The association between dyslipidemia and anthropometric indicators in black and white adolescents residing in Tlokwe Municipality, North-West Province, South Africa: the PAHL study

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Abstract

Background: The dyslipidemia associated with excess weight is a risk for cardiovascular disease. Worldwide and in South Africa adolescent obesity has been reported.

Objectives: To determine the association between dyslipidemia and anthropometric indices in black and white adolescents.

Methods: The study involved 129 black and 69 white adolescents aged 12 to 16 years. Data collected included height, weight, waist circumference (WC) and skinfolds, blood pressure and blood for glucose, insulin, total cholesterol (TC), low density lipoprotein (LDL), high density lipoprotein (HDL), triglycerides (Trig) and C-reactive protein (CRP).

Results: WC correlated negatively with HDL in both blacks (p=0.042) and whites (p=0.008) and in whites it correlated positively with LDL (p=0.006); TC/HDL (p=<0.001) and LDL/HDL ratio (p<0.0001). WC/Hgt correlated negatively with HDL (p=0.028) and positively with LDL/HDL (p=0.026 and p<0.0001) in both races. In whites positive correlations were between WC/Hgt and TC (p=0.049); LDL (p=0.003) and TC/HDL (p<0.0001). BAZ correlated positively with TC/HDL ratio (p=0.004) and LDL/HDL ratio (p=0.002). The most common abnormalities were HDL and LDL.

Conclusion: Whites exhibited more associations between dyslipidemia and anthropometric indicators as compared to Blacks, suggesting that there might be differences in the lipid metabolism or even susceptibility to risk factors in adolescents.

Key words: dyslipidemia, anthropometry, adolescents

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Introduction

There are several risk factors for coronary heart diseases, which can act independently or together. Among the most common are arterial hypertension, smoking, a sedentary lifestyle, diabetes, obesity, dyslipidemias, and a positive familial history of cardiovascular disease (CVD). The precocity of these factors signals the need to develop prevention and intervention strategies in pediatric populations.

Atherosclerosis coronary heart disease (CHD) has multifactorial causes. Studies have established that dyslipidemia plays an important role in its development and progression. Even though clinical CHD only occurs in later life it is known that atherosclerosis may already present itself in young adults. It has also been observed that conditions related to altered lipid levels such as unhealthy dietary habits, tobacco smoking and physical inactivity are acquired during childhood and adolescence. Moreover, obesity, dyslipidemia and hypertension in adolescence have been reported to track into adulthood. Other studies have shown that differences in lipid levels among cultures and ethnic groups appear early in childhood.

Waist circumference (WC) and waist-to-height ratio (WHtR) during childhood are predictors of the development of risk factors for CVD. Visceral adiposity has a strong impact on CVD due to its association with dyslipidemias, arterial hypertension, insulin resistance and diabetes. High plasma triglycerides (TG) and low concentrations of high-density lipoprotein cholesterol...
Childhood obesity has been on the increase in the past decades and furthermore, it has been shown to be a predictor of increased mortality owing primarily to an increased risk of CVD. In addition, the prevalence of individuals with normal body weight who display one or more obesity related morbidity such as type 2 diabetes and high blood pressure is increasing. There is substantial evidence that the association between obesity and CVD is due to adverse CVD risk factor profile that is seen in obese adults. These include type 2 diabetes, hypertension and dyslipidemia. To date it is known that all these are emerging in children and adolescents.

Studies have shown that detection of altered lipid levels in adolescents especially raised serum levels of total cholesterol (TC) and LDL-C accompanied by low HDL-C can be useful in initiating measures for the prevention of atherosclerotic diseases and reduction of mortality rates. The metabolic and physiological changes in the lipid profile of adolescents were found to be more pronounced in males than females due to differences in hormonal changes accompanying puberty.

The dyslipidemia associated with excess weight is a risk for cardiovascular disease. In South African adolescents obesity has been reported and as such the aim of this study was to determine the association between dyslipidemia and anthropometric indices in black and white adolescents.

Methods

Study area

This study was conducted in Tlokwe Municipality (previously known as Potchefstroom Municipality) of the Dr Kenneth Kaunda District Municipality in the North West Province, South Africa. Tlokwe Municipality is located between 26° 43' 0" South and 27° 6' 0" East and longitudes 27, 1000 (27°60′00″E). The municipal ity encompasses several neighboring settlements with a population of 128,357 in a density of 48 km², according to the 2007 community survey. The area is primarily inhabited by Black Africans (70%), 27.0% White Africans, 3.0% Colored and 0.4% Asians (Stats SA, 2007). The major languages spoken in the area are Setswana, Afrikaans and English. The seat of the local municipality is Potchefstroom.

