Obesity, Dyslipidemia and other Risks Factors for Metabolic Syndrome among Indigenous Black African Secondary School Students in Lagos, Nigeria

Bamgboye M. Afolabi[1], Susan J. Holdbrooke[1]

1 Nigerian Institute of Medical Research

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Abstract

Introduction: Metabolic syndrome (MetS) is a group of risk factors which together increase the chance of heart disease, stroke, and type 2 diabetes. In MetS, especially among overweight and obese people, blood pressure and blood glucose are elevated, excess body fat accumulates abdominally, and there is dyslipidemia (notably low level of high-density lipoprotein (HDL) cholesterol and high level of triglycerides). There is scarcity of data available on MetS and dyslipidemia among secondary school children in Lagos, Nigeria.

Objective: To determine the prevalence of dyslipidemia and metabolic syndrome among overweight and obese adolescents in secondary schools in Lagos, Nigeria.

Population and Methods: An institution-based, cross-sectional, descriptive study was conducted from October 2019 to March 2020. A multi-stage sampling approach was used to recruit 624 students aged 10-19 years in secondary schools within Lagos State of Nigeria. Data were collected using a structured questionnaire and anthropometric measurements. Fasting venous blood samples were collected for plasma glucose and lipid profile analysis. Systolic and diastolic blood pressures were measured. A p-value <0.05 was taken as statistically significant.

Results: The overall means (±sd) of age (years), weight (kg), height (m) and BMI were 14.7 (2.2), 47.4 (11.6), 1.6 (0.1) and 19.2 (4.2) respectively with no significant difference relative to gender, except BMI (Kg/m^2) which was higher (t-test= -2.24, P-value=0.03) in girls (19.5±4.1) than boys (18.7±4.5). Only 1 (0.4%) of boy and 17 (4.4%) girls had waist circumference ≥94 cm and ≥80cm correspondingly. Approximately 17%, 75%, 5% and 3% of the students were underweight, healthy, overweight, and obese separately. The overall mean systolic blood pressure (SBP) was 108.2 (12.4) mmHg with about 14%, 4% and 0.5% presenting with pre-hypertension, stage 1 and stage 2 hypertension respectively. Overweight students had the highest SBP of 113.8±12.8 mm Hg while obese subjects had the highest DBP of 79.9±7.5 mm Hg. No obese subject had a low SBP. Approximately 19% and 12% of the study subjects had impaired and diabetic fasting blood glucose (FBG), especially females, those in early-stage adolescence and the overweight subjects. Approximately 71%, 50%, and 86% of the students had high levels of triglyceride, total cholesterol, and low-density lipoprotein while 25% of them had low level of high-density lipoprotein. The overall prevalence of dyslipidemia was 8.5%, more prevalent among obese subjects (20.0%). Overall, 15%, 44%, 32% and 9% had 0, 1, 2 or ≥3 risk factors for metabolic syndrome.

Conclusion: A higher proportion of male, mid-adolescent, and overweight students had a minimum of 3 risk factors for MetSThis is likely to impose a high burden on future health. The extent to which the problem might affect other areas of Nigeria needs investigation.

Bamgboye M. Afolabi[1,2,3], and **Susan J. Holdbrooke**[1]

[1] *Nigerian Institute of Medical Research, 6, Edmond Crescent, Yaba, Lagos, Nigeria.*

[2] *Health, Environment and Development Foundation, Lagos, Nigeria.*

[3] *AfriHealth Optonet Association, Abuja*

[*]**Correspondence:**

Dr. Bamgboye M. Afolabi

Biochemistry and Nutrition Department

Nigerian Institute of Medical Research

6, Edmond Crescent,

Yaba, 101245, Lagos, Nigeria

Tel: +234 (0) 808 008 1946

Email: bmafolabi@gmail.com

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Introduction

Metabolic syndrome, a collection of several cardiovascular risk factors, was once thought to be uncommon in Black Africans in Africa. However, the prevalence of this disorder is relatively high in some populations, increasing with age [1]. It has been suggested that the transition from traditional African diet and lifestyle has contributed to the perceived increase in metabolic disorders[2]. Dyslipidemia is a core part of the metabolic syndrome and its risk factors for cardiovascular diseases and type 2 diabetes (T2DM) [3][4]. Dyslipidemia components include high total cholesterol (TC) and/or triglyceride (TG) levels with low high-density lipoprotein cholesterol (HDL-C) and sometimes high low-density lipoprotein cholesterol (LDL-C)[5][6][7]. Nutritional patterns and consumption behaviors are important in its causation [8][9]. Unfortunately, prevalence of dyslipidemia is increasing in many less well-resourced countries due westernization of diets and lifestyle, reduced physical activity, and consequent obesity in aging populations [2][10]. In diabetes mellitus patients, the most common patterns of dyslipidemia were hypertriglyceridemia with decreased HDL cholesterol levels, which together with elevated levels of LDL particles markedly increase the risk of CVD among people with T2DM patients.

The suggested definition of MetS in adults consists of at least 3 out of 5 predisposing factors: increased central adiposity, elevated triglycerides, decreased HDL-C, elevated blood pressure, and hyperglycaemia [11][12]. However, the American Academy of Paediatrics (AAP) recommended that paediatricians should focus on screening for CVD risk factors screening, rather than defining MetS in adolescents [13]. Estimating MetS prevalence in childhood is challenging due to different criteria used submitted in studies, partly accounting for a prevalence ranging from 0.2 to 38.9 %[14]. A systematic review reported a median prevalence of MetS of 3 (range 0-19) % among 85 children, 29 % (range 10-66) % in obese populations, 12 (range 3-29) % in overweight children, and 0-1% in healthy populations [15][16]. Cook et al [12] reported approximately 90% of obese children and adolescents as having at least one risk factor of MetS. Other studies argued that the prevalence is higher in Hispanics compared to Caucasian or African American populations [17][18], as well as in certain adult population such as East Asians, Asian Indians, Native American and Japanese Americans [19][20].

There is paucity of data on lipid profiles and on metabolic syndrome among apparently healthy Nigerian adolescents. Jaja and Yarhere observed a high prevalence of hypertriglyceridemia among diabetic Nigerian adolescents aged 7-18 years [21]. Odey et al noted low levels of lipid profiles among adolescents in Calabar, in the South-south (SS) geopolitical zone of Nigeria but did not explore adolescent metabolic syndrome [22]. Eke et al [23] noted that hypertriglyceridemia had a higher prevalence than the other lipids among adolescents in Enugu, Southeast Nigeria, emphasizing mainly relationship between body mass index and lipid profiles. These various studies did not disaggregate stages of adolescence or consider the anthropometric nutritional status of their study populations.

The objectives of this current study were to determine prevalence of (1) dyslipidemia and other risk factors, and of (2) metabolic syndrome, among apparently healthy adolescents in various secondary schools in the city of Lagos, Southwest Nigeria.

Populations and Methods

Study site

This descriptive, cross-sectional study was conducted in Lagos State, Southwest Nigeria. Lagos, the most economically important city in the country, is also, the most populous, the second fastest growing city in Africa and the seventh in the world. The city has 616 registered public (372, 60 %) and private (244, 40 %) secondary schools. in the selected Local Government Areas (LGAs) of study [24].

Study population

This consisted of Secondary School students recruited from 16 registered schools across the LGAs in the 3 Senatorial Districts that make up Lagos State. Each secondary school is divided into two arms – Junior Secondary School (JSS) of 3 years -Year 1, 2, 3, (mainly aged 10-15 years) and Senior Secondary School (SSS) also of 3 years -Year 1, 2, 3 (mainly age 16-19 years) – with male and female adolescent students ranging in age from 10-19 years.

Sample size calculation

The sample size was calculated for a single population with 95% confidence interval, 65.6 %[25] proportion, a margin of error 5%, and allowing for 10% non-response. To ensure that our results are representative of all Nigerian ethnic groups resident in Lagos State, the sample size would then be 650 students to cater for attrition and missing data.

Sampling technique and procedure

Multi-stage sampling approach was used involving a combination of stratified sampling, simple random and systematic sampling techniques to recruit 650 10-19-year-old adolescent students in both registered private and public secondary schools in Lagos State. Selection was stratified by junior and senior school years, and proportional to school size. Each school register was used systematically as a sampling frame aiming at a total of 650 students. Recruitment was from October 2019 to March 2020. In all 624 students (241males and 383 females) were included in this descriptive cross-sectional study.

Eligibility criteria

Inclusion criteria. Students had to be apparently healthy Black, indigenous Nigerians resident locally for a minimum of 2 years.

Exclusion criteria. These included any therapeutic diet or drugs, and admissions to a health facility in previous 6 month. Thus, students with diabetes, those taking lipid-lowering medications, or with a history of vascular/liver/renal or other continuing illness were excluded. Pregnancy, suspected pregnancy, or use of oral contraceptive were also exclusion criteria.

Ethical approval and Informed consent

Written informed consent and verbal consent were obtained from parents and assent from participants, respectively. The study protocol was approved by the Institutional Review Board of the Nigerian Institute of Medical Research (NIMR IRB (IRB/18/062)) and the study conducted in accordance with the Declaration of Helsinki (2000).

