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Prevalence of Metabolic Syndrome among 16-21 Years Urban Cameroonian Using NCEP ATPIII and IDF Criteria

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

Original Research Article

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ABSTRACT

Background: The metabolic syndrome is a common metabolic disorder associated to the increasing prevalence of overweight and obesity.
Aims: To assess the prevalence of metabolic abnormalities and metabolic syndrome (MetS) among 16-21 years Cameroonian adolescents and analyzed the influence of age, gender and weight status.
Study Design: This was a cross sectional study.
Place and Duration of study: Commercial High school of Yaoundé, between January and May 2012.
Methods: MetS was defined according to United States (US) adapted pediatric criteria and International Diabetes Federation (IDF) criteria. A cross sectional study was set to collect data from 1765 adolescents (59.1% girls).
Results: Using the US criteria, the prevalence of MetS was 20.3%, while IDF criteria showed a lower prevalence of 15.3%. Girls were at greater risk for MetS (US 25.0% and IDF 23.4%) compared to boys (US 15.0% and IDF 6.1%). The prevalence of MetS was elevated in elder adolescents (US 22.4% and IDF 18.9%) as compared to youngster (US 14.9% and IDF 5.9%). Overweight adolescents (BMI≥25kg/m2) were more exposed to

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MetS (US 25.5% and IDF 26.7%) than normal weight (US 17.4% and IDF 9.0%). MetS prevalence itself varied markedly according to criteria used. Both US and IDF criteria, showed highest rate of low HDL (US 55.0% and IDF 49.3%) and elevated blood pressure (US 28.8% and IDF 27.0%).
Conclusions: The prevalence of MetS among our study population was high especially in girls and overweight adolescents. Individual MetS abnormalities are common in adolescents, further studies are needed to draw a more precise picture of the situation in order to better target interventions to improve future cardiovascular health.

Keywords: Metabolic syndrome; overweight; adolescent; gender; Cameroon.

1. INTRODUCTION

Metabolic syndrome (MetS) is defined as a pattern of metabolic disturbances including central obesity, hyperglycemia, dyslipidemia and hypertension [1,2]. MetS appear to be a useful measure of atherosclerotic cardiovascular disease in adults [3]. Studies have shown that pediatric MetS is a significant predictor of MetS, type 2 diabetes and cardiovascular disease in adulthood [4]. There are several definitions of MetS for adults [5-9], among which the International Diabetes Federation (IDF) definition [7], World Health Organization (WHO) criteria [9] and the Third report of the National Cholesterol Education Program's (NCEP) Adult Treatment Panel (US or ATP III) criteria [5]. Cases of adolescents with MetS have been reported in many populations, but the estimation are difficult to compare because a unanimous definition is lacking [10-14]. Based on adapted ATP III criteria, derived definition of the pediatric MetS for United States (US) children and adolescent have been settled as having three or more of the following abnormalities: high triglyceride level, low HDL-cholesterol level, high fasting glucose level, abdominal obesity, hypertension [15,16]; while the IDF definition of MetS in children and adolescent is inspired by existing IDF criteria for adults as having central obesity plus three or more of the following abnormalities : high triglyceride level, low HDL-cholesterol level, high fasting glucose level, hypertension [7,17].

Overweight and obesity are important risk factors of MetS. MetS is rapidly increasing in prevalence widely in association with rising of overweight and obesity [2,13,15,18-20]. In Cameroon, recent socio-economic changes have led to high disparities in the prevalence of overweight and obesity in adults [21,22] as well as in adolescents [23]. Prior studies in the adult population showed that about a quarter of men and half of women were either overweight or obese [21], this trend is increasing over time at an alarming rate [22] and is associated with metabolic complications all along [24-26]. Few data exist. on adolescent's weight status in Cameroon, and they all point toward an obesogenic aspect of urban environment for child and adolescents [27-29].

The W.H.O recommends more research on the frequency of MetS components and their level in low to middle-income countries (LMICs) [30]. The purpose of the current study is to (i) estimate the prevalence of MetS and its individual's metabolic abnormalities according to Ferranti et al.[15] and IDF criteria respectively [17];(ii) analyse the influence of age, gender and weight status on MetS and it individual components.

