynter AS, Parkin M. Growth in childhood. In: Stanfield P, Brueton M, eds. *Diseases of Children in the Tropics and Subtropics:* London: Hodder & Stoughton, 1991: 255-270.
11. Hamidu LJ, Okoro EO, Ali MA. Blood pressure profile in Nigerian children. *East Afr Med J* 2000; 77(4): 180-184.
12. Gutin B, Basch C, Shea S, *et al*. Blood pressure, fitness, and fatness in 5- and 6-year-old children. *JAMA* 1990; 264: 1123-1127.
13. Ayoola AE. Prevalence of adolescent hypertension in Nigeria. *Nig J Paediatr* 1979; 6: 18-26.
14. Ekunwe EO, Odunjirin OMT. Proteinuria and blood pressure profile of Lagos school children. *Nig J Paediatr* 1989; 16: 15-22.
15. Antia-Obong OE, Antia-Obong LE. Arterial blood pressure of Nigerian urban and rural school children. *Nig J Paediatr* 1991; 18: 3-11
16. Asani MO, Bode-Thomas F. Blood pressure pattern and its correlates among primary school children in Jos, Nigeria. *Highland Medical Research Journal* 2005; 3(2): 51-61.
17. Bernstein D. The cardiovascular system. In: Berhman RE, Vaughn VC, eds. *Nelson Textbook of Paediatrics*. Philadelphia: WB Saunders, 1996: 1368-1374.
18. de Swiet M. The epidemiology of hypertension in children. *Br Med Bull* 1986; 42: 172-175.
19. Hornsby JL, Mongan PF, Taylor AT, *et al*. 'White coat' hypertension in children. *J Fam Pract* 1991; 33: 617-623.
20. Obidike EO. Anthropometry and blood pressure in Nigerian children. *Orient Journal of Medicine* 2007; 19(1-4): 49-53.