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INTERNATIONAL JOURNAL OF CURRENT RESEARCH

International Journal of Current Research
Vol. 5, Issue, 04, pp.815-822, April, 2013

ISSN: 0975-833X

RESEARCH ARTICLE

THE PREVALENCE OF THE METABOLIC SYNDROME IN THE LITTORAL REGION OF CAMEROON

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ARTICLE INFO

Article History:
Received 18th January, 2012
Received in revised form
04th February, 2013
Accepted 27th March, 2013
Published online 13th April, 2013

Key words:
Metabolic syndrome,
Central obesity,
Diastolic hypertension,
Cameroon.

ABSTRACT

Background: The prevalence of metabolic syndrome (MS) as well as it components though low in Sub Saharan Africa, are on a steady rise. The objectives of the present study were to determine the prevalence of this syndrome using the modified International diabetic Federation (IDF) 2005 definition in the Littoral Region of Cameroon and to find out the cause of this rise in prevalence.
Method: A representative sample of total of 1974(733 males and 1241 females) patients aged between 18 -80 years from 10 district hospitals in littoral Region of Cameroon was surveyed between May 2010 and April 2011. These 752 peri-urban and 1222 urban patients were interviewed on their personal medical history and lifestyle options. Blood pressure and anthropometric measurements (height, weight, waist and Hip circumferences) were recorded using standardized methods by trained and certified medical personnel. Blood samples were collected after an overnight fast for fasting blood sugar determination.
Results: Based on the IDF 2005 definition, the prevalence of the metabolic syndrome was 8.4 [95% C I] 7.2%-9.7%). Considering the other definitions, a prevalence rate of 2.5% [C I: 1.8%-3.3%] was obtained using the National Cholesterol Education Program –Adult Treatment Panel(NCEP-ATP III) definition and 1.9% (95 %C.I:1.3-2.6%) based on the WHO, 1999 definition. The prevalence rate was higher in urban than peri-urban(2.4% vs. 1.1%).Central obesity was more prevalent in females than males while hypertension and fasting blood sugar had a higher prevalence in males.The prevalence rate of the components [male: female] were central obesity,16.0%[5.3-24.7], High blood pressure 6.7% [10.8:3.3], Elevated blood glucose 1.2% [2,1:0.4] For all the three definitions of Metabolic Syndrome, the prevalence increased with age[18-36years:0.3%;37-55years 1.7% and >56years 6.2%]. There was a significant difference in the prevalence of the MS between the three age groups for all the different definitions ($p<0.001$). Regardless of the definition of MS employed, no significant difference in the prevalence of MS between males and females was observed. The prevalence of central obesity and diastolic hypertension were highest among the components.
Conclusion: This study gave a prevalence rate of 8.4% (IDF definition) in the Littoral Region of Cameroon. The rate increased with age as expected, and there was no significant difference between the estimates for men and women**.** Central obesity and diastolic hypertension were observed to be the most prevalent components of MS.

INTRODUCTION

Background

Metabolic Syndrome is often defined as a constellation of risk factors that increase the chances for developing cardiovascular disease (1 Despres *et al*., 2008). According to the American Heart Association, up to 25% of US adults have metabolic syndrome (2 Ford *et al*., 2002). Worldwide, prevalence estimates varied with sex, age and ethnicity (2 Ford *et al*., 2002; 3 Guize *et al.*, 2006), ranging from 8% in India to 24 % in the United States and from 7% in France to 46% in India (4 Cameron *et al*., 2004). The NCEP/ ATP III guidelines recognize metabolic syndrome as a secondary target of risk reduction, after an elevated Low Density Lipoprotein (LDL) cholesterol level. Methods for managing metabolic syndrome include reducing underlying causes (obesity physical inactivity) and treating associated non-lipid and lipid risk factors. Several organizations have suggested definitions for the Metabolic Syndrome. In 1998, the World Health Organization (WHO) provided a definition of the metabolic syndrome based on glucose intolerance and more than two other components (5 Alberti *et al.*, 1998). In response, the European Group for the Study of Insulin Resistance countered with a modification of the WHO definition having insulin resistance as its hallmark. (6 Balkau and Charles, 1999). In 2001, the National Cholesterol Education Program (NCEP) released its definition categorizing the risk factors as underlying, major and emerging (7 NIH, 2001). Subsequently, the American Association of Clinical Endocrinologists considered the concept of insulin resistance as central (8 ACE, 2003). The proliferation of definitions suggested that a single unifying definition was desirable (9 Ford, 2005). In the hope of accomplishing this, the International Diabetes Federation (IDF) proposed a further definition for metabolic syndrome for use in epidemiological studies and clinical practice, which would allow for comparison between different population groups and the assessment of its relationship with various health outcomes (10 Grundy *et al*, 2004). Africa is currently experiencing one of the most rapid demographic and epidemiological transitions in world history. The future impact of this on the prevalence of the metabolic syndrome is unknown, but is a matter of concern. The quickening pace of change and adoption of western lifestyles by people in developing countries has led to a sharp rise in the incidence of non communicable diseases such as diabetes, cancer, cardiovascular diseases and hypertension.