2. SUBJECTS AND METHODS

2.1 Sampling

Subjects were recruited from a cross-sectional school-based survey in a leading secondary school of Yaoundé (Cameroon). This school was selected so as to incorporate all social strata, as well as ethnic groups due to its strategic position in the city. A total of 1765 adolescents (721 boys and 1044 girls) with signed informed consent were enrolled at the beginning of the study in school milieu. All 1765 participants completed data on age, weight and height; and then among them, 1450 were screened for waist circumference, 1417 were screened for blood pressure, 757 were screened for blood glucose, 678 were screened for Total cholesterol and triglyceride, and finally 249 participants were screened for HDL-cholesterol. Out of these 1765 adolescents, complete data were obtained for 241 adolescents aged 16-21 years including boys (n=113) and girls (n=128).

2.2 Anthropometry and Blood Pressure Measurements

Anthropometric variables were measured according to existing standards by trained personals. Height was measured without shoes to the nearest 0.1 cm using a portable stadiometer, body weight was measured to the nearest 0.1 kg using an indoor weighing scale with the students' shoes, coats, and other heavy outerwear removed. Height and weight were used to calculate BMI as body mass (kg)/square of height (m^2). Waist circumference was measured midway between the lower rib margin and the iliac crest with non-stretchable plastic tape.

Blood pressure (BP) was measured with a checked electronic sphygmomanometer (Omron) and three blood pressure measurements were taken after 5 minutes intervals.

2.3 Blood Samples and Analysis

Fasting blood samples (5ml) of adolescents where collected after 12-hours overnight fasting, drawn into tubes containing heparin as an anticoagulant for preparation of plasma. Plasma collected was used for the measurement of total cholesterol, triglyceride, HDL-cholesterol, and fasting glucose (cholesterol infinity, triglyceride Infinity, EZ HDLTM cholesterol, Glucose Trinder) from SIGMA Diagnostics.

2.4 Definition of Metabolic Syndrome

MetS was defined using two published definitions. First, the de Ferranti et al. criteria [15] derived from the Adults Treatment Panel III (ATP III) criteria adapted to US pediatric ages, as three or more of the following variables and cut-off points: (1) fasting triglyceride ≥100mg/dl; (2) HDL-cholesterol <45mg/dl for boys and HDL-cholesterol <50mg/dl for girls; (3) fasting glucose ≥110mg/dl; (4) waist circumference >75th percentile for age and sex for US adolescents; (5) systolic blood pressure and/or diastolic blood pressure >90th percentile for sex, age and height recommended by the National Heart, Lung and Blood Institute (US) [31]. Secondly, IDF criteria was applied according to adults existing definition [7], as abdominal obesity for boys (waist circumference ≥94cm); abdominal obesity for girls (waist circumference ≥80cm) plus two of any of the following abnormalities: (1) fasting triglyceride ≥150mg/dl or specific treatment for this lipids abnormality; (2)HDL-cholesterol boys <40mg/dl; girls <50mg/dl or specific treatment for this abnormality; (3) systolic blood

pressure ≥130mmHg and/or diastolic blood pressure ≥85mmHg; (4) fasting glucose ≥100mg/dl or previously diagnosed with type 2 diabetes.

2.5 Statistics

Quantitative data are presented as means with standard error of the mean; differences were tested by Student T-test. Frequency data are given as percentages; comparison between groups was performed using the Chi-square test. The significance level was set at $p<0.05$. Data were analyzed with SPSS 10.0 for Windows (SPSS Inc., 1999).

3. RESULTS

A total of 1765 adolescents (721 boys and 1044 girls) were enrolled in the course of this study. Characteristics of adolescents are shown in Table 1. Mean BMI and triglyceride were higher in girls as compare to boys, 22.6kg/m^2vs 22.3kg/$m^2$and 88.0mg/dl vs 76.2mg/dl (all $P<0.05$) respectively. Mean weight, height, and systolic blood pressure were higher in boys versus girls (all $P<0.001$); total cholesterol was higher in boys compared to girls 149.8mg/dl vs 135.8mg/dl ($P<0.05$). No significant difference was observed between genders for mean age, waist, diastolic blood pressure, fasting glucose, and HDL cholesterol.

Table 1. Characteristics of adolescents according to gender

	Boys		Girls	
	N	**Mean(±SEM)**	**N**	**Mean(±SEM)**
Age [years]	721	18.5(±0.0)	1044	18.5(±0.0)
Weight [Kg]	721	63.3(±0.3)	1044	61.0(±0.3)***
Height [cm]	722	168.3(±0.4)	1044	163.7(±0.2)***
Body Mass Index [kg/m²]	721	22.3(±0.1)	1044	22.6(±0.1)*
Waist circumference [cm]	565	74.4(±0.3)	885	73.7(±0.2)
Systolic Blood Pressure [mm Hg]	579	118.4(±0.6)	838	114.3(±0.4)***
Diastolic Blood Pressure[mm Hg]	579	75.1(±0.5)	838	74.3(±0.4)
Fasting Glucose [mg/dl]	330	88.3(±0.9)	427	89.8(±0.8)
Total Cholesterol [mg/dl]	300	136.4(±3.0)	371	126.7(±2.5)*
Triglyceride [mg/dl]	304	76.2(±3.3)	374	88.0(±3.3)*
HDL cholesterol [mg/dl]	116	46.9(±2.2)	133	49.3(±2.4)