Measurements

Data on socio-demographic and economic characteristics were gathered from both parents and students. In addition, dietary and food consumption pattern, clinical features, physical activity levels and parental medication intake, were collected using a structured questionnaire administered in face-to-face interviews. Body weight, height, neck, waist, and hip circumferences were measured by trained field workers. Weight was measured with minimal clothing to the nearest 0.1 kg using an electronic scale (FBS machine Model HBF-514C and DP scale HN-283), and height without shoes to the nearest millimeter using a portable stature meter (SURGILAC). Waist and hip circumferences were also measured to the nearest millimeter over light clothing, waist midway between the lowest rib and the iliac crest, and hip at the widest part of the buttocks. World Health Organization (WHO) AnthroPlus V1.0.4 (Geneva, Switzerland) was used to calculate BMI-for-age, height-for-age, and percentiles, for boys and girls separately, and Z-scores used for classification according to WHO [26]. Sex-specific categorization was used for BMI. Cut-offs were available for Nigerian or

African for waist circumference were 0.94 m for boys and 0.80 m for girls, no Nigeria- or Africa- specific limits being available for this age group. Blood pressure (upper arm) and pulse rate were measured after 30 min sitting (aneroid sphygmomanometer for a very thin hand {SURGILAC CE 123-HS-20C. [Germany]}, automatic blood pressure monitor for moderate hand {Medical Instrument WUXI, Ltd, EN-BL-8030 [China]} or a mercury sphygmomanometer (long cuff Medical Instrument WUXI, Ltd, EN-BL-8030 [China]} machine for a very big hand). The average of the three measurements was used. Participants were asked to fast overnight, after which 5 ml of venous blood was taken. Fasting blood for glucose was collected into fluoride oxalate tubes while the fasting blood for lipids was collected in Lithium heparin tubes. Both were stored at -20ºC before centrifuging for the production of plasma. Randox Glucose-PAP (Randox Laboratories, UK) reagent was used for analyzing FPG and lipid profile (total cholesterol, HDL, low-density lipoprotein (LDL) and triglycerides) were measured using a photo spectrometric analyzer (BioSystems EN ISO 13485 and EN ISO 9001 standards (Barcelona, Spain).

Statistical analysis

Data were analyzed by descriptive statistics presented as frequency (percent) for the categorical variables and mean with SD and 95% CI for the continuous variables. Analyses were conducted using NCSS version 22 (Kaysville, Utah, USA). Participants were segregated by age group criteria into early (10-14 years), mid (15-16 years), and late adolescents (17-19 years). Analysis of variance, Chi-square with odds ratios, bivariate, and multivariate logistic regression analyses were performed. An unadjusted p-value <0.05 was considered statistically significant. Descriptive statistics were performed for all anthropometric and biochemical data, and values were initially reported as mean (±) standard deviation (SD). Kolmogorov-Smirnov Normality test for normality of data distribution for continuous measures was conducted and when the test failed, Mann-Whitney U-test and Kruskal-Wallis one-way ANOVA were used to determine differences between 2 and 3 medians respectively. Independent Student's t-tests were used to identify differences in anthropometric measurements. Pearson correlations were used to examine associations. Metabolic syndrome severity calculator [27], which considers the adolescent's height (cm), weight (kg), sex, serum triglyceride, HDL-C, fasting glucose, systolic blood pressure, and ethnicity (non-Hispanic, Black), was used to calculate continuous metabolic syndrome (cMetS) risk score for early occurrence of MetS [27].

Definitions

Dyslipidemia was defined as a combination of total cholesterol ≥200 mg/dL, low-density lipoprotein-cholesterol (LDL-C) ≥ 130 mg/dL, triglycerides (TG) ≥130 mg/dL, or high-density lipoprotein cholesterol (HDL-C) < 40 mg/dL [28][29]. The NHLBI criteria specific for children and adolescents were used to identify MetS among participants aged 10 to 19 years[7]. This requires three or more of (i) waist circumference (WC) ≥0.94 m for boys and ≥0.80 m for girls; fasting plasma levels of (ii) TG ≥130 mg/dL; (iii) HDL-cholesterol <40 mg/dL; (iv) LDL-cholesterol ≥130 mg/dL; (v) total cholesterol ≥200 mg/dL; (vi) glucose ≥100mg/dL; (vi) pre-hypertension as Systolic/Diastolic BP (SBP/SDP) 120-129/ <80 mmHg, stage 1 hypertension, BP 130-139/80-89, and stage 2 ≥140/90 mmHg [30]. However, for the purpose of this study, WC, and fasting plasma levels of glucose, triglycerides, and total cholesterol were the variables taken for the assessment of MetS. Underweight was defined as BMI <5th percentile for age, healthy weight as BMI ≥5th to <85th percentile for age, overweight as BMI ≥85th to <95th percentile and obese as BMI ≥95th percentile for age, using the BMI age chart [31]. Fasting plasma glucose (FPG) of <70mg/dL, 70-<100 mg/dL, 100-125.9 mg/dL and ≥126mg/dL were taken as low, normal, impaired (pre-diabetic and diabetic.

Other Abbreviations

- WHO – World Health Organization
- NHLBI – National Heart, Lung and Blood Institute
- NCEP – National Cholesterol Education Program
- IDF – International Diabetes Foundation

Results

Demographic and anthropometric characteristics. Table 1.

A total of 624 (241 (38.6%) boys and 383 (61.4%) girls) study participants were recruited into the study and reported after data from a negligible 26 (4.0%) students were discarded due to incomplete entry. are reported here. There was no significant difference in the means of age (years), weight (kg) and height (m) of boys and girls study subjects, though the mean BMI (kg/m^2) of girls (19.5±4.1) was significantly higher (t-test= -2.24, P-value=0.03) than that of boys (18.7 (4.5). Underweight was significantly more prominent among boys (23.2%) who were approximately twice as likely to be underweight (13.6%, χ^2=6.64, P-value=0.002; OR=1.93, 95% CI = 1.27, 2.93) compared to girls compared to girls (13.6%). Girls, on the other hand, were about 1½ times more likely to be overweight (χ^2=0.99, P-value=0.34; OR=1.50, 95% CI = 0.67, 3.32) and obese (χ^2=0.65, P-value=0.42; OR=1.49, 95% CI = 0.56, 3.92) compared to boys. In all, 5.5% of the girls and 3.7% of the boys were overweight while 3.7% of the girls and 2.5% of the boys were obese. Of the 383 girls, 35 (9.1%) were either overweight or obese, whereas 15 (6.2%) boys were either overweight or obese.

Frequency distribution of systolic and diastolic blood pressure (mm Hg). Table 2.

The overall mean (±sd) systolic blood pressure (SBP in mm Hg) was 108.3 (12.3) with no variation (t-test=0.37, P-value=0.71) among that of boys (108.5±13.9) and girls (108.2±11.4). In all, 16.2%, 6.2% and 0.8% of the boys had pre-hypertension, Stage 1 hypertension and Stage 2 hypertension respectively compared to 11.7%, 2.3% and 0.3% of the girls, though the differences did not approach any level of significance. When segregated by stage of adolescence, mean (±sd) SBP rose steadily among boys, from 106.5 (13.1) in early-, through 110.0 (14.8) in mid-, to 110.7 (13.4) in late-adolescence; and among girls from 107.1(12.2) in early-, through 109.2 (11.1) in mid- and 109.2 (9.9) in late adolescence. Pre-hypertension, Stage 1 hypertension and Stage 2 hypertension were distributed among boys and girls in different stages of adolescence as shown in the Table. Overall, diastolic blood pressure was significantly higher (t-test=-2.35, P-value=0.02) among the girls than boys. When segregated by BMI-for-age, systolic BP (mmHg) of boys also rose steadily from 100.6±14.0 among the underweight boys to 113.5±9.6 among obese boys. However, the rise in SBP among girls was from 102.0±10.6 among the underweight to 113.2±10.1 among the overweight. No significant variation was observed in the SBP among boys and girls in different BMI-for-age. The distribution of systolic and diastolic pre-hypertension, Stage 1 and Stage 2 hypertension are as illustrated in the Table.

Fasting Blood Glucose (FBG) among study subjects. Table 3, Figure 1.

The overall median FBG (mg/dl) was 87.5, higher in boys at 89.7 than girls at 86.3, without a significant difference. However, when segregated by stage of adolescence, it was higher among girls than boys in early- (89.0 vs 87.4) and mid- (94.1 vs 89.9) adolescence while it is higher among boys than girls in late adolescence (91.2 vs 85.5). These variations were not statistically significant. In all, 31.7%, 19.1% and 11.7% of the subjects had low, impaired, or diabetic FBG respectively. Overall, 28.2%, 19.9% and 10.0% of boys and 33.9%, 18.5% and 12.8% of girls had low, impaired, or diabetic FBG, indicating that low and diabetic FBG were more prevalent among girls while impaired FBG was more predominant among boys. Further, separation by stage of adolescence shows that boys in late adolescence (29.8%) and girls in mid adolescence (19.5%) contributed the highest proportion of those with impaired FBG. Diabetic FBG was more prevalent among girls than boys in early- (15.3% vs 12.7%), mid- (11.4% vs 9.5%) and late- (8.5% vs 4.2%) adolescence. It was also more prominent among underweight (17.3% vs 10.7%, χ^2=0.97, P-value=0.32), healthy weight (11.8% vs 9.4%; χ^2=0.42, P-value=0.64) and obese (14.2% vs 0.0%) girls more than boys; Diabetic FBG was more prevalent among overweight boys than girls (22.2% vs 14.3%; χ^2=0.28, P-value=0.60). Figure one illustrates frequency distribution of different levels of FBG among study subjects, categorized by sex, stage of adolescence and BMI-for age, indicating that the highest proportions of impaired and of diabetic FBG were among the underweight and the overweight respectively, regardless of sex or stage of adolescence.

Plasma lipids profiles of participants by stage of adolescence, sex, and BMI-for age. Table 4.

Triglyceride (mg/dl) analysis (Table 4a)

The overall median values of triglyceride (mg/dl) was 180.8, with no significant difference between boys and girls. In all, 14.4% and 70.5% of the study subjects had a mean borderline or high TG level of 115.3 or 218.1 respectively, higher among boys (120.1, 224.1 respectively) than among girls (114.3, 214.8 respectively). When segregated by stage of adolescence, TG level was highest (195.0) in mid adolescence TG level, driven by the TG level of boys (206.3) rather than by girls (182.4). In late adolescence, the proportion of girls with high TG (80.0%) was significantly higher (χ^2=4.70, P-value=0.03, OR=2.48, 95% CI=1.08, 5.69) than that of boys (61.7%), though the median of TG was higher among boys (246.3) than among girls (221.3). Overall, overweight subjects recorded the highest TG level (228.2) but obese boys and overweight girls recorded the highest TG concentration (266.7 and 253.2 separately).

