Original Article

Blood pressure among overweight children aged 7-13 years in 10 rural communities in South Africa: The Tshannda Longitudinal Study

LO Amusa[1], DT Goon[2]

ABSTRACT

Objectives: This study examined the incidence of hypertension among South African rural children involved in the Tshannda Longitudinal Study. This cross-sectional study comprised of 409 children (193 boys and 216 girls) of grades 1-7 from primary schools in Tshannda, Vhembe District, South Africa. It forms Phase 1 of the Tshannda Longitudinal Study.

Methodology: Stature and body mass were measured using standard procedures. Blood pressure (BP) was monitored for three consecutive times using validated electronic devices (Omron 7051T). Hypertension was determined as the average of three separate BP readings where the systolic or diastolic BP was >95th percentile for age and sex.

Results: The incidence of overweight defined by body mass index (BMI) cutoff was 2.6% for boys and 2.9% for girls. The likelihood of the development of hypertension among the children is noticeable at grade level one for both boys and girls (1.7% and 1.3% respectively) and ranged from 0.3% to 1.7% for boys and 1.3% to 5.2% for girls. Overall, the incidence of hypertension was 1.5% and 1.8% in boys and girls, respectively. Blood pressure correlated positively with stature, body mass, BMI and body fat ($p = 0.00$).

Conclusions: The findings demonstrate the need for routine measurement of BP as part of physical examination in school children and use of cutoffs tailored to metabolic risks may be essential for assessment of overweight.

KEY WORDS: Overweight children, Body mass index, Body fat, Blood pressure, South Africa.

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INTRODUCTION

The prevalence of elevated blood pressure (BP) is high world-wide; two-thirds of those affected are from developed countries while one-thirds of those affected are from developing countries.[1] This implies that cardio-metabolic and renal diseases could reach epidemic proportions in future. Recent data from the US suggest that the level of blood pressure (BP) and the incidence of hypertension in children and adolescents is rising.[2] Globally, the prevalence of hypertension in children is reported to be 1-3%.[3] This increased prevalence of hypertension in school-aged may likely be attributed to the rising prevalence of overweight.

Childhood overweight and obesity is especially associated with an increased risk of cardiovascular disease (CVD) risk factors early in life.[4,5] Africa has witnessed increased urbanization and changing lifestyles, factors which have, in turn, raised the incidence of CVD.[6] Perhaps, hypertension remains the most threatening risk factor both in adults and children. Overweight and hypertension are common

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conditions in the South African black population.[7] Education and early detection may help improve the long-term outcomes of children and adolescents with hypertension. The Tshannda Longitudinal Study was designed to investigate the health status of rural South African children attending formal primary education in Tshannda, Vhembe District, Limpopo Province, South Africa. We took the blood pressure (BP) measurements of the children to determine the incidence of hypertension among them.

METHODOLOGY

This was a cross-sectional study among primary school children attending 10 public schools in Tshannda area of Mutale Municipality, Limpopo Province, South Africa. A total of 409 (193 boys and 216 girls) grades 1-7 were sampled.

The sampling frame was defined using the enrolment number for each school. This study employed a stratified, two stage cluster sampling strategy. This procedure ensures adequate representativeness of the study population in the sample. The procedure involved arrangement of study population into schools and class-level clusters. The first stage involved selecting randomly, schools with a probability proportional to the size and enrolment of each school. The second stage involved selecting classes within the participating schools systematically and with equal probability of participation. This afforded all learners in the selected class the eligibility to participate in the study.

The nature and scope of the study were explained to the children and their parents who gave informed consent. The study was approved by the Research and Publications Committee (RPC), University of Venda, South Africa, the Limpopo Department of Education (DoE), and the respective principals of the schools where the survey was conducted.

