ORIGINAL ARTICLE

Prevalence of the metabolic syndrome and its components in secondary school student population in the city of Douala, Cameroon

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Abstract. While the burden of metabolic syndrome (MetS) is still increasing in sub-Saharan Africa, there is a lack of data among young Cameroonian population. The aim of this study was to evaluate the prevalence of MetS and its components among secondary school students in Douala. This was a cross-sectional prospective study carried out on 803 students recruited from February to May 2021 in public and private secondary schools in Douala city, Cameroon. MetS was assessed according to the IDF/AHA/NHLBI 2009 consensus definition. The data collection consisted of a questionnaire on sociodemographic characteristics, measurement of anthropometric parameters (height, weight, body mass index (BMI), waist circumference) and overnight fasting blood sample. Blood pressure (BP), fasting blood glucose, HDL cholesterol and triglycerides were measured using standard methods. The mean age was 18±3 years, 73.3% female. The prevalence of MetS was 27.4%, common among participants aged ≥16 years, and higher in females compare to males (33.7% vs. 11.1%, P<0.0001). The prevalence of MetS components i.e abdominal obesity, high BP, fasting hyperglycemia, low-level HDL cholesterol and hypertriglyceridemia were 14.1, 18.1, 42.8, 51.4 and 38.6% respectively. All MetS components were significantly higher in females compared to males except for high BP which was similar among the genders. In our study population, the prevalence of MetS is high and this calls for improved monitoring to limit the evolution of associated cardiometabolic complications among young Cameroonians.

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Introduction

The metabolic syndrome (MetS) refers to a particular state of morbidity characterized by a constellation of several metabolic abnormalities i.e. glucose intolerance; insulin resistance; dyslipidemia (particularly hypertriglyceridemia and low-level HDL cholesterol); high blood pressure; abdominal obesity (1) There is an ongoing rise of prevalence of the MetS globally, and particularly in developing countries, mainly due to the evolution of obesity linked to poor diet, sedentary lifestyle and the acceleration of economic and demographic transition (2). Globally, the prevalence of MetS is increasing in many countries like USA (3) and China (4) and there is now about one quarter of people having MetS in the world (1). In recent years, the global prevalence of obesity, diabetes, and hypertension has increased significantly (5,6), which contributes to an increase in the prevalence of MetS (7). This syndrome is associated with increase prevalence of cardiovascular diseases and diabetes which are major public health concerns worldwide (8) although there is still ongoing discussion on some MetS component thresholds in black people (9,10) and definition and diagnostic criteria are not yet harmonized in teenager (11).

Increase in sex steroidal hormones and other hormones during puberty may be associated with obesity and insulin resistance which may persist in adulthood and result in increased CVD risk (12). Insulin resistance which is a key mechanism in the development of MetS (13) is almost physiological during pubertal stage. Actually, fuel metabolism is

altered during puberty to preserve lean muscle mass and to maximize fat as and alternated fuel source (14). Besides, puberty associated with abdominal obesity is integral part of the mechanisms associated with the development of the MetS (5,15,16) including hypertension, dyslipidemia and hyperglycaemia. Globally, the prevalence of MetS ranges from 1.2 to 22.6% in youth and 9.0 to 35.0% in adults (13,17).

In Cameroon, the scientific literature does not have sufficient data to establish the national prevalence of MetS. However, some studies estimate the prevalence of MetS to be between 7.4 and 21.4% (18,19), depending on the definition used, the region, the year the study was conducted, the age group of the target population. The main objective of our study was to determine the prevalence of MetS and its components in students in the city of Douala using the 2009 consensus definition of MetS.

Methods

Design. This was a cross-sectional prospective study carried out from February through May 2021 in two public and one private secondary schools in the city of Douala (which is the economical capital and one of the most populated city in Cameroon). Participants were students aged 10 to 27 years, regularly registered in the school in all levels.