Total cholesterol (mg/dl) analysis (Table 4b)

The median total cholesterol (TChol) of boys (204.0) was higher than that of girls (198.0) without any noteworthy variance. Approximately half (49.5%) of the study subjects had high levels of TChol with boys and girls recording median of 260.9 and 250.4 respectively. Mean total cholesterol concentration was highest in early adolescence (207.3) with girls having a slightly higher level (207.3) than boys (206.0). Girls in early adolescence were about 1.2 times more likely to have high level of TChol than boys (χ^2=0.93, P-value=0.33; OR-1.17, 95% CI=0.85, 1.62). In general, boys recorded the highest median Tchol of 260.9, especially those in early adolescence (261.8). Segregated by BMI-for-age, obese subjects had the highest median TChol of 277.1, driven by the median of 283.4 recorded by obese girls who were 2½ times more likely to have high TChol than boys (χ^2=0.17, P-value=0.68, OR=2.50, 95%CI=0.35, 18.04).

Low-density lipoprotein (mg/dl) analysis (Table 4c)

Surprisingly, 85.9% of all the study subjects presented with high level of LDL-cholesterol (mg/dl), mostly girls (86.7%) than boys (84.6%). There was a remarkable statistical variation (Mann-Whitney U=-3.03, P-value=0.002) in the median value of LDL-cholesterol of boys (271.5) compared to that of girls (295.4). High concentration of LDL-cholesterol in boys (n=204, 294.0) was also significantly lower (Mann-Whitney U=-3.24, P-value=0.001) than that among girls (n=332, 315.0). Interestingly, the highest concentration of median LDL-cholesterol was in early (n=260, 315.2) and lowest in late (n=100, 282.9) adolescence, a feature that recured among boys (n=91, LDL-C=300.3) and girls (n=169, LDL-C=324.4) throughout the study. Overall, obese subjects (n=20) recorded the highest median LDL-Cholesterol of 322.4. Obese girls were 1½ times more likely to present with high LDL-cholesterol compared to obese boys (χ^2=0.65, P-value=0.42, OR=1.50, 95%CI=0.56, 3.92). Overweight girls were also 1½ times more likely to present with high LDL-cholesterol compared to overweight boys (χ^2=0.99, P-value=0.32, OR=1.50, 95%CI=0.67, 3.32) but underweight girls were not as likely to have higher LDL than underweight boys (χ^2=9.63, P-value=0.002, OR=0.52, 95% CI=0.34, 0.79). .

High-density lipoprotein (mg/dl) analysis (Table 4d)

The overall media HDL-cholesterol level was 55.9, with no statistically significant difference between the value for boys (54.1) and for girls (56.5). Approximately 25% of all the study subjects presented with low level of HDL-cholesterol, with a median of 26.8 (26.7 for boys and 27.1 for girls). HDL-cholesterol was lowest (55.2) in mid adolescence compared to its values in early (56.2) or late (57.0) adolescence, lower among boys (53.7) than girls (58.1) in early adolescence, lower among boys (53.3) than girls (55.5) in mid adolescence but lower among girls (56.6) than boys (57.0) in late adolescence, though not of these variations was statistically significant. Those in mid adolescence had the highest prevalence (26.1%) of HDL-cholesterol <40 mg/dl, especially boys (28.6%) more than girls (24.4%). When categorized by BMI-for-age, the highest proportion of those with HDL-cholesterol <40 mg/dl were overweight boys, (n=3, HDL-cholesterol=21.2 mg/dl). In all, 18 (16.7%) underweight), 123 (26.4%) healthy weight, 8 (26.7%) overweight and only 1 (5.0%) obese subject presented with low (<40 mg/dl) HDL-cholesterol level.

Distribution of dyslipidemia by gender, stage of adolescence and BMI-for-age. Table 5.

The overall prevalence of dyslipidemia in this study cohort was 8.5% more prevalent among boys (10.8%) than among girls (7.0) though the difference was not statistically important, indicating that boys were more than 1½ more likely to have dyslipidemia (χ^2=2.66, P-value=0.10, OR-1.59, 95% CI=0.91, 2.80) or to be at risk of the condition (RR=1.53, 95% CI=0.92, 2.56). The prevalence of dyslipidemia was also highest (47.2%) in early adolescence when boys were about 1.40 times more at risk than girls (RR=1.36, 95% CI=0.64, 2.88). Although the prevalence was lower (37.7%) in mid adolescence, the risk was still higher (RR=1.79, 95% CI=0.78, 4.13). Surprisingly, the highest prevalence (71.7%) of dyslipidemia was notice among those with healthy weight with a higher prevalence among girls (74.1%) than boys (69.2%) with healthy weight. The prevalence of dyslipidemia was 3.8% among overweight (0.0% among boys; 7.4% among girls) and 7.5% among obese (3.8% among boys; 11.1% among girls) students.

Specific risk factors for metabolic syndrome. Table 6.

In all, 46.1%, 32.0% and 9.1% of the boys and 42.0%, 32.6% and 9.4% of the girls had at least 1, 2 or 3 risk factor for MetS, When the risk factors were considered, 92 (14.7%) had no risk factor of whom 31 (33.7%) and 61 (66.3%) were boys and girls respectively; 272 (46.3%) had at least 1 risk factor for MetS, among whom 111 (40.8%) were boys and 161 (59.2%) girls; 202 (32.4%) had 2 risk factors for MetS among whom 77 (38.1%) were boys and 125 (61.9%) girls, while 58 (9.3%) had three or more risk factors, including 22 (37.9%) boys and 36 (62.1%) girls. Of the 31 early adolescence subjects with risk factors ≥3 for MetS 19 (61.3%) were girls and 12 (38.9%) boys, the 20 in mid adolescence 11 (55.0%) were girls and 9 (45.0%) boys and of the 7 in late adolescence, 6 (85.7%) were girls and only 1 (14.3%) was a boy. Surprisingly, risk factors of ≥3 for MetS was more prevalent (7.1%) among the underweight than among healthy weight (5.9%), overweight (3.8%)

or obese (5.7%) subjects. Low-density lipoprotein was the most prevalent risk factor (85.9%) among all, including boys (84.6%) and girls (86.7%).

Discussion

Published literature and data on severe dyslipidemia among secondary school students in Africa, including Nigeria is rare. This current study investigated the prevalence of overweight, obesity, dyslipidemia and of Metabolic Syndrome (MetS) among 10-19-years-old indigenous Black Nigerian adolescent attending secondary school students in Lagos, Southwest Nigeria. The application of various criteria in the numerous definitions of metabolic syndrome has rendered the estimation of its prevalence problematic [32]. At present, there are no agreed guidelines or diagnostic criteria for metabolic syndrome in the pediatric population [20]. There are some key findings in this study that merit discussion. The mean age (14.7±2.1 years) of the subjects in this study is comparable to the 15.2±0.1 reported from a similar study in South Africa [33]. The overall 5% prevalence of overweight in this study is much lower than the 11.8% reported in a Norwegian study but the 5% prevalence of obesity is higher than the 2.4% prevalence reported in the same Norwegian study [34]. Further the 42.4% prevalence of overweight among males in this study is higher than the 25.6%, 21.6% and 19.7% reported among Kuwaitis, Jordanians and Syrian and the 57.6% prevalence of overweight among females is also higher than the 26.6%, 20.8% and 19.7% reported among Libyans, Kuwaitis and Syrians in a study conducted in 7 Arab countries [35]. The 27.3% prevalence of male obesity in the present study is lower than the 34.8% reported among Kuwaiti adolescents while the 72.7% prevalence in females is much higher than the 20.6% reported in the same study. The prevalence of obesity among males and female in this study is much higher than the 0.9% and 0.5% reported in another study conducted in Ghana and Uganda which included 13-15 years adolescents [36]. The 10.6% prevalence of overweight/obesity in this study is lower than the 40.2% prevalence reported from a South African study [33]. Nutritional behavioral pattern, dietary preference, lack of formal physical exercise, sleep duration, insulin, and hormonal effect, especially estrogen and growth hormone, may be the most likely biological explanations for higher prevalence of overweight and obesity among female adolescents. A study reports that when the duration of sleep is increased from 7.5 to 10 h per day, a 4% reduction occurs in the prevalence of overweight/obesity [37]. Studies have also confirmed the link between greater sedentary time and obesity development in adolescents [38][39][40]. Coldwell et al and other studies postulated that hormonal changes in female adolescents may be implicated in a preference for salty, sweet, or high fat foods [41][42][43]. One study postulates that adipokines, released from visceral adipose tissue is associated with MetS and CVD[44] and another reports that stimulation of the renin-angiotensin system (RAS) is a vital contributor to neurohumoral pathway that promotes the development of MetS [45].

The surprising high proportions, (70.5%, 49.5%, and 85.9%) of students with hyperlipidemia for TG, TChol and LDL are incomparable to the 4.5%, 12.1% and 9.2% reported from a Ghana School Survey conducted in Accra and Kumasi in a study in Ghana [46] or the 3.6% of total cholesterol reported from another study in Eti-Osa Local Government Area of Lagos State[47]. These disparities might be due to excessive dietary intake of saturated and trans fats, rather than hereditary causes. The overall 8.5% prevalence of dyslipidemia in this study is lower than the 29.9% reported from Iran [48] or the 30% from Tanzania [49]. The 10.8% and 7.0% prevalence of dyslipidemia among boys and girls in this study are much lower than the 33.3% and 17.9% respectively among boys and girls in Saudi Arabia [50] or various gene transformations leading to excessive production, or impaired clearance of triglycerides and low-density lipoprotein, or in very little production or excessive clearance of high-density lipoprotein. In resource-rich countries, secondary dyslipidemia is as a result of inactive lifestyle associated with abundant dietary intake of total calories, saturated fat, cholesterol, and trans fats which are polyunsaturated or monounsaturated fatty acids to which hydrogen atoms have been added; they are used in some processed foods and are as atherogenic as saturated fat [51]. Clinically, dyslipidemia and metabolic syndrome may contribute tocoronary artery disease, stroke, and peripheral arterial disease, extremely high lipid levels may give a milky appearance to blood plasma and highly elevated triglyceridemia alone may cause hepatosplenomegaly, acute pancreatitis, paresthesias, dyspnea, and confusion [51]. Further, the 6.1% prevalence of MetS in this study is higher than the 5.2% reported from India [52] or 1.4% from Tanzania [49]. Although the overweight and obesity were more prevalent among females than males, there were more males with MetS≥90th percentile score than females. The 14.1% and 4.7% proportions of MetS ≥90th percentile score among males and female subjects in this study are higher than the 6.7% and 5.6% reported in a South African study [33].