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Yet epidemiological studies of MS using validated methods are scarce especially in Central Africa. Although the prevalence of individual components of the MS (like hypertension and Non-Insulin Dependent Diabetes mellitus, NIDDM) have been reported from sub-Saharan Africa (11 Mbanya *et al*., 1997, 12 Mbanya *et al*., 1998, 13 Van der Sande *et al.*, 2000, 14 Pouane *et al*., 2002), we are not aware of any population-based study of the prevalence of the MS in the Littoral Region of Cameroon. Android obesity also termed central obesity have been reported to be the most prevalent component of the metabolic syndrome in Yaoundé (urban) and Evodoula (rural population) of the central region of Cameroon (15 Fezeu *et al.*, 2007). No such study has been done in the Littoral region of Cameroon. The use of thresholds for waist circumference that are specific to different populations around the globe has been repeatedly advocated (16 Molarius *et al*., 1999; 17 Misra *et al*., 2005). Prevalence rate in Yaoundé, an administrative capital may be different from that of Douala, Cameroon's largest city and the commercial capital. Data from these two cities may permit generalization of the prevalence for the urban population of Cameroon, considering their multi-ethnic composition. This study aims at determining the prevalence of the MS in the Littoral Region of Cameroon using the IDF, 2005 consensus definition and finding out the causative factors. This IDF 2005 definition will be used throughout the present study with reference made to the other definitions for the sake of comparison.

METHODS

Study design and sampling technique

A hospital-based and cross sectional survey was conducted in urban and peri-urban areas of Littoral Region of Cameroon. Sampling was purposive because the study targeted adult (age 18+) population of urban and peri-urban areas of the Littoral Region. Sampling was clustered because participants were sampled at the level of specific chosen locations, notably the district hospital or other health centers found at the level of the sampled health district. Sampling was randomized because it was by chance that a participant could visit the health center where the medical team conducting the study was based. Thus the sampling method used for this study was purposive, clustered, and randomized. A prior pilot study was conducted at the Douala Cardiovascular Center (a specialized center for the treatment of most of the determinants of MS) in order to ascertain the competence of the trained personnel and the validity of the instruments to be used.

Study area and participants

The study area was the coastal area of Cameroon (Douala, the commercial capital and the districts in the peri-urban zone), where the main activity in the urban area is commerce and other sedentary occupations as opposed to the peri-urban area where the main activity is farming with the inhabitants having a relatively more physically active lifestyle. The Cameroon National Institute of Statistics gives the population of Douala according to the 2005 census as 1,906, 962 inhabitants. Douala is a multiethnic city with the highest expatriate population, thus a random sample from here should be more representative of urban cities in Cameroon. The climate in both the urban and peri-urban areas is warm and humid as opposed to the relatively colder climate in the capital city Yaounde.. Patients were recruited from four district hospitals in the peri-urban region (Loum, Mbanga, Dibombari and Edea) and from the Douala municipality (District Hospitals of Deido, New Bell, Cite des Palmiers, Nylon, Bonassama and Polyclinic Bonanjo Annexe). The inclusive criteria were: Age (18 to 80 years), Overnight fast, and voluntary acceptance to participate to the study (signing of the informed consent). Individuals from both sexes were recruited. Excluded from this study were pregnant women and any individual suffering from chronic diseases. A total 1974 participants were recruited for this study between May of 2010 and April 2011.

Measurements

Trained nurses obtained blood pressure and anthropometric measurements (height, weight, waist and hip circumferences) and collected a venous blood sample for measurement of glucose. The waist circumference was measured with a spring-loaded measuring tape midway between the inferior angle of the ribs and the superior iliac crest at the high point of the iliac crest at minimal respiration to the nearest 0.1 cm, whereas hip circumference was measured at the outer most points of the greater trochanters. The Waist /Hip Ratio (WHR) was recorded to the nearest 2 decimal places. Plasma glucose concentration was measured using an enzymatic reaction (Glucose oxidase method). Information on lifestyle options area of residence, sporting activities, occupation, alcohol consumption, sleep patterns and consumption of rapid sugars), medical and medication history, was recorded using a semi-structured questionnaire.

Metabolic syndrome Designation

Prevalence of the Metabolic Syndrome and its components were estimated using the modified International Diabetes Federation, (IDF) 2005 definition (using the compulsory criterion and 2 others). This was the main definition used for the study. This prevalence rate was then compared with those of the other definitions including the one published by the World Health Organization (WHO, 1999); NCEP-ATP III (2002); and Joint Initiative Statement (JIS, 2009). The determinants or components of MS considered in this study were: Body Mass Index (BMI), Waist/Hip Ratio (WHR), Elevated Blood Sugar, Waist Circumference (WC) and Hypertension (HT).

Ethical considerations

The study protocol was approved by the National Ethics Committee of the Ministry of Public Health, Cameroon as well as administrative clearance from the Authorities of the Littoral region. All subjects gave informed consent to participate and the authors followed the Declaration of Helsinki on biomedical research involving human subjects.