Study sample

Data on a total of 198 adolescents (129 Blacks and 69 Whites) from six schools out of the eight schools which were purposively recruited within the Tlokwe municipality with four from Kageng Township (that mainly consists of people with low socio-economic background) and two in Potchefstroom town (that mainly consists of people with high socio-economic background) participated in the study. This study is part of a five year observational multidisciplinary longitudinal study on Physical Activity and Health Longitudinal Study (PAHLS) that started in 2010. The study conveniently selected grade 8 pupils for baseline so as to make the five-year follow-up feasible; additionally, given the short time frame schools are good grounding to conduct research studies which are longitudinal in nature for its logistics. The group of pupils studied may not be considered to be representative of the adolescents’ population of either Tlokwe municipality or South Africa in general. Its goal was to describe the development of physical activity and determinants of health risk factors in adolescents attending high schools within Tlokwe municipality areas of the North West Province of South Africa since such information in this region is lacking in the literature, as such information may be of gratefull in addressing the abnormalities of health risk factors.

Anthropometric measurements

Anthropometric measurements of height, weight and skinfolds were measured by Level 2 Criteria anthropometrists according to the standard procedures described by the International Society for the advancement of Kinanthropometry: ISAAC. Height was measured by the use of stadiometer to the nearest 0.1 centimeters (cm) with participants in a bare feet standing upright position with the head in the Frankfort plane. Weight was measured to the nearest 0.1 kilogram (kg) with an electronic scale with the subject wearing minimal clothing. The triceps and subscapular skinfolds were measured to the nearest 0.2 mm with a Harpenden (British Indicators, UK) skinfold caliper and the average of two measurements were used. The waist circumference (WC) was measured, to the nearest 0.1 cm with a 7-mm-wide flexible steel tape (Lufkin, Cooper Tools, Apex, NC), at the midpoint between the lower rib margin and the iliac crest. The hips were measured to the nearest 0.1 cm at maximum extension of the buttocks. Waist-to-hip ratio (WHR) was calculated from waist and hip circumferences. Body mass index (BMI) as a measure of body composition was calculated as body mass (kg/m²); Subsequently, height-for-age z-score (HAZ), weight-for-height z-score (WHZ), weight-for-age z-score (WAZ) and as well as BMI z-score (BAZ) were classified according to WHO Multicentre study references.

Blood analysis

Participants were requested to fast for 12 hours before blood samples were taken in the morning. Professional nurses took venous blood from the cephalic vein for the preparation of serum. The tubes were kept for approximately 30 min to coagulate and then centrifuged for 15 min at 2000g for the serum. The serum was divided into aliquots and stored at -84°C until analysed at an accredited laboratory (Ampath Laboratories, Pretoria, South Africa). Serum was used for the analyses of total cholesterol (TC), low density lipoproteins (LDL), high density lipoproteins (HDL), triglycerides (Trig) and C-reactive proteins CRP. Serum TC, LDL, HDL, Trig, was measured with a Vitros DT60 II Chemistry Analyser (Ortho-Clinical Diagnostics, Rochester, NY, USA) with Vitros reagents and controls. Serum high-sensitivity C-reactive protein was determined by rate turbidimetry with a High Sensitivity C-Reactive Protein kit (CRPH, IMMAGE, Immunochemistry Systems, Fullerton, (CA, USA) with control serum as an external standard.

Diagnosis of abnormal lipid parameters

Abnormal lipid parameters were defined by using the following criteria: HDL-C: <1.2 mmol/L, LDL-C: >2.5 mmol/L, TC: >2.3 mmol/L, LDL/TC ratio: <2.20, HDL/LDL ratio: <3.5.

Ethical considerations

This study was approved by the ethics committee of North-West University (Potchefstroom campus) and approved by both the North-West Province Department of Health and Social Welfare Research committee and Department of Education. Written informed consent was obtained from the adolescents’ parents/guardians and their verbal assent was obtained.

Statistical analysis

WHO Anthroplus software was used to calculate the adolescents’ BAZ-scores. Data was analyzed using SPSS (version 19). Since most of the data were not normally distributed non-parametric tests were computed. Descriptive statistics were computed and data are presented as medians and interquartile ranges. Mann-Whitney U test was used to test for differences between two groups and furthermore differences were computed after adjusting for gender. X2-test was used to compare differences between categorical data and Spearman’s correlation coefficients were used to assess the association between anthropometric indices and measures of iron status. Partial correlations after adjusting for gender were also computed. Linear regression analyses were done to determine anthropometric predictors of lipid parameters. A p-value of <0.05 was considered statistically significant.