Conclusion and Recommendation

This study has documented dyslipidemia prevalence of 8.3% among the adolescents in Lagos Nigeria. A considerable proportion of the subjects of this study presented with hyper-triglyceridemia, hypercholesterolemia, hyper low-density lipoprotein and hypo high-density lipoprotein. Surprisingly a worrying number of the subjects of study had impaired and diabetic fasting blood sugar as well as systolic and diastolic hypertension. Underweight study subjects also presented with dyslipidemia and metabolic syndrome. Metabolic syndrome is discreetly widespread among adolescents in Lagos, Nigeria. Because adolescent overweight and obesity habitually linger into adulthood, it is imperative to challenge the causes and sources of increased risk for the metabolic syndrome in early adolescence or even earlier to avert the development of cardio-vascular diseases, stroke or any of the aforementioned illnesses in adulthood. It is therefore recommended that a multi-center and multi-disciplinary research be carried out among the teeming adolescents in or out of secondary schools in Nigeria with equal numbers of females and males to clarify the risk of metabolic syndrome among indigenous Black African Nigerians adolescents. Clinicians in African should consider metabolic syndrome when an adolescent presents with elevated level of triglyceride, low level of high-density cholesterol and impaired or diabetic fasting blood sugar, especially when the patient is overweight or obese. Such patients should be further assessed for hypertension associated with chronic kidney disease and for cardiovascular damage with echocardiography. There is no reason to assume that dyslipidemia is uncommon among secondary school students in Nigeria or that these students do not show signs of metabolic syndrome. There is high awareness of the need for the results of this study to be confirmed by future researches. In the interim period, it is recommended that the State Government commences a screening exercise for dyslipidemia and metabolic syndrome across the state to possible causes and ensure early diagnosis of sequel such as cardio-vascular accidents and other pathologies among these students.

Tables and Figures

Table 1. Demographic and anthropometric characteristics of study subjects by gender.

Variable		Boys (n=241, 38.6%)	Girls (n=383, 61.4%)	t-test (P-value)		All (n=624)
		Mean (±sd)				
Age (years)		14.8 (2.2)	14.7 (2.1)	ns		14.7 (2.2)
Weight (Kg)		46.5 (12.5	48.0 (11.0)	ns		47.4 (11.6)
Height (m)		1.6 (0.1)	1.6 (0.1)	ns		1.6 (0.1)
BMI Kg/m^2		18.7 (4.5)	19.5 (4.1)	-2.24 (0.03)		19.2 (4.2)
Waist circumference*		65.0 (6.6)	65.7 (6.7)	ns		65.4 (6.7)
		Freq. (%)		χ^2 (P-value)	OR (95% CI)	-
Stage of adolescence	Early	110 (45.6)	190 (49.6)	0.93 (0.33)	0.85 (0.62, 1.18)	300 (48.1)
	Mid	84 (34.9)	123 (32.1)	0.50 (0.48)	1.13 (0.80, 1.59)	207 (33.2)
	Late	47 (19.5)	70 (18.3)	0.15 (0.70)	1.08 (0.72, 1.63)	117 (18.7)
BMI-for-age	Underweight	56 (23.2)	52 (13.6)	9.64 (0.002)	1.93 (1.27, 2.93)	108 (17.3)
	Healthy weight	170 (70.5)	296 (77.3)	3.55 (0.06)	0.70 (0.49, 1.02)	466 (74.7)
	Overweight!	9 (3.7)	21 (5.5)	0.99 (0.32)	0.67 (0.30, 1.49)	30 (4.8)
	Obese!!	6 (2.5)	14 (3.7)	0.65 (0.42)	0.67 (0.25, 1.78)	20 (3.2)

** Male Waist circumference ≥94 cm n=1 (0.4%); Mean (±sd) = 98.0 (0.0) and <94 cm n=240 (99.6%); Mean (±sd) = 64.9 (6.3); * Female Waist circumference ≥80 cm n=17 (4.4%); Mean (±sd) = 84.8 (4.2) and <80 cm n=366 (95.6%); Mean (±sd) = 64.8 (3.3)*

! There was no significant difference in the proportion of males and females that were overweight, however, females were 1.5 times more likely to be overweight than males (χ^2=0.99, 0.32; OR=1.50, 95% CI=0.67, 3.32). !! There was no significant difference in the proportion of males and females that were obese, however, females were 1.5 times more likely to be obese than males (χ^2=0.65, 0.42; OR=1.49, 95% CI=0.56, 3.92)

Table 2. Frequency distribution of systolic and diastolic blood pressure (mm Hg) among the Secondary School students in the study.

Variable	Sub-variable	All		Gender				t-test (P-value)
				Boys		Girls		
		n (%)	Mean (±sd)	n (%)	Mean (±sd)	n (%)	Mean (±sd)	
Systolic BP (mmHg)	All	624 (100.0)	108.3 (12.4)	241 (38.6)	108.6 (13.9)	383 (61.4)	108.2 (11.4)	0.37 (0.71)
	Low	41 (6.6)	83.9 (5.1)	23 (9.5)	84.9 (4.4)	18 (4.7)	82.6 (5.7)	1.41 (0.17)
	Normal	472 (75.6)	106.2 (7.7)	162 (67.2)	105.4 (7.8)	310 (80.9)	106.5 (7.6)	-1.47 (0.14)
	Pre-hypertension	84 (13.5)	123.9 (2.9)	39 (16.2)	124.3 (2.9)	45 (11.7)	123.6 (3.0)	1.09 (0.28)
	Stage 1 hypertension	24 (3.8)	132.9 (2.0)	15 (6.2)	133.1 (1.8)	9 (2.3)	132.7 (2.5)	0.42 (0.68)
	Stage 2 hypertension	3 (0.5)	147.3 (9.3)	2 (0.8)	142.0 (1.4)	1 (0.3)	158.0 (0.0)	0.0 (0.0)
Diastolic BP (mmHg)	All	624 (100.0)	66.2 (9.5)	241 (38.6)	65.1 (10.3)	383 (61.4)	67.0 (9.0)	-2.35 (0.02)
	Low	299 (47.9)	58.4 (5.6)	129 (53.5)	57.6 (5.9)	170 (44.4)	59.1 (5.4)	-2.26 (0.02)
	Normal	278 (44.5)	71.4 (3.7)	92 (38.2)	71.1 (3.7)	186 (48.6)	71.6 (3.7)	-1.06 (0.29)
	Pre-hypertension	39 (6.3)	83.3 (2.9)	16 (6.6)	83.9 (3.2)	23 (6.0)	82.9 (2.6)	1.03 (0.31)
	Stage 1 hypertension	8 (1.3)	93.6 (3.4)	4 (1.7)	92.8 (2.4)	4 (1.0)	94.5 (4.4)	-0.68 (0.53)

