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Lipid Profile and Risk Factors for Cardiovascular Disease Among Obese Children in Schools in Three Municipalities of Abidjan (Côte D'ivoire)

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Abstract | **Original Research Article**

Almost all studies on lipid changes have been conducted in adults. However, epidemiological studies have shown that childhood obesity is associated with an increased risk of premature mortality in adulthood, due to higher rates of cardiovascular mortality. The aim of this study was to determine the lipid profile of obese children and to identify the prevalence of the main risk factors for cardiovascular disease. A cross-sectional study was therefore conducted in Abidjan involving 64 children aged 5 to 15 years, from several schools, divided into 31 obese subjects and 33 normal-weight subjects. Measurements of height, weight, waist circumference, abdominal circumference, and BMI were taken. Blood samples were used to determine concentrations of total cholesterol, LDL cholesterol, HDL cholesterol, and triglycerides. Weight, waist circumference, abdominal circumference, and BMI were significantly higher in obese children compared to normal-weight children ($p < 0.05$). The prevalence of obesity was higher among girls than among boys. The lipid levels observed in obese children were, for the most part, significantly higher than those in normal-weight children: total cholesterol, 65.6% versus 0%; LDL cholesterol, 65.4% versus 0%; triglycerides, 56.2% versus 15.6%. In contrast, HDL cholesterol levels were significantly lower in 59.4% of obese children, while no normal-weight child had low HDL levels. These results underscore the need to strengthen the management of obese children in order to prevent potential risk factors for cardiovascular disease in adulthood.
Keywords: Obesity, child, lipid profile.

INTRODUCTION

Overweight and obesity pose a growing threat to public health in developed countries more so than in developing countries such as Côte d'Ivoire.

The prevalence of obesity is increasing worldwide at an alarming rate, and more so in developed countries than in underdeveloped countries. In African countries, the prevalence of obesity is higher in urban populations than in rural populations.

Dietary lipids, due to their high energy content, play an important role in the development of this condition (Kang, 2002). Indeed, disruptions in the system that transports these lipids throughout the body (in the form of lipoproteins) could lead to these health problems (Pont, 2002; Proenza, 2000). Epidemiological studies agree that childhood obesity is associated with an increased risk of premature mortality in adulthood, due in particular to higher rates of cardiovascular mortality (INSRM, 2006).

Indeed, obesity is associated with several health-compromising complications such as diabetes (Goran *et al.,* 2003), dyslipidemia (Cook *et al.,* 2011), cardiovascular diseases (Allman-Farinelli, 2011), respiratory diseases (Davidson *et al.,* 2014), metabolic disorders (Bell *et al.,* 2014), orthopedic conditions (Taylor *et al.,* 2005), and impaired endothelial function (Hanzu *et al.,* 2011). However, most studies on lipid changes have focused primarily on adults; few have been conducted on obese children (Baumgartner *et al.,* 1989).

In Africa, epidemiological studies have shown an increase in the prevalence of obesity among children and adolescents (Corriea *et al.,* 2014 ; Lokrou and Nioble, 2008). However, very few of these studies have focused on cardiovascular risk factors in this population group.

In Côte d'Ivoire, few epidemiological studies have focused on cardiovascular risk factors in children. It is in this context that we decided to conduct this study, the aim of which is to determine the lipid profile of the obese children who participated in this study and to identify the prevalence of their main cardiovascular risk factors.

I. MATERIALS AND METHODS

Materials

This study was conducted in six schools three public and three private in three districts of the city of Abidjan, Côte d'Ivoire.

The study included children aged 5 to 15 at the time of the survey. Any child for whom parental/guardian consent was not provided, any child absent during the survey period, and any child present but suffering from a chronic or acute illness was excluded from the study. At the end of the survey, 1,251 children were recorded across all the schools visited.

Lipid analyses were performed on 64 children, including 31 obese children and 33 of normal weight, who constituted the control group. The parents of these 64 children were contacted again to obtain their consent prior to blood collection. The technical materials consisted of survey materials, blood collection materials, and blood storage and analysis materials.

Methods

Anthropometric measurements include body weight, height, waist circumference, body mass index, hip circumference, and waist circumference.
Weight and height were measured according to the standard guidelines of the World Health Organization (WHO, 1995).

