Ellisras Longitudinal Study 2017: the association of fat patterning with blood pressure in Polokwane private school children aged five to 15 years (ELS 22)

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Abstract

Background: Obesity is a risk factor for non-communicable diseases and is of global public health concern. It is estimated that more than one billion adults are overweight, of which at least 300 million are obese. Over-fatness, measured by means of the sum of the triceps and subscapular skinfold thicknesses greater than the 85th percentile, increased significantly in girls after menarche and peaked at 17 years, with 11% of girls being overweight.

Additionally, it is known that late childhood is an important period for the development of a central patterning of body fat, which predisposes to coronary heart disease at a later age. It is also suspected that essential hypertension may have its inception in childhood.

Monyeki et al. reported a low incidence of hypertension and overweight in rural school children living in the Ellisras area. The association between fat patterning and hypertension has received little attention in urban school children. Therefore the main objectives of this study were to investigate the association of fat patterning and blood pressure among five- to 15-year-old black children attending private schools in Polokwane, South Africa, and to determine the prevalence of obesity and hypertension.

Methods

A total of 1 665 subjects (846 boys and 819 girls), aged five to 15 years attending all three private schools in Polokwane, a city in the Limpopo Province, participated in the survey. Generally, children attending private schools in South Africa fall within the middle and high socio-economic groups of the population. All children attending school on the days of the survey participated in the study. Informed consent had been obtained from the parents and/or guardians prior to the survey and ethical approval for the study was obtained from the Ethics Committee of the University of Limpopo. The survey was undertaken at the schools over a period of 20 days.

All children underwent a series of anthropometric measurements, including weight, height and skinfolds ([supr-iliac (SPIL), subscapular (SSCP), triceps (TRCP) and biceps (BCP)]. A Martin anthropometer was used to measure height to the nearest 0.1 cm and an electronic scale measured weight to the nearest 0.1 kg. A slim skinfold caliper was used to measure skinfolds.

All training and measurements were carried out in accordance with the standard procedures of the International Society for the Advancement of Kinanthropometry. The fieldworkers
underwent testing for reliability of measurements as part of their training, in order to achieve a technical error of measurement within the accepted limits.

The sum of four skinfolds (SPIL + SSCP + TRCP + BCP) was used as an indicator of total body fatness. The proportion of body fat on the trunk relative to that on the limbs was used as an indicator of the central pattern of body fat (visceral fat). This was calculated by two formulae:

- ratio of trunk-to-limb skinfolds (SS/ST) = (SSCP + SPIL)/(TRCP + BCP)
- ratio of subscapular-to-triceps skinfolds (S/ST) = SSCP/(SSCP + TRCP)

As an indicator of lower trunk fat patterning, the ratio of subscapular-to-supra-iliac skinfolds was used:

- trunk ratio (SS/STTB) = (SSCP + SPIL)/(SSCP + SPIL + BCP) + TCP).

An average of two systolic and diastolic blood pressure readings was taken with an electronic monitoring kit, with the child seated and resting for at least five minutes. The bladder of the Micronta variable r the pulse rate and blood pressure and displays them concurrently within the accepted limits.

Table 1 shows descriptive statistics for weight, height, BMI, systolic and diastolic blood pressure, triceps, subscapular, biceps and supra-iliac skinfolds, the sum of four skinfolds, ST, SS and SSTB of Polokwane private school children aged five to 15 years. All variables showed significant differences between girls and boys in other age groups except for SS/STTB (trunk ratio) and systolic blood pressure in all age groups. Girls showed a higher sum of four skinfold mean values [29.6 (8.50) –44.1 (19.68)] in all age groups than boys [25.3 (8.36) –34.0 (19.83)], and the difference was significant (p < 0.05). Girls also showed higher BMI mean values [16.4 (3.1) –17.8 (3.6)] in age groups eight to 10 and 11–15 years old than boys [15.9 (2.3) –16.9 (3.1)]. Yet again girls exhibited higher diastolic blood pressure [64.0 (9.3)] than boys [63.0 (10.2)] at age group five to seven years old. Boys showed a non-significantly higher mean systolic blood pressure value [92.1 (11.3)] than girls [91.4 (10.0)] in age group five to seven years old.