Blood pressure was monitored using the Omron electronic blood pressure equipment recommended by the World Hypertension Society. This equipment permits the measurement of both blood pressure and heart rate. It consists of a bladder which measures 13 x 25 cm and a snugly wrap. Hypertension was determined as the average of three separate BP readings where the systolic or diastolic BP was >95th percentile for age and sex.[8]

A Martin anthropometer was used to measure stature to the last 0.1 cm. A beam Seca Alpha weighing scale (Model 770) with a capacity of 200 kg and with a true zero balance was used to measure body mass to the last complete 0.1 kg. A Harpenden (John Bull) caliper with inter-jaw pressure of 10g/mm^2 was used to measure skinfolds to the last 0.2 mm. The measurements were monitored by a qualified level 3 Kinanthropometrist. All measurements were taken according to the standard procedures suggested by the International Society for the Advancement of Kinanthropometry (ISAK).[9] Body Mass Index (BMI) was derived from the general equation, BMI = Body Mass ÷ Height^2 (kg.m^2); i.e. mass divided by height (in meters) squared. International recommended BMI cut-off points for overweight and obesity for both boys and girls based on age were applied to the data.[10]

Data was analyzed using descriptive statistics. The parametric t-test was applied to test significance level at $p<0.05$ between sexes while the F-test was used to test the significance level of the variables across the seven grade levels. The Statistical Package for the Social Sciences (SPSS) was applied to the data. The statistical significance was set at $p<0.05$.

RESULTS

Table-I presents the stature, body mass, BMI, body fat and blood pressure (SBP and DBP) of the participants according to age and sex. Generally, girls show increase in body mass from grade 5 upwards than boys. BMI in girls was comparable with those of boys at grade levels 1 to 4. However, girls show consistently higher BMIs from grade level 5 and reached a statistically significant level ($p<0.05$) at grade level 7 compared with boys. The pattern of development for percent body fat is similar throughout the grade levels in both sexes. Values for girls are, however, higher (but not statistically significant) than the boys as from grade level 5. Blood pressure showed a similar pattern of development between the sexes throughout the grade levels. The values for SBP and DBP are similar for boys and girls from grade levels 1 to 5. Between grade levels 5 and 6, and 6 and 7 the BP values are higher in the girls than in the boys, but the differences are not statistically significant.

Shown in Table-II is the correlation of systolic and diastolic blood pressures with age, stature, body mass, BMI and body fat. Although SB and DB pressures did not significantly ($p>0.05$) correlate with age, statistically significant ($p<0.05$) positive correlation was observed with stature, body mass, BMI and body fat.

The likelihood of the development of hypertension among the children is noticeable at grade level one for both boys and girls (1.7% and 1.3% respectively) and ranged from 0.3% to 1.7% for boys and 1.3% to 5.2% for girls. The highest noticeable value for boys was in grade one and decreased with increase in

Table-I: Stature, body mass, body mass index, body fat and blood pressure according to age and sex.