*SEM, standard error of the mean; differences boys versus girls were calculated by Student T-test and differences were set as *P<0.05, **P<0.01 and ***P<0.001.*

The prevalence of MetS components is shown in Table 2 (a) and (b). According to de Ferranti et al. MetS criteria (Table 2 (a)), elevated blood pressure, low HDL and high triglyceride were more common than abdominal obesity and elevated fasting blood glucose. Abdominal obesity was common in heavy adolescents (BMI≥25kg/m2) compared to others (BMI<25kg/m^2), 16.0% vs 2.2% ($P<0.001$); the same pattern was observed with elevated fasting blood glucose, 12.9% vs 7.6% ($P<0.001$). Low HDL was more common in elder adolescents 59.8% vs 41.7% ($P<0.05$). High triglyceride level was more common in girls compared to boys 33.4% vs 24.3% ($P<0.05$). According to IDF criteria (Table 2(b)), elevated blood pressure, and low HDL-cholesterol were more common than abdominal obesity, elevated blood glucose and elevated triglyceride. Abdominal obesity was significantly more common in girls ($P<0.001$), elder adolescents ($P<0.001$) and heavier adolescents ($P<0.001$).

Elevated blood pressure were more common in girls and heavier adolescents (all P<0.01). Low HDL cholesterol was more common in Girls than boys 57.1% versus 40.5% (P<0.05).

Table 2(a). Prevalence of individual MetS abnormalities among Cameroonian adolescents aged 16 to 21 years (according to NCEP ATPIII adapted criteria (de Ferranti et al., 2004))

Sample size	Abdominal obesity	Elevated Blood Pressure	High glucose level	Low HDL-cholesterol level	High TG level
	WC≥75th	BP≥90th	FG ≥110mg/dl	HDL<45(M)/ 50(F) mg/dl	FTG ≥100mg/dl
	1450	1417	757	249	678
Total	4.7	28.8	8.7	55.0	29.3
Gender					
Boys	3.7	32.8**	6.0*	52.5	24.3*
Girls	5.4	26.2	10.7	57.1	33.4
Age classes					
[16 - 18]	4.0	29.4	7.5	41.7*	29.1
[19 - 21]	5.4	28.3	9.5	59.8	29.4
BMI Status					
BMI<25kg/m2	2.2***	26.3***	7.6*	54.2	25.2**
BMI=>25kg/m2	16.0	39.5	12.9	56.2	39.3

*MetS: Metabolic Syndrome; WC: waist circumference; BP: blood pressure; FG: fasting glucose; HDL: high density lipoprotein; TG: triglyceride; FTG: fasting triglyceride; BMI: body mass index; M: male; F: Female. Chi-square test of prevalence of metabolic syndrome abnormalities between subgroups: *P<0.05, **P<0.01, ***P<0.001.*

Table 2(b). Prevalence of individual MetS abnormalities among Cameroonian adolescents aged 16 to 21 years (according to IDF)

Sample size	Abdominal obesity	Elevated Blood Pressure	High glucose level	Low HDL-cholesterol level	High TG level
	WC≥94(M)/ 80cm(F)	BP≥130/85mmHg	FG≥100mg/dl	HDL<40(M)/ 50(F) mg/dl	FTG≥150mg/dl
	1450	1417	757	249	678
Total	12.1	27.0	20.0	49.3	12.9
Gender					
Boys	2.1***	31.6**	15.7*	40.5*	9.8*
Girls	18.6	23.7	23.4	57.1	15.5
Age classes					
[16 - 18]	8.4***	25.8	21.5	40.2	14.5
[19 - 21]	16.3	28.1	19.0	52.7	11.8
BMI status					
BMI<25kg/m2	4.6***	24.5***	18.0*	47.5	11.3
BMI≥25kg/m2	45.5	37.1	27.0	52.5	16.6

*MetS: Metabolic Syndrome; WC: waist circumference; BP: blood pressure; FG: fasting glucose; HDL: high density lipoprotein; TG: triglyceride; FTG: fasting triglyceride; BMI: body mass index; M: male; F: Female. Chi-square test of prevalence of metabolic syndrome abnormalities between subgroups: *P<0.05, **P<0.01, ***P<0.001.*