Table 2 indicates the prevalence of over-fatness and hypertension among Polokwane children aged five to 15 years. The prevalence of over-fatness ranged from 7.3–12.3%, with girls being more over-fat (10.1–12.3%) than boys (7.3–10.3%). There was a high prevalence of hypertension in girls, ranging from 1.4–33.0%, who were more hypertensive than boys (3.6–21.3%).

Table 3 shows linear regression coefficients for the association between systolic and diastolic blood pressure and hypertension among Polokwane private school children aged five to 15 years. Both systolic and diastolic blood pressure showed a significant positive (p < 0.001) association with the sum of four skinfolds and all skinfold ratios, unadjusted and adjusted for age and gender. Logistic regression was performed to determine the relationship between blood pressure, sum of four skinfolds and ratios of skinfolds, both unadjusted and adjusted for age and gender. Logistic regression was used to estimate the association between over-fatness and the odd incident of hypertension, unadjusted and adjusted for age and gender. All data were analysed with a statistical package for social science (SPSS) version 25. The statistical difference was set at p < 0.05.
significant association only when unadjusted (beta ranged between 0.29 and 62.08, 95% CI ranged between 0.26 and 0.33 and 49.00 and 75.17).

Table 4 shows the odds ratio and 95% CI for the association of over-fatness and high blood pressure among Polokwane children aged five to 15 years. There was a significant positive (\( \beta < 0.001 \)) association between over-fatness and hypertension, both unadjusted (OR = 3.11; 95% CI = 2.17–4.46) and adjusted for age and gender (OR = 3.29; 95% CI = 2.22–4.86).

### Discussion

The aim of this cross-sectional study was to determine the association of fat patterning with blood pressure in Polokwane's privately educated school children aged five to 15 years old. There was a significant association between fat patterning variables and blood pressure. In this study, skinfold thickness in girls was significantly higher than in boys. This result is in agreement with the results of other studies which found higher fat patterning ratios, and the sum of the skinfolds with blood pressure. Gupta et al. indicated that low socio-economic status favours higher proportions of the sample of black school children studied, mainly the girls. There was an association between fat patterning and blood pressure. Children with high body fatness are at risk for developing high blood pressure. These results raise the possibility of using fat patterning ratios and BMI as predictors of hypertension and obesity in children.

### Conclusion

Obesity and borderline hypertension were found in a significant proportion of the sample of black school children studied, mainly the girls. There was an association between fat patterning and blood pressure. Children with high body fatness are at risk for developing high blood pressure. These results raise the possibility of using fat patterning ratios and BMI as predictors for hypertension in children.

The present study found a positive association between fat patterning ratios and blood pressure. The findings of this study agree with those of Monyeki et al., who found a significant positive association between BMI, S/T and S/SSTB ratios, and the sum of the skinfolds with blood pressure. Gupta et al. indicated that low socio-economic status favours higher blood pressure in childhood and adulthood. However nutritional factors are the largest environmental factors believed to cause hypertension, which has been studied extensively. There is a need to ethnically test a good intervention to diminish the prevalence of hypertension among these populations, in order to minimise the resultant high rates of cardiovascular morbidity and mortality.

A limitation of this study is that we did not include the socio-economic level of the participants’ families, therefore we cannot state whether children with a high prevalence of over-fatness and hypertension were from a high- or middle-income population. This study also did not include nutritional status and the physical activities of the participants, so we do not know what foods contributed to the incidence of hypertension and obesity, or whether physical inactivity may have been the cause. Further investigation is necessary, including nutritional status, physical activity and socio-economic level of these Polokwane children.

### Table 3.

<table>
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<th>Blood pressure</th>
<th>Unadjusted</th>
<th>Adjusted for age and gender</th>
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<tr>
<td></td>
<td>Beta</td>
<td>p-value</td>
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<td>Systolic BP</td>
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<td>Sum of four skinfolds</td>
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<td>S/T</td>
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<td>S/ST</td>
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<td>S/SS/SSTB</td>
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<td>Diastolic BP</td>
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<td>Sum of four skinfolds</td>
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<td>BP</td>
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**p < 0.001; CI = confidence interval; OR = odds ratio.**
References