Weight (in kg) was measured with participants barefoot and wearing light clothing using a Sohenle electronic scale with an accuracy of 0.5 kg.

Height (in meters) was measured using a measuring rod with an accuracy of 0.1 cm for participants who were barefoot, with feet together and flat on the ground, back, buttocks, and heels pressed against the vertical board of the measuring rod, and the head positioned horizontally so that the line of sight was perpendicular to the body.

Body Mass Index (BMI) in kg/m² was calculated by dividing weight in kilograms by height squared in square meters. BMI is the measure used to classify children according to their nutritional status.

Waist circumference was measured using a flexible tape measure. To measure waist circumference, the child stands upright, and the tape is placed around the abdomen just above the navel after exhaling normally. When taking this measurement, ensure that the tape measure is neither too loose nor too tight, that it lies flat against the waist, and, most importantly, that the measurement is taken horizontally around the back.

Children with a waist circumference (WC) above the 90th percentile are considered to have abdominal obesity according to French guidelines (Rolland-Cachera *et al.,* 2001).

To assess the weight status of children, data from the BMI determination table and the age- and sex-specific BMI for children and adolescents aged 5–18 years for both girls and boys were used (WHO 2007).

Collection of blood samples from the children surveyed

Based on the information obtained from the survey, 64 children were selected for biological testing. Of these 64 children, 31 were obese and 33 were of normal weight (controls). For each child, a fasting venous blood sample (taken 12 hours after the last meal) was collected from the antecubital fossa in the morning. The blood, collected in 5-ml Vacutainer tubes (red and purple caps), was immediately transported to the medical testing laboratory of the Biochemistry Department at Treichville University Hospital (Abidjan, Ivory Coast). Once at the laboratory, the blood samples were centrifuged at 3,000 rpm for 5 minutes to obtain serum. The serum aliquots obtained were stored by freezing (-20°C) in sealed microtubes until analysis. Every precaution was taken to ensure that all procedures were performed away from sunlight to prevent the alteration of certain biochemical parameters.

Measurement of serum biochemical parameters in the children surveyed

The serum obtained was used to measure various serum parameters, including total cholesterol (TC), HDL cholesterol (HDL), LDL cholesterol (LDL), and triglycerides (TG), using the COBAS INTEGRA® 400 Plus automated analyzer (France). The protocol for each assay was pre-established and programmed into the instrument. The assays were performed according to the manufacturer's instruction manual and using appropriate reagents (kits).

Statistical analysis of the results

The data were double-entered into an Excel spreadsheet, cross-checked in EpiInfo version 3.2.5, and cleaned to remove discrepancies. Data analysis was performed using SPSS 20 software. Quantitative variables were expressed as means, either with standard deviation (SD) or 95% confidence interval (95% CI). Qualitative variables are expressed as proportions. To facilitate calculations, age was converted to decimals using the Ireton formula (Ireton, 2006). Comparisons of means were performed using Student's t-test. Proportions were compared using Pearson's chi-square test. All tests used a 5% significance level.