Ethical considerations. The study was approved by the institutional ethical board of the University of Douala (ethical clearance N°2508 CEI-Udo/02/2021/M). All the participants included were briefed on the object of the study and were asked to sign informed consent. Data were collected by a trained survey officer and each survey sheet were coded for privacy. All data were stored on a secured computer.

Procedure. The study procedure consisted of questionnaire administration, anthropometric measurement and blood sample collection. Participants were provided with questionnaires and were asked to fast overnight and the blood samples and anthropometric parameters were collected in the morning before 12 PM.

Data collection and all measurements were performed in a secured place in the school. Items in the questionnaire included socio-demographic parameters i.e. age, gender, education, physical activity, family and personal history of diabetes, obesity, hypertension and stoke, smoking and alcohol consumption.

Measurements. Body weight was measured in kilograms (kg) using electronic medical scale. Height was measured to the nearest 0.5 cm with fixed stadiometer. BMI was calculated as weight in kilograms divided by the square of height in meters (kg/m^2). Overweight was defined as a BMI at least 25 kg/m^2 and obesity as a BMI at least 30 kg/m^2. Waist circumference was measured using a tape measure, halfway between the last rib and the anterior superior iliac spine at the end of expiration.

Blood pressure and heart rate measurements were performed after a 15-min rest, in the seated position, following standardized recommendations for blood pressure measurement. Three consecutive BP measurements were taken at time intervals of at least 5 min using a validated automated sphygmomanometer (THUASNE 3W1-A) with the cuff's width adjusted to the arm's circumference.

Participants were instructed to fast for at least 10 h overnight and venous blood samples were collected into vacuum-stoppered heparinized tubes. The samples were then centrifuged at 3000 rotations per minute for 10 min before being analyzed using COBAS C111® automated analyzer. Blood glucose, lipids profile (HDL, LDL, total cholesterol and triglycerides) were assayed from the samples.

MetS was assessed in participants aged 16 years and older according to IDF/AHA/NHLBI 2009 collective consensus (20) which defined MetS for at least three of the following features: Waist circumference (WC) ≥94 cm for male and ≥80 cm for female; Triglycerides ≥150 mg/dl; HDL cholesterol: <40 mg/dl for males and <50 mg/dl female; fasting blood glucose: ≥100 mg/dl; Blood pressure ≥130/85 mmHg. For participants aged less than 16 years, the same criteria were applied except for WC who was considered high if it is higher or equal to the 90th percentile for age and sex (21).

Statistical analysis. Data collected were recorded using Microsoft office Excel 2016 software and analyzed using SPSS 24 (IBM Statistics). Data were presented as mean ± standard deviation (SD) for quantitative variables and counts and percentages for qualitative variables. Student-t test was used to compare quantitative variables while Chi-square test was used for qualitative variable comparisons. Differences were considered significant for $P<0.05$.

Results

We recruited 803 participants, mean age 18±3 years with 73.3% females (n=589). Table I shows the anthropometric, biological and social characteristics of the study population. Mean age was similar between male and female (P=0.753), height, SBP, and tobacco consumption levels were significantly higher in male compared to female. On the contrary, hip circumference, heart rate, BMI, alcohol consumption and physical activity were significantly higher in female compared to male. There were no significant gender differences in weight, waist circumference, DBP, fasting blood glucose, HDL cholesterol, LDL cholesterol, total cholesterol and triglycerides.

Table II shows the prevalence of MetS and its components among participants stratified by age groups and compared between male and female. The prevalence of MetS in the whole sample was 27.4%; common in female participants. The common MetS components were low HDL cholesterol (51.4%), hyperglycemia (42.8%) and hypertriglyceridemia (38.6%). All the components' frequencies in the sample were significantly higher in female compared to male; except for high blood pressure that was similar between the two groups. MetS and its components were common among ≥16 years group. Hyperglycemia, low-level HDL cholesterol and hypertriglyceridemia were most represented abnormalities among ≥16 years group while only 3 participants had hypertriglyceridemia in <16 years group. In the <16 years group, only low-level HDL cholesterol was significantly higher in female while in the ≥16 years group all the parameters were significantly higher in female compared to male, except for blood glucose that was similar between the two groups.