Table 3(a) and (b) resume the prevalence of metabolic syndrome in sample of 241 adolescents with complete data. In Table 3(a), according to de Ferranti et al. criteria (ATPIII adapted criteria), the prevalence of MetS was 20.3%. 93.3% of adolescents had at least one MetS factor, and 8 adolescents (3.3%) had 4 MetS factors. No significant associations were observed between Number of MetS components and gender, Age classes, or BMI status. In Table 3(b), according to IDF criteria, we observed 15.3% of MetS and overall 32.3% adolescents had central obesity with at least one other MetS factor. Gender was significantly associated with MetS as girls were more prone to MetS than boys, 23.4% vs 6.1% (P<0.001). Heavier adolescents (BMI≥25kg/m^2) had elevated prevalence of MetS compared to others, 26.7% vs 9.0% (P<0.001).

Table 3(a). Number of MetS components among Cameroonian adolescents aged 16 to 21 years (according to NCEP ATPIII adapted criteria (de Ferranti et al., 2004))

		No. of subjects	No. of components				
			0	≥1	≥2	≥3 (MetS)	≥4
Total		241	6.6	93.3	58.5	20.3	3.3
Gender	ns						
Boys		113	7.0	92.9	51.3	15.0	1.7
Girls		128	6.2	93.7	64.8	25.0	4.6
Age classes steps	ns						
[16 - 18]		67	8.9	91.0	55.2	14.9	-
[19 - 21]		174	5.7	94.2	59.7	22.4	4.5
BMI Status	ns						
BMI<25kg/m^2		155	8.3	91.6	56.7	17.4	1.9
BMI≥25kg/m^2		86	3.4	96.5	61.6	25.5	5.8

No., number; MetS, metabolic syndrome; BMI, body mass index; association between MetScomponents and different variable were calculated using Chi-square test; ns, not significant;

Table 3(b). Number of MetS components among Cameroonian adolescents aged 16 to 21 years (according to IDF)

		No. of subjects	No. of components			
			no MetS	≥01+Cetobe	≥02+Cetobe	MetS
Total		241	67.6	32.3	28.2	15.3
Gender	***					
Boys		113	82.3	17.6	15.0	6.1
Girls		128	54.6	45.3	39.8	23.4
Age classes steps	ns					
[16 - 18]		67	79.1	20.8	16.4	5.9
[19 - 21]		174	63.2	36.7	32.7	18.9
BMI Status	***					
BMI<25kg/m^2		155	79.3	20.6	17.4	9.0
BMI=>25kg/m^2		86	46.5	53.4	47.6	26.7

*No., number; MetS, metabolic syndrome; Centobe: central obesity; BMI, body mass index; association between MetS components and different variable were calculated using Chi-square test; ns, not significant; ***P-value<0.001.*

4. DISCUSSION

The significant findings from this study are (i) the relative high rate of individual MetS components, (ii) the influence of gender and body weight status and finally (iii) the baseline estimation of MetS in urban Cameroonian adolescents. Using de Ferranti et al criteria (derived from ATP III criteria), the prevalence of MetS was found to be 20.3%, while IDF criteria showed a lower prevalence of 15.3%. Our results suggest that girls are at greater risk for MetS (de Ferranti et al 25.0% and IDF 23.4%) than boys (de Ferranti et al. 15.0% and IDF 6.1%). The prevalence of MetS increased with age as it was higher in elder adolescents (de Ferranti et al 22.4% and IDF 18.9%) compared to younger (de Ferranti et al 14.9% and IDF 5.9%). Lastly, group with elevated BMI (≥25kg/m^2) was more exposed to MetS (de Ferranti et al 25.5% and IDF 26.7%) than the group withlow BMI (de Ferranti et al 17.4% and IDF 9.0%). The prevalence of MetS itself varied markedly according to criteria used [20,26]. The same feature was observed in the present study with 20.3% versus 15.3% MetS according respectively to de Ferranti et al [15] and IDF criteria [7] respectively.

Little information exists concerning MetS in sub-Saharan Africa even at adulthood level [32]. The first studies on the subject were conducted in Cameroon in the mid-90-s [26,33], using IDF criteria they reported MetS prevalence of 1.5% and 1.3% among dwelling urban women and men respectively [26]. Previous studies on adolescents reported a prevalence of MetS of 10% in USA [15], 3.7% in China [13], and in the present, 20.3% according to de Ferranti et al Criteria [15].