Stage of adolescence

		All						Boys						Girls					
		Early		Mid		Late		Early		Mid		Late		Early		Mid		Late	
		n (%)	Mean (±sd)	n (%)	Mean (±sd)	n (%)	Mean (±sd)	n (%)	Mean (±sd)	n (%)	Mean (±sd)	n (%)	Mean (±sd)	n (%)	Mean (±sd)	n (%)	Mean (±sd)	n (%)	Mean (±sd)
Systolic BP (mmHg)	All	300 (48.1)	106.9 (12.5)	207 (33.2)	109.5 (12.7)	117 (18.7)	109.8 (11.4)	110 (45.6)	106.5 (13.1)	84 (34.9)	110.0 (14.8)	47 (19.5)	110.7 (13.4)	190 (49.6)	107.1 (12.2)	123 (32.1)	109.2 (11.1)	70 (18.3)	109.2 (9.9)
	Low	22 (7.3)	84.0 (5.3)	14 (6.8)	83.9 (4.8)	5 (4.3)	82.8 (5.7)	12 (10.9)	86.2 (3.5)	8 (9.5)	83.1 (5.6)	3 (6.4)	84.3 (3.8)	10 (5.3)	81.5 (6.2)	6 (4.9)	85.0 (3.8)	2 (2.9)	80.5 (9.2)
	Normal	235 (78.3)	105.4 (7.9)	146 (70.5)	106.6 (7.4)	91 (77.8)	107.6 (7.4)	80 (72.7)	105.0 (8.3)	50 (59.5)	105.4 (7.3)	32 (68.1)	106.7 (7.6)	155 (81.6)	105.6 (7.7)	96 (78.1)	107.2 (7.4)	59 (84.3)	108.1 (7.3)
	Pre-HT	32 (10.7)	123.7 (2.9)	36 (17.4)	124.1 (3.1)	16 (13.7)	124.0 (2.9)	13 (11.8)	123.9 (2.7)	18 (21.4)	124.1 (2.9)	8 (17.0)	125.6 (3.1)	19 (10.0)	123.5 (3.1)	18 (14.6)	124.2 (3.3)	8 (11.4)	122.4 (1.4)
	Stage 1 HT	9 (3.0)	133.0 (2.3)	10 (4.8)	132.9 (1.9)	5 (4.3)	132.8 (2.2)	4 (3.6)	132.3 (1.5)	7 (8.3)	133.4 (1.9)	4 (8.5)	133.3 (2.2)	5 (2.6)	133.6 (2.9)	3 (2.4)	131.7 (1.5)	1 (1.4)	131.0 (0.0)
	Stage 2 HT	2 (0.7)	150.5 (10.6)	1 (0.5)	141.0 (0.0)	0 (0.0)	0 (0.0)	1 (0.9)	143.0 (0.0)	1 (1.2)	141.0 (0.0)	0 (0.0)	0 (0.0)	1 (0.5)	158.0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Diastolic BP (mmHg)	All	300 (48.1)	65.6 (9.4)	207 (33.2)	67.0 (10.2)	117 (18.7)	66.6 (8.7)	110 (45.6)	64.4 (10.1)	84 (34.9)	65.7 (10.7)	47 (19.5)	65.6 (10.0)	190 (49.6)	66.3 (8.9)	123 (32.1)	67.9 (9.8)	70 (18.3)	67.2 (7.7)
	Low	152 (50.7)	48.3 (5.4)	96 (46.4)	58.2 (5.6)	51 (43.6)	59.1 (6.3)	60 (54.5)	57.1 (5.6)	44 (52.4)	57.4 (5.7)	25 (53.2)	58.9 (6.8)	92 (48.2)	59.1 (5.1)	52 (42.3)	58.9 (5.4)	26 (37.1)	59.3 (6.0)
	Normal	128 (42.7)	71.1 (3.9)	88 (42.5)	71.9 (3.5)	62 (53.0)	71.5 (3.6)	42 (38.2)	70.7 (3.6)	31 (36.9)	71.8 (4.0)	19 (40.4)	70.9 (3.6)	86 (45.2)	71.3 (4.0)	57 (46.3)	71.9 (3.3)	43 (61.4)	71.7 (3.6)
	Pre-HT	18 (6.0)	83.6 (3.3)	18 (8.7)	83.0 (2.3)	3 (2.6	83.7 (4.0)	7 (6.4)	84.0 (4.1)	7 (8.3)	83.4 (2.4)	2 (4.3)	85.5 (3.5)	11 (5.8)	83.4 (2.9)	11 (8.9)	(82.7 (2.4)	1 (1.4)	80.0 (0.0)
	Stage 1 HT	2 (0.6)	98.0 (2.8)	5 (1.4)	92.0 (2.3)	1 (0.9)	93.0 (0.0)	1 (0.9)	96.0 (0.0)	2 (2.4)	91.0 (0.0)	1 (2.1)	93 (0.0)	1 (0.5)	100.0 ().0)	3 (2.5)	92.7 (3.1)	0 (0.0)	0 (0.0)

		BMI-for-age																							
		All								Boys								Girls							
		Underweight		Healthy weight		Overweight		Obese		Underweight		Healthy weight		Overweight		Obese		Underweight		Healthy weight		Overweight		Obese	
		n (%)	Mean (±sd)	n (%)	Mean (±sd)	n (%)	Mean (±sd)	n (%)	Mean (±sd)	n (%)	Mean (±sd)	n (%)	Mean (±sd)	n (%)	Mean (±sd)	n (%)	Mean (±sd)	n (%)	Mean (±sd)	n (%)	Mean (±sd)	n (%)	Mean (±sd)	n (%)	Mean (±sd)
Systolic BP (mmHg)	All	108 (17.3)	101.3 (12.4)	466 (74.7)	109.4 (11.9)	30 (4.8)	113.8 (12.8)	20 (3.2)	113.4 (10.7)	56 (23.2)	100.6 (14.0)	170 (70.5)	110.8 (12.8)	9 (3.7)	112.9 (18.2)	6 (2.5)	113.5 (9.6)	52 (13.6)	102.0 (10.6)	296 (77.3)	108.6 (11.2)	21 (5.5)	114.2 (10.1)	14 (3.7)	113.3 (11.4)
	Low	22 (20.4)	84.2 (4.5)	17 (3.7)	83.0 (6.0)	2 (6.6)	87.0 (2.8)	0 (0.0)	0 (0.0)	15 (26.8)	84.0 (4.9)	6 (3.5)	86.3 (3.3)	2 (22.2)	87.0 (2.8)	0 (0.0)	0 (0.0)	7 (13.5)	84.7 (3.8)	11 (3.7)	81.2 (6.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
	Normal	79 (73.1)	103.9 (7.9)	359 (77.0)	106.4 (7.6)	18 (60.0)	109.3 (7.0)	16 (80.0)	109.2 (6.8)	36 (64.3)	103.8 (7.8)	118 (69.4)	105.7 (7.9)	3 (33.3)	108.7 (7.0)	5 (83.3)	110.4 (6.6)	43 (82.7)	103.9 (8.0)	241 (81.4)	106.7 (7.5)	15 (71.4)	109.5 (7.3)	11 (78.6)	108.6 (7.1)
	Pre-HT	5 (4.6)	122.4 (2.2)	72 (15.5)	124.1 (3.0)	5 (16.7)	122.6 (2.6)	2 (10.0)	126.5 (3.5)	3 (5.4)	123.3 (2.3)	34 (20.0)	124.4 (2.8)	1 (11.1)	120.0 (0.0)	1 (16.7)	129.0 (0.0)	2 (3.8)	121.0 (1.4)	38 (12.8)	123.8 (3.1)	4 (19.0)	123.3 (2.5)	1 (7.1)	124.0 (0.0)
	Stage 1 HT	2 (1.9)	133.5 (2.1)	15 (3.2)	133.1 (1.9)	5 (16.7)	132.0 (1.4)	2 (10.0)	133.5 (4.9)	2 (3.6)	133.5 (2.1)	10 (5.9)	133.3 (1.9)	3 (33.3)	132.0 (1.7)	0 (0.0	0 (0.0)	0 (0.0)	0 (0.0)	5 (1.7)	132.6 (2.2)	2 (9.5)	132.0 (1.4)	2 (14.3)	133.5 (5.0)
	Stage 2 HT	0 (0.0)	0 (0.0)	3 (0.6)	147.3 (9.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (1.2)	142.0 (1.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.3)	158.0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Diastolic BP (mmHg)	All	108 (17.3)	62.5 (10.2)	466	66.6 (9.1)	30	70.7 (11.1)	20 (3.2)	79.9 (7.5)	56 (23.2)	61.6 (10.7)	170 (70.5)	65.7 (9.5)	9 (3.7)	71.1 (17.4)	6 (2.5)	70.3 (5.9)	52 (13.6)	63.4 (9.6)	296 (77.3)	67.1) (8.8)	21 (5.5)	70.6 (7.6)	14 (3.7)	71.1 (8.2)
	Low	71 (65.7)	56.7 (6.4)	214 (45.9)	58.9 (5.3)	10 (33.3)	59.0 (5.8)	4 (20.0)	62.3 (2.5)	40 (71.4)	56.5 (6.9)	84 (49.4)	58.1 (5.3)	4 (44.4)	54.8 (5.9)	1 (16.7)	63.0 (0.0)	31 (59.6)	57.1 (5.9)	130 (43.9)	59.4 (5.2)	6 (28.6)	61.8 (4.0)	3 (21.4)	62.0 (3.0)
	Normal	32 (29.6)	71.4 (3.2)	220 (47.2)	71.5 (3.8)	14 (46.7)	72.4 (4.1)	12 (60.0)	69.8 (3.5)	12 (21.4)	70.9 (2.8)	75 (44.1)	71.3 (3.9)	1 (11.1)	70.0 (0.0)	4 (66.6)	69.8 (2.9)	20 (38.5)	71.7 (3.5)	145 (49.0)	71.6 (3.7)	13 (61.9)	72.6 (4.2)	8 (57.2)	69.9 (3.9)
	Pre-HT	3 (2.8)	83.0 (3.6)	27 (5.8)	83.3 (2.5)	5 (16.7)	84.4 (4.2)	4 (20.0)	82.5 (4.4)	3 (5.4)	83.0 (3.6)	9 (5.3)	84.3 (2.8)	3 (33.3)	85.0 (4.6)	1 (16.7)	80.0 (0.0)	0 (0.0)	0 (0.0)	18 (6.1)	82.8 (2.1)	2 (9.5)	83.5 (5.0)	3 (21.4)	83.3 (4.9)
	Stage 1 HT	2 (1.9)	91.5 (0.7)	5 (1.1)	94.0 (4.1)	1 (3.3)	96.0 (0.0)	0 (0.0)	0 (0.0)	1 (1.8)	91.0 (0.0)	2 (1.2)	92.0 (1.4)	1 (11.1)	96.0 (0.0)	0 (0.0)	0 (0.0)	1 (1.9)	92.0 (0.0)	3 (1.0)	95.3 (5.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

Systolic BP: Kolmogorov-Smirnov Normality test value =0.026, Decision (Alpha =5%) Can't reject normality

Diastolic BP: Kolmogorov-Smirnov Normality test value =0.095, Decision (Alpha =5%) Can't reject normality

Table 3. Gender differentiation of Fasting Blood Glucose of study subjects relative to Stage of adolescence and BMI-for-age.