Grade levels	*Gender (n)*	*Stature (cm)*	*Body mass (kg)*	*BMI (kg m^{-2})*	*Body fat (%)*	*SBP (mm Hg)*	*DBP (mm Hg)*
1	Boys (11)	115.2 ± 5.2*	20.3 ± 2.0	15.1 ± 0.7*	23.3 ± 0.2*	97.6 ± 10.0*	64.8 ± 9.3*
	Girls (10)	122.7 ± 12.5*	20.3 ±2.3	14.0 ± 2.2*	24.7 ± 0.7*	92.8 ± 9.3*	62.6 ± 5.2*
2	Boys (19)	124.0± 14.3	22.5 ± 3.8*	14.8 ± 2.3	23.2 ± 1.0*	90.2 ± 10.6*	64.0 ± 6.7*
	Girls (33)	124.5 ± 6.4	24.2 ± 3.6*	15.6 ± 1.4	25.0 ± 0.6*	97.5 ± 12.0*	66.1 ± 8.3*
3	Boys (34)	131.0 ± 7.5*	27.9 ± 4.4*	16.4 ± 2.5*	23.4 ± 1.0*	93.7 ± 12.8*	65.8 ± 6.0
	Girls (29)	128.0 ± 11.5*	25.0 ± 5.3*	15.3 ± 2.4*	24.8 ± 0.8*	97.6 ± 12.6*	65.4 ± 7.6
4	Boys (31)	131.3 ± 5.3	27.7 ± 3.5	16.0 ± 1.3	23.4 ± 0.7*	97.1 ± 11.3*	67.7 ± 9.8
	Girls (37)	132.0 ± 7.3	27.7 ± 5.4	15.8 ± 1.7	25.3 ± 1.2*	99.0 ± 1 2.6*	67.7 ± 7.8
5	Boys (19)	138.4 ± 6.7	31.8 ± 5.6	16.5 ± 2.0*	23.9 ± 1.0*	99.2 ± 14.1	68.3 ± 7.2*
	Girls (22)	137.7 ± 10.1	32.6 ± 10.2	17.0 ± 3.1*	25.9 ± 3.4*	100.8 ± 12.7	75.6 ± 9.5*
6	Boys (20)	142.2 ± 12.0*	33.6 ± 6.3*	16.5 ± 1.7*	23.6 ± 0.8*	97.0 ± 10.7*	65.4 ± 12.1*
	Girls (18)	147.5 ± 8.3*	39.2 ± 6.8*	18.0 ± 2.8*	26.9 ± 2.2*	111.0 ± 14.1*	75.6 ± 9.5*
7	Boys (59)	148.9 ± 1.0*	40.8 ± 1.0*	18.2 ± 3.3*	24.4 ± 1.9*	104 ± 14.2*	67.2 ± 8.3*
	Girls (67)	151.1 ± 6.5*	44.3 ± 8.9*	19.3 ± 3.1*	26.7 ± 2.3*	107.3 ± 12.9*	72.8 ± 8.4*
Total	Boys (193)	136.7 ± 13.5	31.8 ± 9.9*	16.7 ± 2.7	23.7 ± 1.3*	98.2 ± 13.3*	66.5 ± 8.5*
	Girls (216)	137.6 ± 11.1	33.0 ± 11.2*	17.3 ± 5.5	25.8 ± 2.0*	102.0 ± 13.4*	69.1 ± 8.4*

Values are mean ± SD; BMI = body mass index; SBP = systolic blood pressure; DBP = diastolic blood pressure; *p = indicates p<0.05

grade level. This result is unusual. The reverse should be the case. For the girls there was a progressive increase in the tendency towards development of hypertension from grade level 1 to 7 except a small decrease in grade level 5. Girls in grade level 6 showed the highest value of incidence of hypertension (5.2%).

As Table-III shows the incidence of overweight, boys ranged between 0% in grade level one to 2.9% in grade level 7 while girls ranged between 0% in grade level one to 4.5% in grade level 7. The incidence of hypertension in boys was lower than the combined value of all the grades (1.3% versus 1.5%). The value for the overweight factor is, however, slightly higher (2.9% versus 2.6%). The prevalence of both hypertension and overweight in the girls is higher than the combined value of all the grades (4.6% versus 1.8%, and 4.3% versus 2.9%).

DISCUSSION

The present study examined the incidence of hypertension among rural school children attending primary schools in Tshannda, South Africa. The incidence of hypertension was 1.5% and 1.8% in boys and girls, respectively. The values vary among the grade levels, the highest being 5.2% and 4.6% in girls at grade levels 6 and 7, respectively. These values are comparable with those reported by Monyeki et al[8] in a similar study but far higher than the reported values in other studies.[8,11,12] Similar results are reported for the incidence of overweight. This observation is worrisome, given that children who are obese are at greater risk for high blood pressure when they reach adulthood. The reason for the difference between the prevalence of hypertension in this study and those in the previous studies might be the usage of different age groups, methods and definitions of blood pressure, and differences in reported prevalence and risk estimates. It is possible too, that geographic location may account for the difference in distribution of BP. Regional difference exists in the BP among pediatric and adult populations from various geographic areas of the world, India, US and

Table- II: Relationship of systolic and diastolic blood pressure with age, stature, body mass, body mass index and body fat in Pearson correlation analysis.