Table I. Anthropometric, biological and social characteristics of participants by gender.

	Over all (N=803)	Male (N=214)	Female (N=589)	P-value
Age (years)	18±3	18±3	18±3	0.753
Weight (kg)	59.0±11.3	60.3±11.0	58.6±11.4	0.063
Height (cm)	162±8	167±10	160±7	<0.0001
BMI (kg/m²)	22.6±6.8	21.6±3.0	23.0±7.7	0.013
Waist circumference (cm)	73±8	72±7	73±8	0.210
Hip circumference (cm)	77±8	75±7	78±9	<0.0001
Systolic BP (mmHg)	118±13	121±11	116±13	<0.0001
Diastolic BP (mmHg)	72±10	71±10	72±11	0.153
Heart rate (beat/min)	82±14	75±13	85±14	<0.0001
Fasting blood glucose (mg/dl)	97±15	96±14	98±16	0.092
HDL cholesterol (mg/dl)	47±12	48±11	47±12	0.277
LDL cholesterol (mg/dl)	136±47	134±42	136±48	0.694
Total cholesterol (mg/dl)	212±49	212±44	212±051	0.996
Triglycerides (mg/dl)	144±56	142±52	145±058	0.523
Physical activity	562 (70)	164 (20.4)	398 (49.6)	0.013
Alcohol consumption	421 (65.8)	133 (73.1)	288 (62.9)	0.014
Tobacco consumption	23 (3.6)	13 (7.1)	10 (2.2)	0.005

Results are presented as mean ± standard deviation and count (percentage); N, Number of participant; BMI, body mass index; BP, blood pressure; HDL, high density lipoprotein; LDL, low density lipoprotein.

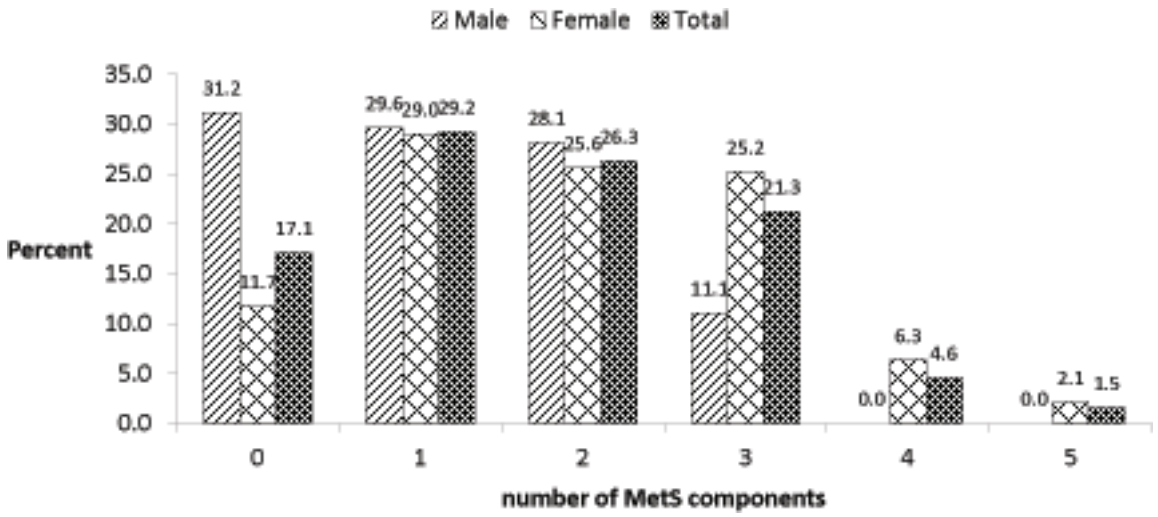

Figure 1. Distribution of number of MetS components by age group.