II. RESULTS

Distribution of children by gender and nutritional status

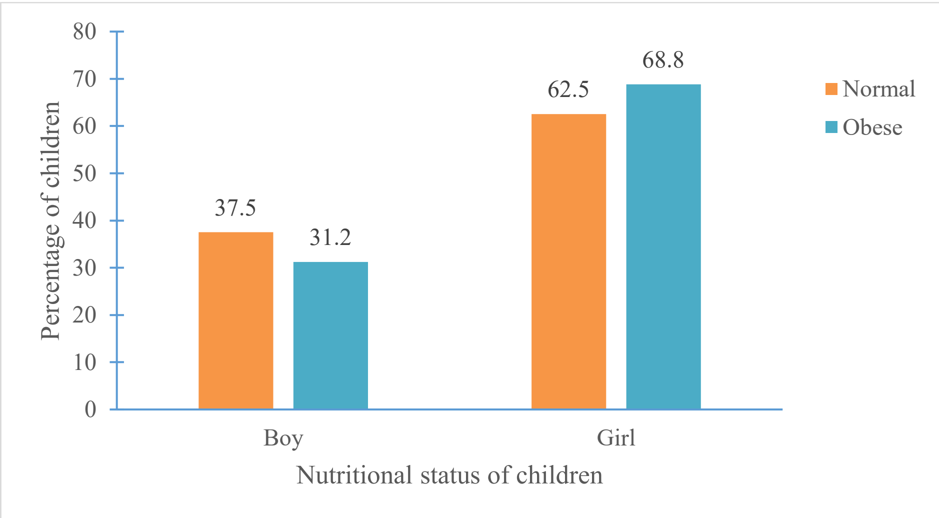
The study population consisted of 64 children, including 33 children of normal weight and 31 obese children. The mean age is 9.50 ± 1.91 years, ranging from 5 to 15 years. The mean weight is 37.76 ± 12.76 kg. Table I presents the main anthropometric characteristics of normal-weight and obese children. Weight, BMI, waist circumference, and Abdominal circumference is significantly higher in obese children compared to normal-weight children ($p < 0.05$).

Figure 1 shows the nutritional status of children by gender. Among normal-weight children, 37.7% are boys and 62.5% are girls. Among obese children, 68.8% are girls and 31.2% are boys. ($p = 0.021$)

Table I : Anthropometric and biological characteristics of normal-weight and obese children

	Normal weight n = 33	Obese n = 31	P
Age (years)	9,19 ± 1,85	9,79 ± 1,94	0,201
weight (kg)	29,13 ± 6,56	45,87 ± 11,85	0,012
Height (m)	1,34 ± 0,11	1,43 ± 0,11	0,081
BMI (kg/m²)	16,37 ± 1,7	22,25 ± 3,15	0,012
Waist circumference (cm)	62,55 ± 5,26	73,66 ± 7,94	0,005
Abdominal circumference(cm)	60,54 ± 3,88	74,27 ± 8,7	0.004

Results are expressed as mean ± standard deviation; BMI: Body Mass Index



p = 0,021

Figure 1: Nutritional status of children by sex

Serum lipid levels in children

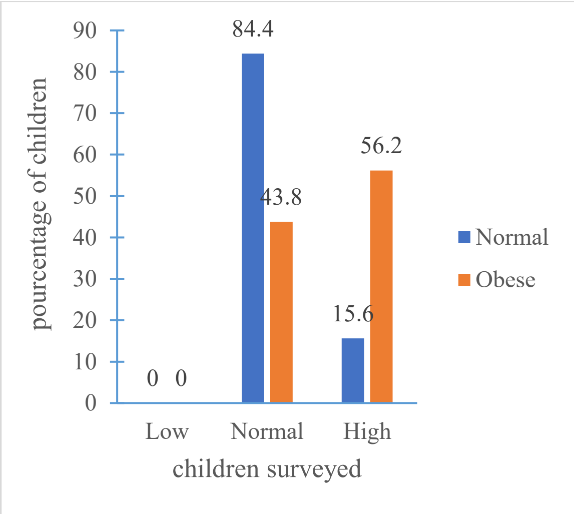
This study evaluates blood levels of triglycerides, total cholesterol, HDL cholesterol, and LDL cholesterol.

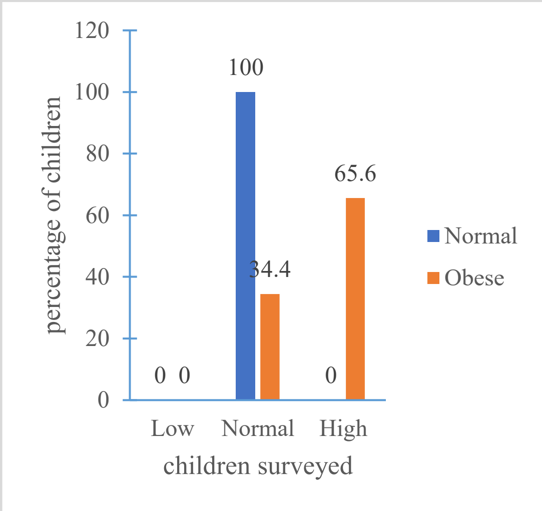
Figure 2A shows that 15.6% of normal-weight children have high triglyceride levels, compared to 56.2% of obese children who have high triglyceride levels (triglycerides >1.50 g/L), with a statistically significant difference ($p = 0.001$).