Variable	Sub-variable	All		Gender				Mann-Whitney U (P-value)
				Boys		Girls		
		n (%)	Median	n (%)	Median	n (%)	Median	
Fasting Blood Glucose (mg/dl)	All	624 (100.0)	87.5	241 (38.6)	89.7	383 (61.4)	86.3	0.66 (0.51)
	Low	198 (31.7)	52.6	68 (28.2)	51.9	130 (33.9)	53.9	0.57 (0.57)
	Normal	234 (37.5)	88.0	101 (41.9)	89.7	133 (34.7)	87.2	0.71 (0.48)
	Impaired	119 (19.1)	109.8	48 (19.9)	108.5	71 (18.5)	110.4	-0.47 (0.64)
	Diabetic	73 (11.7)	149.2	24 (10.0)	158.4	49 (12.8)	140.1	1.36 (0.18)

Stage of adolescence

Sub-variable	All						Boys						Girls					
	Early		Mid		Late		Early		Mid		Late		Early		Mid		Late	
	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median
All	300 (48.1)	87.6	207 (33.2)	86.9	117 (18.7)	88.6	110 (45.6)	87.4	84 (34.9)	89.9	47 (19.5)	91.2	190 (49.6)	89.0	123 (32.1)	94.1	70 (18.3)	85.5
Low	96 (32.0)	51.9	67 (32.4)	55.9	35 (29.9)	49.2	34 (30.9)	51.9	23 (27.4)	51.7	11 (23.4)	57.9	62 (32.6)	52.5	44 (35.8)	56.7	24 (34.3)	48.9
Normal	108 (36.0)	87.9	79 (38.2)	87.5	47 (40.2)	88.6	43 (39.1)	87.6	38 (45.2)	89.9	20 (42.6)	89.3	65 (34.2)	88.1	41 (33.3)	86.3	27 (38.6)	88.1
Impaired	53 (17.7)	110.3	39 (18.8)	110.0	27 (23.1)	107.9	19 (17.3)	108.6	15 (17.9)	109.8	14 (29.8)	106.6	34 (17.9)	110.5	24 (19.5)	111.0	13 (18.6)	109.8
Diabetic	43 (14.3)	149.6	22 (10.6)	138.9	8 (6.8)	152.8	14 (12.7)	158.4	8 (9.5)	166.2	2 (4.2)	174.2	29 (15.3)	149.2	14 (11.4)	135.4	6 (8.5)	144.9

BMI-for-age

	All				Boys								Girls							
	Underweight (n=108)	Healthy weight (n=466)	Overweight (n=30)	Obese (n=20)	Underweight		Healthy weight		Overweight		Obese		Underweight		Healthy weight		Overweight		Obese	
	Median				n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median
All	90.4	86.4	94.8	72.8	56 (23.2)	92.1	170 (70.5)	87.4	9 (3.7)	112.7	6 (2.5)	72.8	52 (13.6)	88.6	296 (77.3)	86.0	21 (5.5)	87.2	14 (3.7)	77.3
Low	57.6	51.2	45.7	54.7	12 (21.4)	57.7	53 (31.2)	50.5	0 (0.0)	0.0	3 (50.0)	44.9	17 (32.7)	56.0	98 (33.1)	51.6	8 (38.1)	45.7	7 (50.0)	61.3
Normal	87.8	88.1	86.0	89.9	21 (37.5)	88.8	74 (43.5)	89.8	4 (44.5)	82.5	2 (33.3)	84.2	13 (25.0)	85.2	111 (37.5)	86.9	6 (28.6)	90.8	3 (21.4)	93.5
Impaired	110.0	109.7	112.7	110.9	17 (30.4)	109.7	27 (15.9)	106.9	3 (33.3)	117.7	1 (16.7)	110.9	13 (25.0)	110.9	52 (17.6)	110.5	4 (19.0)	107.2	2 (14.3)	109.8
Diabetic	136.6	149.6	145.2	141.5	6 (10.7)	166.7	16 (9.4)	158.4	2 (22.2)	176.8	0 (0.0)	0.0	9 (17.3)	134.4	35 (11.8)	149.2	3 (14.3)	135.0	2 (14.3)	141.5

Kolmogorov-Smirnov Normality test value =0.095, Decision (Alpha =5%) Reject normality

For Early-stage adolescents: *!Mann-Whitney U=-0.23 (P-value=0.81), ^Mann-Whitney U=0.30 (P-value=0.76); #Mann-Whitney U=0.16 (P-value=0.87); $Mann-Whitney U=-0.23 (P-value=0.82); *Mann-Whitney U=0.69 (P-value=0.0.49).* ***For Mid-stage adolescents:*** *!!Mann-Whitney U=0.03 (P-value=0.97); ^^Mann-Whitney U=1.09 (P-value=0.28); ##Mann-Whitney U=0.03 (P-value=0.97); $$Mann-Whitney U=-0.40 (P-value=0.69); **Mann-Whitney U=0.89 (P-value=0.37);* ***For Late-stage adolescents:*** *!!!Mann-Whitney U=0.75 (P-value=0.46); ^^^Mann-Whitney U=0.29 (P-value=0.77); ###Mann-Whitney U=0.15 (P-value=0.91); ***Mann-Whitney U=0.67 (P-value=0.50);*

For All FBS / BMI-for-age: *!Mann-Whitney U=-66 (P-value=0.51), !!Mann-Whitney U=-0.16 (P-value=0.87); !!!Mann-Whitney U=1.78 (P-value=0.07); !!!!Mann-Whitney U=--0.65 (P-value=0.51); ^Mann-Whitney U=0.69 (P-value=0.0.49).* ***For Mid-stage adolescents:*** *!!Mann-Whitney U=0.03 (P-value=0.97); ^^Mann-Whitney U=1.09 (P-value=0.28); ##Mann-Whitney U=0.03 (P-value=0.97); $$Mann-Whitney U=-0.40 (P-value=0.69); **Mann-Whitney U=0.89 (P-value=0.37);* ***For Late-stage adolescents:*** *!!!Mann-Whitney U=0.75 (P-value=0.46); ^^^Mann-Whitney U=0.29 (P-value=0.77); ###Mann-Whitney U=0.15 (P-value=0.91); ***Mann-Whitney U=0.67 (P-value=0.50);*

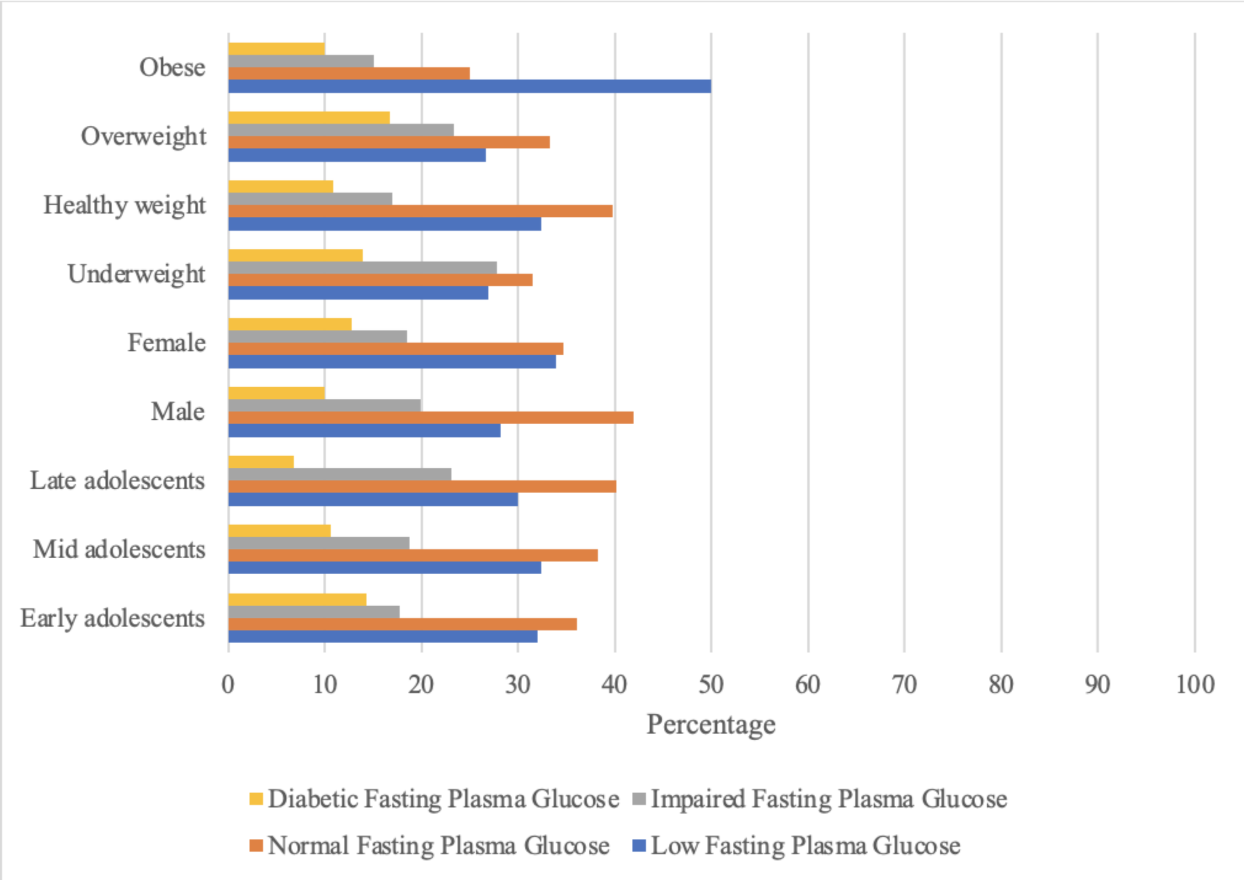

Figure 1. Proportion of study subjects with low, normal, impaired, and diabetic fasting plasma glucose levels relative to stage of adolescence, sex, and BMI percentile.

Table 4a. Triglyceride profile of participants by gender, stage of adolescence, and BMI-for age.