Fig. 1 shows the number of MetS components in the population and according to gender. Regarding the components of MetS in the general population, 17.1% had no MetS component, 55.5% had one or two components, and 6.1% had four to five components. Only female participants had more than three MetS components and 11.1% male compared to 25.2% female had three components. Differences were significant between the two groups (P<0.0001).

Fig. 2 shows frequencies of different association of MetS components. The most frequent association of MetS components was hyperglycemia + hypertriglyceridemia + low-level HDL cholesterol with 51.6%. Other components associations represented less than 10% of the sample.

Discussion

This was a cross-sectional descriptive study aimed to contribute to the literature around the prevalence of metabolic syndrome and its components among secondary school children in Cameroon. One of the major findings in this study is the 27.4% prevalence of MetS found according the IDF/AHA/NHLBI consensus of 2009 criteria. Low-level HDL cholesterol (51.4%), hyperglycemia (48.8%) and hypertriglyceridemia (38.6%) were the main drivers of that prevalence. MetS was significantly predominant in female (33.7%) compared to male (11.1%) and in participants aged 16 years and older (33%) compared to their younger counterparts (1.6%). Few studies have reported

Table II. Metabolic syndrome and its components stratified by age groups and compared between male and female.

Under 16 years (n=167)				
	Total (N=167)	Male (N=52)	Female (N=115)	P-value
Waist circumference (≥90^{e} percentile)	0	0	0	-
Blood glucose (≥100 mg/dl)	23 (18.0)	7 (14.9)	16 (19.8)	0.652
Blood pressure (≥130/85 mmHg)	32 (19.2)	9 (17.3)	23 (20.0)	0.844
Triglycerides (≥150 mg/dl)	3 (1.8)	0	3 (2.6)	0.585
HDL cholesterol (<40 mg/dl)	97 (58.1)	13 (25.0)	84 (73.0)	<0.0001
Metabolic syndrome	2 (1.6)	0	2 (2.5)	0.729
16 years and older (n=636)				
	Total (N=636)	Male (N=162)	Female (N=474)	P-value
Waist circumference (≥94 ♂; 80 ♀ cm)	113 (17.8)	1 (0.6)	112 (23.6)	<0.0001
Blood glucose (≥100 mg/dl)	315 (53.3)	80 (52.6)	235 (53.5)	0.923
Blood pressure (≥130/85 mmHg)	113 (17.8)	36 (22.2)	77 (16.2)	0.11
Triglycerides (≥150 mg/dl)	307 (48.3)	68 (42.0)	239 (50.4)	0.077
Cholesterol HDL (<40 ♂; 50 ♀ mg/dl)	316 (49.7)	31 (19.1)	285 (60.1)	<0.0001
Metabolic syndrome	195 (33.0)	22 (14.5)	173 (39.4)	<0.0001
All participants (n=803)				
	Total (N=803)	Male (N=214)	Female (N=589)	P-value
Obesity	113 (14.1)	1 (0.5)	112 (19.0)	<0.0001
Hyperglycemia	308 (42.8)	89 (23.4)	219 (64.8)	<0.0001
High blood pressure	145 (18.1)	45 (21.0)	100 (17.0)	0.224
Hypertriglyceridemia	310 (38.6)	68 (31.8)	242 (41.1)	0.021
Low-level HDL cholesterol	413 (51.4)	44 (20.6)	369 (62.6)	<0.0001
Metabolic syndrome	197 (27.4)	22 (11.1)	175 (33.7)	<0.0001

Results are presented as number of participant (percentage); HDL, high density lipoprotein.

on MetS in Cameroon in young age as well as in adulthood with various prevalence mainly depending on the diagnostic criteria. We used in this study the IDF/AHA/NHLBI consensus of 2009 criteria which is the latest the most frequently used definition of MetS (8,11,19,21).