Regarding total cholesterol, 65.6% of obese children have high total cholesterol levels (total cholesterol > 2.40 g/L), and 34.4% of obese children have normal total cholesterol levels. All children of normal weight have normal total cholesterol levels. (Figure 2B).

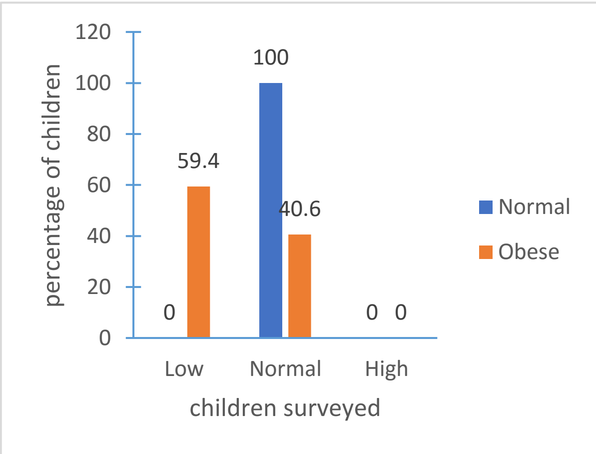
The results for HDL cholesterol levels show that 59.4% of the obese children in the study have low HDL levels (HDL <0.4 g/L), whereas all children of normal weight have normal HDL levels, with a statistically significant difference ($p = 0.001$) (Figure 2C).

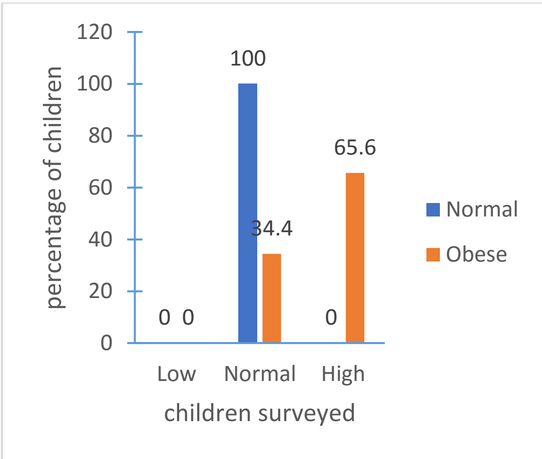
Elevated LDL levels were observed in 65.6% of obese children (LDL > 1.59 g/L). Normal LDL levels were observed in 34.4% of obese children and in all normal-weight children (Figure 2D). All these values show a significant difference between normal-weight and obese children ($p = 0.001$).





A: Triglyceride Levels in Normal-Weight and Obese Children
B: Total Cholesterol Levels in Normal-Weight and Obese Children





C: HDL Cholesterol Levels in Normal-Weight and Obese Children
D: LDL Cholesterol Levels in Normal-Weight and Obese Children
Figure 2: Overview of serum lipid levels in children

III. DISCUSSION

The results of this study showed that obese children exhibit abnormal lipid profiles compared to controls, with a significant increase in total cholesterol, LDL, and triglycerides, and a significant decrease in HDL. These results are consistent with those of Scheen (1998) in Belgium, who demonstrated that being overweight is strongly correlated with hypertriglyceridemia, a decrease in HDL cholesterol levels, and an increase in LDL cholesterol. However, according to Mistra et al. (2004), the combination of these three abnormalities puts individuals at high risk for atherosclerosis.

The obese children in this study have elevated serum lipid levels. These results corroborate those of Charles in 2006, who states in his studies that children's serum lipid levels increase with overweight and obesity. Indeed, the alteration in the lipid profile can be explained by changes in dietary habits, decreased physical activity, and the significant role of cholesterol and triglycerides in the pathophysiology of obese individuals. The study by (Faye *et al.,* 2011) highlights a higher risk of metabolic syndrome and cardiovascular disease among these children.