Variable	Sub-variable	All		Gender				Mann-Whitney U (P-value)
				Boys		Girls		
		n (%)	Median	n (%)	Median	n (%)	Median	
Triglyceride (mg/dl)	All	624 (100.0)	180.8	241 (38.6)	187.1	383 (61.4)	179.5	0.66 (0.51)
	Healthy (<90)	94 (15.1)	61.1	40 (16.6)	59.1	54 (14.1)	62.2	0.08 (0.93)
	Borderline (≥90-≤129)	90 (14.4)	115.3	29 (12.0)	120.1	61 (15.9)	114.3	0.10 (0.92)
	High (≥130)	440 (70.5)	218.1	172 (71.4)	224.1	268 (70.0)	214.8	0.89 (0.37)

Stage of adolescence

Sub-variable	All						Boys						Girls					
	Early		Mid		Late		Early		Mid		Late		Early		Mid		Late	
	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median
All	300 (48.1)	171.6	207 (33.2)	195.0	117 (18.7)	187.8	110 (45.6)	169.3	84 (34.9)	206.3	47 (19.5)	187.1	190 (49.6)	175.8	123 (32.1)	182.4	70 (18.3)	189.0
Healthy (<90)	51 (17.0)	59.1	24 (11.6)	68.8	19 (16.2)	60.3	21 (19.1)	53.6	10 (11.9)	79.8	9 (19.1)	57.8	30 (15.8)	63.4	14 (11.4)	60.6	10 (14.3)	65.4
Borderline (≥90-≤129)	45 (15.0)	115.5	32 (15.5)	112.7	13 (11.1)	120.1	13 (11.8)	115.2	7 (8.3)	121.7	9 (19.1)	121.3	32 (16.8)	116.5	25 (20.3)	110.9	4 (5.7)	115.0
High (≥130)	204 (68.0)	213.5	151 (72.9)	227.2	85 (72.7)	220.5	76 (69.1)	215.0	67 (79.8)	227.9	29 * (61.7)	246.3	128 (67.4)	210.8	84 (68.3)	222.7	56 * (80.0)	221.3

BMI-for-age

Sub-variable	All				Boys								Girls							
	Under weight	Healthy weight	Over weight	Obese	Underweight		Healthy weight		Overweight		Obese		Underweight		Healthy weight		Overweight		Obese	
	Median				n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median
All	180.8	179.9	205.9	180.2	56 (23.2)	192.6	170 (70.5)	177.3	9 (3.7)	171.0	6 (2.5)	182.0	52 (13.6)	171.3	296 (77.3)	171.8	21 (5.5)	227.2	14 (3.7)	180.2
Healthy (<90)	49.2	65.3	77.8	68.7	7 (12.5)	37.8	31 (18.2)	66.1	0 (0.0)	0.0	2 (33.3)	73.1	9 (17.3)	55.1	38 (12.8)	64.8	4 (19.0)	73.1	3 (21.4)	61.4
Borderline (≥90-≤129)	121.5	114.3	113.7	120.8	7 (12.5)	118	20 (11.8)	116.2	1 (11.1)	125.0	1 (16.7)	120.8	8 (15.4)	121.6	50 (16.9)	113.8	3 (14.3)	109.6	0 (0.0)	0.0
High (≥130)	204.5	219.1	228.2	205.7	42 (75.0)	213.3	119 (70.0)	261.4	8 (88.9)	179.8	3 (50.0)	266.7	35 (67.3)	195.0	208 (70.3)	216.3	14 (66.7)	253.2	11 (78.6)	192.1

Table 4b. Total cholesterol profile of participants by gender, stage of adolescence, and BMI-for age.

	Sub-variable	All		Gender				Mann-Whitney U (P-value)
				Boys		Girls		
		n (%)	Median	n (%)	Median	n (%)	Median	
Total Cholesterol (mg/dl)	All	624 (100.0)	199.4	241 (38.6)	204.0	383 (61.4)	198.0	0.69 (0.49)
	Healthy (<170)	221 (35.4)	131.9	87 (36.1)	133.3	134 (35.0)	131.7	0.49 (0.63)
	Borderline (≥170-≤199)	94 (15.1)	184.6	31 (12.9)	187.2	63 (16.4)	185.4	0.35 (0.72)
	High (≥200)	309 (49.5)	253.9	123 (51.0)	260.9	186 (48.6)	250.4	0.99 (0.32)

Stage of adolescence

Sub-variable	All						Boys						Girls					
	Early		Mid		Late		Early		Mid		Late		Early		Mid		Late	
	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median
All	300 (48.1)	207.3	207 (33.2)	198.1	117 (18.7)	192.5	110 (45.6)	206.0	84 (34.9)	214.1	47 (19.5)	191.8	190 (49.6)	207.3	123 (32.1)	183.5	70 (18.3)	196.0
Healthy (<170)	94 (31.3)	129.0	81 (39.1)	135.1	46 (39.3)	128.9	39 (35.5)	125.5	29 (34.5)	148.5	19 (40.4)	135.1	55 (28.9)	133.3	52 (42.3)	132.9	27 (38.6)	117.3
Borderline (≥170-≤199)	49 (16.3)	184.1	28 (13.5)	189.0	16 (13.7)	183.9	15 (13.6)	182.8	9 (10.7)	194.5	7 (14.9)	188.2	34 (17.9)	185.1	19 (15.4)	183.5	9 (12.9)	182.5
High (≥200)	157 (52.3)	255.9	98 (47.3)	247.8	55 (47.0)	252.4	56 (50.9)	261.8	46 (54.8)	260.9	21 (44.7)	251.3	101 (53.2)	254.0	52 (42.3)	241.1	34 (48.5)	252.6

BMI-for-age

Sub-variable	All				Boys								Girls							
	Under weight	Healthy weight	Over weight	Obese	Underweight		Healthy weight		Overweight		Obese		Underweight		Healthy weight		Overweight		Obese	
	Median				n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median
All	204.1	198.0	213.9	228.9	56 (23.2)	213.2	170 (70.5)	203.3	9 (3.7)	187.2	6 (2.5)	189.7	52 (13.6)	194.2	296 (77.3)	196.2	21 (5.5)	223.9	14 (3.7)	265.5
Healthy (<170)	135.1	131.1	122.9	144.4	17 (30.4)	139.5	64 (37.6)	128.0	3 (33.3)	127.4	3 (50.0)	144.4	21 (40.4)	128.3	102 (34.5)	131.7	7 (33.3)	132.7	4 (28.6)	143.0
Borderline (≥170-≤199)	179.3	185.1	185.0	0.0	9 (16.0)	179.3	20 (11.8)	189.4	2 (22.2)	181.7	0 (0.0)	0.0	6 (11.5)	179.6	54 (18.2)	184.6	2 (9.5)	191.1	0 (0.0)	0.0
High (≥200)	268.4	252.6	250.4	277.1	30 (53.6)	258.8	86 (50.6)	262.2	4 (44.5)	244.7	3 * (50.0)	227.6	25 (48.1)	256.4	140 (47.3)	247.4	12 (57.1)	260.5	10 * (71.4)	283.4

**Comparing mean TChol in obese girls to obese boys (χ^2=0.17, P-value=0.68, OR=2.50, 95%CI=0.35, 18.04).*

Table 4c. Low-density lipoprotein profile of participants by gender, stage of adolescence, and BMI-for age.

Low-density lipoprotein (mg/dl)

Sub-variable	All		Gender: Boys		Gender: Girls		Mann-Whitney U (P-value)
	n (%)	Median	n (%)	Median	n (%)	Median	
All	624 (100.0)	289.6	241 (38.6)	271.5	383 (61.4)	295.4	-3.03 (0.002)
Healthy (<110)	67 (10.7)	65.7	29 (12.0)	58.3	38 (9.9)	67.7	-0.41 (0.68)
Borderline (≥110-≤129)	21 (3.4)	123.4	8 (3.3)	123.5	13 (3.4)	123.4	0.04 (0.97)
High (≥130)	536 (85.9)	305.4	204 (84.6)	294.0	332 (86.7)	315.0	-3.24 (0.001)

Stage of adolescence

Sub-variable	All: Early		All: Mid		All: Late		Boys: Early		Boys: Mid		Boys: Late		Girls: Early		Girls: Mid		Girls: Late	
	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median
All	300 (48.1)	295.2	207 (33.2)	284.6	117 (18.7)	273.1	110 (45.6)	280.4	84 (34.9)	280.1	47 (19.5)	248.7	190 (49.6)	310.4	123 (32.1)	291.6	70 (18.3)	275.6
Healthy (<110)	32 (10.7)	66.4	23 (11.1)	61.8	12 (10.3)	61.6	14 (12.7)	60.4	10 (11.9)	52.2	5 (10.6)	67.9	18 (9.5)	67.7	13 (10.6)	79.3	7 (10.0)	39.0
Borderline (≥110-≤129)	8 (2.7)	123.5	8 (3.9)	121.7	5 (4.2)	124.0	5 (4.5)	123.6	2 (2.4)	118.9	1 (2.1)	120.8	3 (1.6)	120.3	6 (4.9)	121.7	4 (5.7)	124.8
High (≥130)	260 (86.6)	315.2	176 (85.0)	303.9	100 (85.5)	282.9	91 (82.7)	300.3	72 (85.7)	298.2	41 (87.2)	273.1	169 (88.9)	324.4	104 (84.5)	310.0	59 (84.3)	296.4

BMI-for-age

Sub-variable	All: Under weight (n=108)	All: Healthy weight (n=466)	All: Over weight (n=30)	All: Obese (n=20)	Boys: Underweight		Boys: Healthy weight		Boys: Overweight		Boys: Obese		Girls: Underweight		Girls: Healthy		Girls: Overweight		Girls: Obese	
	Median				n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median
All	265.7	290.1	298.6	322.4	56 (23.2)	247.7	170 (70.5)	280.1	9 (3.7)	306.0	6 * (2.5)	169.9	52 (13.6)	289.4	296 (77.3)	295.0	21 (5.5)	295.7	14 * (3.7)	331.0
Healthy (<110)	60.8	65.7	0.0	69.0	5 (8.9)	46.0	22 (13.0)	61.6	0 (0.0)	0.0	2 (33.3)	69.0	3 (5.8)	79.3	35 (11.8)	67.2	0 (0.0)	0.0	0 (0.0)	0.0
Borderline (≥110-≤129)	122.7	123.5	123.4	0.0	1 (1.8)	120.8	6 (3.5)	125.2	1 (11.1)	123.4	0 (0.0)	0.0	1 (1.9)	124.6	10 (3.4)	121.8	2 (9.5)	122.8	0 (0.0)	0.0
High (≥130)	289.4	310.3	306.0	331.0	50 (89.3)	265.7	142 (83.5)	295.8	8 (88.9)	310.6	4 (66.7)	271.5	48 (92.3)	294.7	251 (84.8)	316.3	19 (90.5)	301.6	14 (100.0)	331.0

Table 4d. High-density lipoprotein profile of participants by gender, stage of adolescence, and BMI-for age.