The prevalence of MetS found in our study (27.7%) was higher than that found in a population of students aged 16-21 years old in the city of Yaoundé (20.3%) (19). The prevalence of MetS found in that study was also lower than that of the group of 16 years and older in our study (33%). On the contrary, our prevalence was almost similar to the 32.5% prevalence found on older population (mean age 44±17 years) in West region Cameroon (22). Our results confirm the ongoing epidemiological transition faced by Douala and Yaounde which are respectively economic and politic capital in Cameroon. Other studies using the IDF to define MetS had also found a lower prevalence compared to our study i.e. Ethiopia (4.8%) (23), South Africa (3-6%) populations (24), Congo-Brazzaville (15.9%) (25) and USA (9.3%) (26) although higher prevalence using the IDF criteria were found in Iran (37.4%) and Tunisia (45.5%) (27). Discrepancies in the prevalence of MetS could also been explained by genetic and environmental divergences among populations that could influence the development of MetS components like obesity (28).

Low-level HDL Cholesterol (51.4%), hyperglycemia (42.8%) and hypertriglyceridemia (38.6%) were the main drivers of the MetS in our study. These findings are consistent with some studies (29,30) while other studies found high blood pressure (31,32) and higher WC (33) as main character of MetS. Study on student in Yaounde (19) found similar trend for low-level HDL cholesterol (49.3%) but lower prevalence for hyperglycemia (20%) and hypertriglyceridemia (12.9%) compare to our study. The 13.6% prevalence of abdominal obesity found in our study was higher than that reported in Yaoundé (12.1%) (19), but lower in that reported in Egypt (78%) (34), in Spain (31.4%) (35), and in a meta-analysis involving 14 African and Middle Eastern countries (67.6%) (36). Abdominal obesity, Low-level HDL

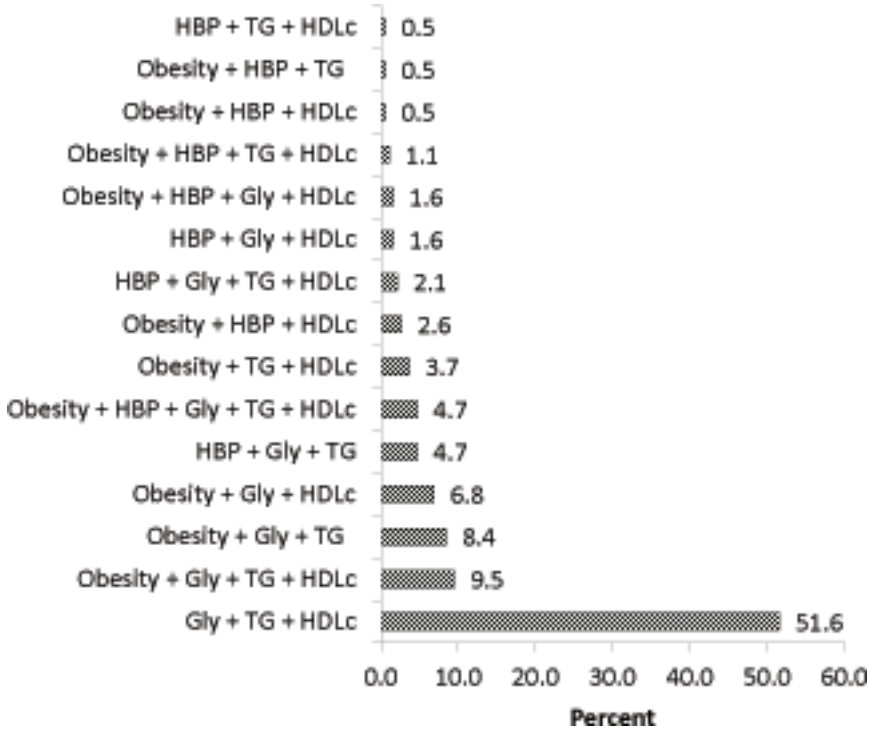

Figure 2. Association of MetS components in individuals with MetS MetS, metabolic syndrome; HBP, High blood pressure; TG, hypertriglyceridemia; HDLc, low-level High Density Lipoprotein cholesterol; Gly, hyperglycemia.