In Benin, however, the study by (Yessoufou *et al.,* 2012) on the prevalence and role of lipids in the development of obesity shows normal levels of triglycerides and HDL in the studied population. In their study, only LDL metabolism was disrupted among students at the National Medical-Social Institute (INMES) and the Institute of Applied Biomedical Sciences (ISBA) in Cotonou, out of the four parameters measured (CT, HDL, LDL, and TG).

Obesity contributes significantly to the onset of diseases such as diabetes, high blood pressure, and high blood cholesterol (hypercholesterolemia), which, in turn, promote atherosclerosis, a cardiovascular risk factor (Assmann *et al.,* 2002).

The onset of a specific type of dyslipidemia leads to a significant increase in cardiovascular risk (Ginsberg *et al.,* 2006), characterized by elevated plasma levels of TG and VLDL, cholesterol-enriched LDL particles that are smaller and denser than normal LDL, as well as a decrease in plasma HDL concentration.

The hypertriglyceridemia observed in insulin-resistant patients is primarily due to increased lipolysis, which leads to elevated plasma concentrations of non-esterified fatty acids (NEFA), resulting in overproduction of triglycerides (TG) and very-low-density lipoproteins (VLDL) (Qiu *et al.,* 2005). Furthermore, the increased flux of NFA (non-esterified fatty acids) stimulates hepatic and intestinal TG synthesis and thus requires the transfer of lipids to apolipoprotein B100 and apolipoprotein B48, as well as their stability.

Hypertriglyceridemia is also thought to be linked to decreased LPL (lipoprotein lipase) activity. In cases of insulin resistance, LPL is less activated by insulin. Consequently, there is reduced hydrolysis of VLDL, leading to an increase in plasma TG concentration (Florez *et al.,* 2006). These disorders result in a reduced LDL metabolism, resulting in an increase in small, dense, highly oxidizable LDL particles (Ducobu, 2005). These modified LDL particles are taken up by scavenger receptors, which are abundant on macrophages; the uptake of these LDL particles leads to the accumulation of cholesterol in the macrophages of the vascular wall, thereby causing them to transform into foam cells, which play an essential role in the early stages of atherogenesis (Ducobu, 2003). These findings suggest that these children are at high risk for metabolic and cardiovascular diseases.

According to the results of this study, there is a strong correlation between BMI and waist circumference. This correlation has been highlighted in several studies (Janssen *et al.,* 2005 ; Hirschler *et al.,* 2005).

The children in this study are less affected by hyperglycemia; this observation is consistent with that of Bougnères and Le Stunff (2007), who found it in only 10 to 15% of obese children. Type 2 diabetes, on the other hand, is quite rare. In fact, only children with a strong genetic predisposition to diabetes (children of Asian descent and, to a lesser extent, those of Sub-Saharan African descent) may develop the disease if they become obese. Among children of European or North African descent, obesity does not lead to diabetes before adulthood (Druet *et al.,* 2006).

Among the children in the study population, only 6.2% of normal-weight children and 9.4% of obese children have elevated fasting blood glucose levels. The prevalence of fasting hyperglycemia is very low and is similar to that reported by (Wiegrand *et al.,* 2004 and Druet *et al.,* 2006), who found a lower prevalence of hyperglycemia in the European study on glucose tolerance and type 2 diabetes in children and adolescents.

The highest prevalence among obese children, after low HDL cholesterol, was hypertriglyceridemia. The lowest prevalences were for waist circumference and hyperglycemia.

IV. CONCLUSION

This study highlights a marked disruption of the lipid profile among obese schoolchildren in Côte d'Ivoire, characterized by elevated total cholesterol, LDL, and triglycerides, together with a significant reduction in HDL. These lipid abnormalities indicate an increased cardiometabolic risk from early childhood and underscore the necessity of prompt, multidimensional management of pediatric obesity. Our findings reinforce the urgent need to integrate systematic screening for dyslipidemia into school health programs and to promote tailored nutritional and behavioral interventions aimed at preventing progression to cardiovascular disease in adulthood. Beyond the clinical dimension, the implementation of targeted public health strategies that account for the socio-economic and cultural context of Côte d'Ivoire is essential to mitigate the long-term impact of childhood obesity on population health.

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