	Sub-variable		All	Gender				Mann-Whitney U (P-value)
				Boys		Girls		
		n (%)	Median	n (%)	Median	n (%)	Median	
High-density lipoprotein (mg/dl)High-density lipoprotein (mg/dl)	All	624 (100.0)	55.9	241 (38.6)	54.1	383 (61.4)	56.5	-0.58 (0.56)
	Low (<40)	154 (24.7)	26.8	67 (27.8)	26.7	87 (22.7)	27.1	-0.30 (0.76)
	Borderline (40-45)	39 (6.2)	42.0	15 (6.2)	42.0	24 (6.3)	42.2	-0.19 (0.85)
	Healthy (>45)	431 (69.1)	67.3	159 (66.0)	72.0	272 (71.0)	65.0	1.03 (0.30)

Stage of adolescence

Sub-variable	All						Boys						Girls					
	Early		Mid		Late		Early		Mid		Late		Early		Mid		Late	
	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median
All	300 (48.1)	56.2	207 (33.2)	55.2	117 (18.7)	57.0	110 (45.6)	53.7	84 (34.9)	53.3	47 (19.5)	57.0	190 (49.6)	58.1	123 (32.1)	55.5	70 (18.3)	56.6
Low (<40)	70 (23.3)	27.3	54 (26.1)	28.2	30 (25.6)	23.9	31 (28.2)	26.8	24 (28.6)	26.3	12 (25.5)	27.0	39 (20.5)	28.6	30 (24.4)	29.9	18 (25.7)	22.1
Borderline (40-45)	21 (7.0)	43.6	11 (5.3)	41.6	7 (6.0)	41.9	7 (6.4)	43.6	5 (6.0)	41.6	3 (6.4)	41.3	14 (7.4)	43.0	6 (4.9)	41.5	4 (5.7)	42.5
Healthy (>45)	209 (69.7)	70.3	142 (68.6)	62.9	80 (68.4)	64.2	72 (65.4)	73.4	55 (65.4)	69.5	32 (68.1)	76.1	137 (72.1)	69.3	87 (70.7)	62.4	48 (68.6)	62.9

BMI-for-age

Sub-variable	All				Boys								Girls							
	Under weight (n=108)	Healthy weight (n=466)	Over weight (n=30)	Obese (n=20)	Underweight		Healthy weight		Overweight		Obese		Underweight		Healthy weight		Overweight		Obese	
	Median				n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median	n (%)	Median
All	55.0	56.0	58.4	54.9	56 (23.2)	55.2	170 (70.5)	54.3	9 (3.7)	49.1	6 (2.5)	52.0	52 (13.6)	54.7	296 (77.3)	56.4	21 (5.5)	59.4	14 (3.7)	55.3
Low (<40)	29.1	26.7	23.1	27.1	11 (19.6)	29.2	52 (30.6)	26.6	3 (33.3)	21.2	1 (16.7)	36.8	7 (13.5)	28.9	71 (24.0)	27.9	5 (23.8)	23.2	4 (28.6)	24.2
Borderline (40-45)	42.7	42.0	44.9	41.3	3 (5.4)	42.0	10 (5.9)	42.3	1 (11.1)	44.9	1 (16.7)	41.3	3 (5.8)	44.2	20 (6.8)	42.0	1 (4.8)	44.8	0 (0.0)	0.0
Healthy (>45)	62.5	68.3	70.0	75.8	42 (75.0)	63.8	108 (63.5)	74.6	5 (55.6)	58.4	4 (66.6)	79.1	42 (80.8)	60.4	205 (69.3)	65.3	15 (71.4)	70.7	10 (71.4)	73.9

*Triglyceride: Kolmogorov-Smirnov Normality test value =0.093, Decision (Alpha =5%) Reject normality; Total cholesterol: Kolmogorov-Smirnov Normality test value =0.055, Decision (Alpha =5%) Reject normality; Low-density lipoprotein: Kolmogorov-Smirnov Normality test value =0.204, Decision (Alpha =5%) Reject normality; High-density lipoprotein: Kolmogorov-Smirnov Normality test value =0.153, Decision (Alpha =5%) Reject normality. * (χ^2=4.70, P-value=0.03, OR=2.48, 95% CI=1.08, 5.69)*

Table 5. Percentage distribution of dyslipidemia by gender, stage of adolescence and BMI-for-age of study subjects.

Variable	Sub-variable	Freq.	%
Gender	Boys	26	10.8
	Girls	27	7.0
Stage of adolescence	Early	25	8.3
	Mid	20	9.7
	Late	8	6.8
BMI-for-age	Underweight	9	8.3
	Healthy weight	38	8.2
	Overweight	2	6.7
	Obese	4	20.0

Table 6. Specific risk factors for metabolic syndrome and its prevalence as demarcated by the occurrence of three of five known risk factors relative to gender.

Risk factors for Metabolic syndrome		All	Gender		Stage of adolescence						BMI-for-age			
					Boys			Girls			Boys		Girls	
			Boys	Girls	Early	Mid	Late	Early	Mid	Late	Under weight	Healthy weight	Under weight	Healthy weight
n (%)		624 (100.0)	241 (38.6)	383 (61.4)	110 (45.6)	84 (34.9)	47 (19.5)	190 (49.6)	123 (32.1)	70 (18.3)	56 (23.2)	170 (70.5)	52 (13.6)	296 (7.3)
BMI ≥85th percentile !		50 (8.0)	15 (6.2)	35 (9.1)	11 (10.0)	2 (2.4)	2 (4.3)	23 (12.1)	7 (5.7)	5 (7.1)				
WC ≥94 cm (boys)		1 (0.4)	1 (0.4)	-	1 (0.9)	0 (0.0)	0 (0.0)	-	-	-	-	-	-	-
WC ≥80 cm (girls)		19 (5.0)	-	19 (5.0)	-	-	-	12 (6.3)	3 (2.4)	4 (5.7)				
Pre-HT/HT *		111 (17.8)	56 (23.2)	55 (14.4)	18 (16.4)	26 (31.0)	12 (25.5)	25 (13.2)	21 (17.1)	9 (12.9)	5 (8.9)	46 (27.1)	2 (3.8)	44 (14.9)
HDL <40 mg/dL **		154 (24.7)	67 (27.8)	87 (22.7)	31 (28.2)	24 (28.6)	12 (25.5)	39 (20.5)	30 (24.4)	18 (25.7)	11 (19.6)	52 (30.6)	7 (13.5)	71 (24.0)
TG ≥130 mg/dL ***		440 (70.5)	172 (71.4)	268 (70.0)	76 (69.1)	67 (79.8)	29 (61.7)	128 (67.4)	84 (68.3)	56 (80.0)	42 (75.0)	119 (70.0)	35 (67.3)	208 (70.3)
FSG glucose ≥ 100dL !!		192 (30.8)	72 (29.9)	120 (31.3)	33 (30.0)	23 (27.4)	16 (34.0)	63 (33.2)	38 (30.9)	19 (27.1)	23 (41.1)	43 (25.3)	43 (82.7)	87 (29.4)
Number of risk factors for Metabolic syndrome	≥ 3	58 (9.3)	22 (9.1)	36 (9.4)	12 (10.9)	9 (10.7)	1 (2.1)	19 (10.0)	11 (8.9)	6 (8.6)	4 (7.1)	10 (5.9)	2 (3.8)	17 (5.7)
	2	202 (32.4)	77 (32.0)	125 (32.6)	33 (30.0)	25 (29.8)	19 (40.4)	60 (31.6)	38 (30.9)	27 (38.6)	18 (32.1)	56 (32.9)	14 (26.9)	99 (33.4)
	1	272 (43.6)	111 (46.1)	161 (42.0)	54 (49.1)	40 (47.6)	17 (36.2)	79 (41.6)	52 (42.3)	30 (42.9)	28 (50.0)	79 (46.5)	30 (57.7)	126 (42.6)
	0	92 (14.7)	31 (12.9)	61 (15.9)	11 (10.0)	10 (11.9)	10 (21.3)	32 (16.8)	22 (17.9)	7 (10.0)	6 (10.7)	26 (15.3)	6 (11.5)	54 (18.2)

*WC=Waist circumference; HT=Hypertension, HDL=High-density lipoprotein; LDL= Low-density lipoprotein; TG= Triglyceride. *Boys with Pre-hypertension and stages 1 and 2 hypertension were 1.40 times more likely to be at risk for MetS (χ^2=7.96, P-value =0.005, RR=1.40, 95% CI=1.13, 1.74) than Girls;**Boys with HDL<40 mg/dL, were about 1.2 times more likely to be at risk for MetS (χ^2=2.05, P-value =0.15, RR=1.18, 95% CI=0.95, 1.46) than Girls; ***Boys with TG≥130 mg/dL were slightly more likely to be at risk for MetS (χ^2=0.14, P-value =0.71, RR=1.04, 95% CI=0.84, 1.30) than Girls. !Girls with BMI ≥85th percentile were about 1.2 times more at risk for MetS (χ^2=1.70, P-value =0.19, RR=1.16, 95% CI=0.95, 1.40) than Boys.!! Girls with serum glucose ≥100mg/dL were slightly more likely to be at risk for MetS (χ^2=0.15, P-value =0.70, RR=1.02, 95% CI=0.90, 1.17) than Boys.*

Declaration of Competing Interest

The authors declare no competing interest.

Data for reference

The data used to substantiate and validate the findings of this study are available from the corresponding author upon request.

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