Study among overweight adolescents reported 31.2% MetS for US [15], 27.7% MetS for Chinese [13], 21.5% for Brazilian [20], 34.4% for their Tunisian counterparts [2], and our present study showed a prevalence of 25.5% that fall close to the bottom end of bracket observed in leading developing countries. Overweight adolescents (BMI≥25kg/m^2) who had one, two, three and four factors of the MetS are comparable between Chinese adolescents (75.9%, 51.9%, 20.4%, and 5.6%), US adolescents (88.5%, 56.0%, 28.7%, and 5.8%) and Cameroonian adolescents (96.5%, 61.5%, 25.5% and 5.8%) (all applying the US criteria developed by de Ferranti et al [15]. These results highlight the importance of tackling MetS early on at childhood and adolescence level by acting toward weight control [13,15,18,19].

Gender difference on MetS prevalence was previously observed in adult urban dwelling Cameroonian as 1.5% for women and 1.2% for men according to IDF criteria [26], we observed the same gender differences between girls (de Ferranti et al 25.0% and IDF 23.4%) and boys (de Ferranti et al 15.0% and IDF 6.1%). No such difference were observed in the US adolescents [15], while Brazilian [20], Chinese [13], South African [34], and Tunisian [2] urban dwelling boys showed elevated prevalence compare to girls.

Comparing the different individual MetS factors between Cameroonian, Chinese [13] and US [15] adolescents, there were comparable high prevalence of low HDL-cholesterol in all groups; but the prevalence of elevated blood pressure, high fasting glucose and high triglyceride were all highest in Cameroonian compared to their Chinese and US counterpart. Finally, central obesity was higher in US adolescents, while lower in Chinese adolescents compared to Cameroonian adolescents. All these were observed according to de Ferranti et al. MetS definition criteria [15]. The difference may be caused by genetic factors, dietary habits, physical activity patterns or other lifestyle differences that need details investigations [13,19]. Previous study in adult population revealed that central obesity followed by elevated blood pressure were the major abnormalities contributing to MetS [26], all the MetS factors used here were higher than those published former for adult population. The important

differences may be due to the fact that adult's data used here were derived from early 90-s, before the important increased in MetS abnormalities as central obesity (up to +190%), elevated blood pressure and elevated BMI (≥25kg/m^2) revealed by recent investigations [22,35].

This study is representative of urban Cameroonian adolescents because it is based on large sample of adolescents selected in school, and the schooling rate is 94% in Yaoundé (94% for girls and 95% for boys) [36]. This high school attendance rate is due to the fact that public education is free and primary education is compulsory in Cameroon [23,36]. This is the first study examining the prevalence and distribution of MetS among 16 to 21 year-old Cameroonian. However, there are some limitations to be considered. First the data collection process could not allow us to obtain enough complete data, this weaken the power of our analysis at the particular level of MetS rate. Secondly the collection of data was only in one urban area of one region of the country; which limits the potential conclusions to that area, and is not applicable to general rural areas. Thirdly the estimation of MetS is based on a proposed definition for US adolescents using the historical cut-off points from NHANES III and adults IDF cut-off points due to lack of MetS definition in Cameroonian adolescents.

Finally, we compared the Cameroonian adolescents aged 16-21 years with US adolescents aged 12-19 years and Chinese adolescents aged 15-19 years. Here the prevalence of MetS was not significantly difference between younger (16-18 years) and older (19-21years) adolescents, similar results were previously reported in the US adolescents, hence our present comparison may still be valid anyhow. While prevalence observed in this study cannot absolutely be generalized to every urban city in Cameroon, as important social differences exist, it can be compared to prevalence recorded in other leading urban cities in other countries.

5. CONCLUSION

In conclusion, the prevalence of MetS among our study population was high especially in girls and overweight adolescents and ultimately adds to the limited amount of MetS data in sub-Saharan Africa. The prevalence of MetS is higher among Cameroonian urban overweight adolescents even though comparable to either US or Chinese counterparts. These results along with known elevated and increasing prevalence of overweight, obesity in Cameroon during the last decade along with the sustain economic growth [22], highlight the need for effective overweight and obesity prevention strategies. This study set a baseline for further intervention on monitoring evolution of MetS in Cameroonian adolescents.

CONSENT

Not applicable.

ETHICAL APPROVAL

All authors hereby declare that this study was performed in accordance with the ethical standards and approved by the School Administration and the National Ethics Committee (N°:225/CNE/SE/2012). Parents or guardians of all participants provided written and signed informed consent prior to participation to the study. Personal identification numbers were assigned to each participant to maintain anonymity.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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