cholesterol and hypertriglyceridemia in the adolescent have a great impact on the development of cardiovascular disease in adulthood. The high prevalence of this components combined with the large difference found between younger participants (<16 years) and older participants (>=16 years) emphasize the necessity for a rapid diagnosis of MetS in adolescents and targeted interventions to reduce the risk of cardiovascular mortality in adulthood (37).

MetS and all its components (except high blood pressure) were significantly more frequent in female compare to male. This result is consistent with those obtained in Yaoundé students, Cameroon (19) and in other populations (30). Another study on the American population showed a higher proportion in men (38). Apart from gender, age also has a significant influence on the metabolic syndrome, but appears here as a protective factor for younger people because only participant who have more than 16 years old are affected.

Approximately 14.6% of the participants had at-risk blood pressure levels according to the IDF/AHA/NHLBI consensus definition. This lower prevalence of hypertension than those observed in studies conducted in Yaoundé (19,39) is justified by the fact that our study population had a low consumption of cigarette which is a main factor for hypertension (40). This result is in line with the Tunisian study conducted in 2010 (41), and can be explained by the presence of obesity in the MetS, because the prevalence of hypertension increases with the severity of obesity and excess abdominal fat (42). Regarding fasting hyperglycemia, about 42.8% of the participants had a fasting blood glucose level above 100 mg/dl. This result is similar to those found in southwestern Benin in 2015 (43) and could be explained by a diet very rich in sugar or even an abnormality of glucose regulation in the participants.

In this study, various associations of the components of MetS were observed in people with MetS, but the most predominant association was hyperglycemia + hypertriglyceridemia + low-level HDL cholesterol (51.6%). This result corroborates the role of these three components as the main leaders of MetS in our population. Our results however differ from that obtained in a Canadian survey (44), which instead identified the association Obesity + low-level HDL cholesterol + hypertriglyceridemia as the most frequent. These differences could be explained by the diversity of the populations studied in terms of gender, age, lifestyle and environment, which are socio-demographic factors that enable the development of MetS components.

Limitations

The main limitation of our study is that we recruited participants in only three secondary schools of the Douala city. This is however mitigate by the considerable sample size of our study which probably include participants from every part of the city. Other studies using probabilistic sampling procedure are necessary to draw more precise conclusions.

Conclusions

MetS is a major concern in our population with a 27.4% prevalence. More than 80% of the sample had at least one MetS component and the most prevalent components found in our study were Low-level HDL cholesterolemia, hyperglycemia and hypertrigryceridemia. MetS was strongly related to age and gender. Compared to other studies, our study shows rise of MetS in adolescents and young adults and emphasizes the necessity for public health policies targeting dietary habits and

other factors that could help curve the rise of MetS in young people.

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Contributions

AACN, MSH, designed the study protocol, and wrote the first manuscript draft; BLEC, MBYJ, led the statistical analyses and contributed to the manuscript draft; BN, MBYJ, ENB, BNBJ, contributed to logistic and data collection; MNJ, GJ, ANPB, BB, ENLS, TA, critically contributed to analysis, discussion, and interpretation of the data, and to the writing of the manuscript. All the authors approved the final version to be published.

Ethical approval and consent to participate

The study was approved by the institutional ethical board of the University of Douala (ethical clearance N 2508 CEI-Udo/02/2021/M).

Availability of data and material

Data and materials are available by the authors.

Informed consent

All the participants included were briefed on the object of the study and were asked to sign informed consent.

Conflict of interest

The authors declare no potential conflict of interest.

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