Results

Differences were observed in weight, height, BMI, BAZ and WC with Black adolescents recording lower values in these variables even after adjusting for gender differences. With regard to SST ratio it only showed significant differences after adjusting for gender. Biochemical variables that showed differences between the two races before and after adjusting for gender were total cholesterol and LDL, with blacks showing significantly lower values than Whites, even though the significant levels dropped after adjustment for gender (Table 1). Triglyceride and glucose levels were lower in blacks before adjusting for gender as were TC/HDL ratio and LDL/TG ratio with lower values recorded in Black adolescents but these differences were not there after adjusting for gender differences (Table 1).
Tables 2 and 3 show crude correlation coefficients in 126 (97.5%) Blacks and 35 (50.7%) Whites (X²= 2.660; p = 0.0001) after adjusting for gender. BAZ correlated positively with all measured lipid parameters except with HDL, which was negatively correlated but after adjusting for gender it correlated negatively with TC, LDL, and HDL in Black adolescents and positively with LDL/HD ratio in Whites.

Waist circumference-to-height ratio showed positive correlations with all lipid parameters except with HDL, which was negatively correlated with in both races. After adjusting for gender differences the remaining associations were with TC/HDL ratio (r=0.333; p<0.0001) and LDL/HDL ratio (r=0.353; p<0.0001). WC was negatively associated with HDL in black adolescents (r=0.179; p=0.042) and this was even stronger after adjusting for gender differences (r= -0.442; p=0.002). Further, after taking the gender differences into consideration it correlated positively with LDL/HDL ratio. In Whites the contrary WC was positively correlated with LDL (r=0.483; p=0.003), TC/HDL ratio (r=0.442; p<0.0001) and LDL/HDL ratio (r=0.478; p<0.0001) and negatively with HDL (-0.316; p=0.008). After adjusting for gender differences all the correlations remained except with HDL and further WC showed a positive correlation with TC (r=0.360; p=0.034). Skinfolds indices showed varied associations with the lipid parameters in both races (Tables 2 and 3).
The predictions of skinfolds indices were inconsistent among the indices in both races (Table 4).

In both races the prevalence of abnormal lipid values were high for girls, scored at after TC. This evidence shows that elevated TC and LDL-C levels were more prevalent in both races women.

Table 4. Linear regression models for assessing the associations between anthropometric indices and abnormalities in black and white adolescents.

Discussion

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Hypertension and elevated levels in blood pressure were found in both races, according to the American Heart Association, the American College of Cardiology, and the World Health Organization. The prevalence of hypertension is higher among adolescents with abnormal lipid levels, and to a lesser extent in children and adolescents. Thus, the above associations found in the current study (results not shown) are consistent with previous studies. The association between abnormal lipid levels and abnormal blood pressure in adolescents has been observed with a shift to a more westernised lifestyle, as observed in developing countries worldwide.

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epidemiological studies. This could be of important public health implication and reduce the risks associated with dyslipidemia if it can be detected early in adolescence especially in individuals with a familial history of dyslipidemia. Thus the current results show that even at this early stage abdominal fat deposition contribute to an adverse lipid profile.

Studies have linked the association between hypertriglyceridemia and central obesity to the increased number of adipocytes in the abdominal region, which promote insulin resistance and thus intensifying the release of free fatty acids (FFA) into the circulation. The FFA then provide a substrate for triglycerol synthesis in the liver, leading to increased hepatic release of triglycerides and central obesity to the increased number of adipocytes in the abdominal region, which promote insulin resistance and thus intensifying the release of free fatty acids (FFA) into the circulation.

Hyperinsulinemia is also known to enhance hepatic VLDL synthesis, thus it may directly contribute to the increased plasma Trig and LDL-C levels. Resistance to the action of insulin on lipoprotein lipase in peripheral tissues may also contribute to elevated Trig and LDL-C. It has also been suggested that insulin resistance may be involved in the reduced HDL-C levels in type 2 diabetes patients. As such the findings in the present study suggest the need to monitor lipid levels in adolescents.

Gender and pubertal development stages are the other factors that have been shown to influence the lipid profile of individuals, while other evidence has shown that BMI influences Trig levels irrespective of age and gender. However, in the current study no data was available on the adolescents’ pubertal development stages to can assist in adding to this pool of literature. On the other hand, studies have shown that differences in hormonal changes may be involved in the reduced HDL-C levels in type 2 diabetes patients. As such the findings in the present study suggest the need to monitor lipid levels in adolescents.

Conclusion
The study showed that whites exhibited more associations between dyslipidemia and anthropometric indicators compared as black adolescents with WC/Hgt ratio being the index associated with most measured lipid parameters, suggesting that there might be differences in the lipid metabolism or even susceptibility to risk factors in adolescents. Furthermore, the association between dyslipidemia and adiposity in this study adds to the current literature that it is necessary to introduce screening and preventative measures at an early age due to the adverse consequences posed by tracking of these risk factors into adulthood, but these results have to be cautiously interpreted as the smaller sample sizes in both populations might have affected the results in one way or another as such warranting larger epidemiological studies in this setting.

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