Variable	*SBP (mm Hg)*		*DBP (mm Hg)*	
	R	*p value*	*R*	*p value*
Age (years)	0.16	0.07	0.12	0.21
Stature (cm)	0.40	0.00	0.28	0.02
Body mass (kg)	0.43	0.00	0.33	0.00
BMI (kg/m^2)	0.34	0.00	0.28	0.02
Body fat	0.27	0.00	0.38	0.00

SBP = systolic blood pressure; DBP = diastolic blood pressure.

Table–III: Incidence of hypertension and overweight in the Tshannda rural children.

			Hypertension [a]		*Overweight*[b]	
Grade	*Gender (N)*		*Boys*	*Girls*	*Boys*	*Girls*
level	*Boys*	*Girls*	*%*	*%*	*%*	*%*
1	11	10	1.7	1.3	0	0
2	19	33	1.2	2.5	0.5	1.2
3	34	29	1.2	2.7	2.2	1.7
4	31	37	0.6	2.1	2.5	2.6
5	19	22	1.3	1.9	2.6	2.8
6	20	18	0.3	5.2	2.6	3.9
7	59	67	1.3	4.6	2.9	4.5
All grades	193	216	1.5	1.8	2.6	2.9

[a] The average SDP and DPB e" 95th percentile for age and sex were measured on at least three separate occasion.
[b] Internationally recommended BMI cut-off points in children.[10]

China.[13-15] However, the high prevalence of hypertension in girls compared with boys might not be unconnected with the social and cultural lifestyle of females (in general) who are expected to stay at home and attend to household chores. This then calls for a great interest and concerted effort in the investigation of early development of the risk factors and their health-related outcomes.[16]

The SD for SBP and DPB in each grade level of our children compared with the SD for SBP and DBP in the national childhood BP dataset presented in the National High Blood Pressure Education Program (NHBPEP) Working Group on High Blood Pressure in Children and Adolescents Report.[17] These national childhood BP data, report SDs for SBP of 10.7 mm Hg for males and 10.5 mm Hg for females and SDs of DBP of 11.6 mm Hg for males and 11.0 mm Hg for females. As indicated in Table-I the SD of BP values in our grade levels are nearly similar.

In the present study, blood pressure correlated positively with stature, body mass, BMI and body fat significantly (p=0.00). This result agrees with the results of other studies.[11-23,18]

Only school children were measured in this study. Our results do not necessarily apply to all Tshannda children. Another possible limitation of the study was that BP was measured on a single occasion, at variance with the National High Blood Pressure Education Program (NHBPEP)[17] criteria that require BP to be measured at least on three occasions. This could have affected the estimate of the prevalence of hypertension in our sample. However, in our analysis, BP was mainly considered as a continuous variable thus minimizing misclassification problems. We could not lay hands on the birth weights of the children as most of them were not born in standard hospitals where appropriate records are kept. Again, factors such as socio-economic circumstances and other environmental exposures during childhood and even before birth, including difference in other risk factors may have influenced the results of BP values.[19] These were not studied. Therefore, our data should be interpreted with caution. For example, it would be interesting to examine the association between nutrition and the other risk factors and its predictability of the prevalence of hypertension among children in the seven grade levels.

Our data indicate that Tshannda school children are at risk of elevated BP particularly for those who are overweight. Girls are more predisposed to hypertension than boys particularly in grade levels 6 and 7. Being a longitudinal study, a follow-up of these children will help to evaluate trends in childhood hypertension among the overweight group. Finally, to detect hypertension as a risk factor in children, routine screening as well as promoting educational programmes on healthy lifestyles would be beneficial.

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