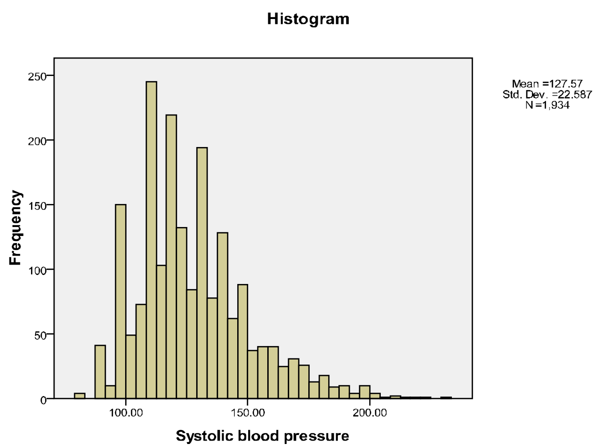
Statistical analysis

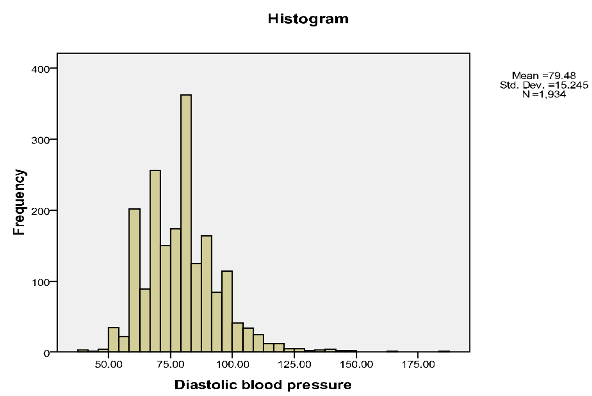
Data from the questionnaires and laboratory reports were entered into Epi-Info 6.04d (CDC, 2001). Range and consistency checks were used to minimize data entry errors. Data were then exported from Epi-Info to SPSS version 17 for analysis. To answer specific questions, some variables were derived from 'raw variables' using direct compute command or command syntax such as the generation of the BMI from height and weight of the patient. A syntax journal was developed for each major step of the analysis. Syntax was also indispensable to solve specific problems that could not be done using direct interactive-window analysis. Data was later analyzed using the following approaches: The case summaries procedures were used to calculate values of central tendencies and dispersion. Continuous variables were then screened for normality and homogeneity of variance using Kolmogorov-Smirnov and Shapiro-Wilk tests, the means, the median and the kurtosis values. The variables were approximately normally distributed and parametric tests were then used to compare groups for the significant difference. Independent Sampled T test was used to compare two independent samples for significant difference whilst ANOVA helps in comparing more than two subsets. For categorical variables, descriptive statistics was used to present the distribution of subjects between and within subsets using frequencies and proportions. Associations between lifestyle options and determinants of the Metabolic syndrome was done using χ^2-test and Analysis of Variance (ANOVA) .Multivariable analysis was conducted using the Binomial logistic regression models since Metabolic Syndrome is both a categorical and a dichotomous variable. Two modeling approaches were used-the Binomial Logistic Regression Model (used to appraise the explanatory power of the various components of the metabolic syndrome) and the Multiple linear Regression Model (applied to continuous variables which were the Biochemical indicators).

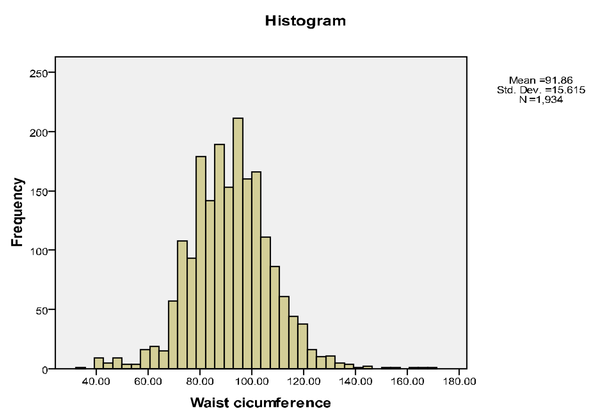
RESULTS

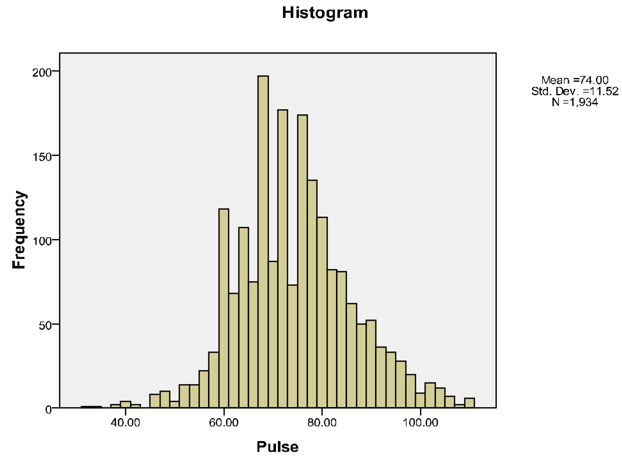
Response rate and study group

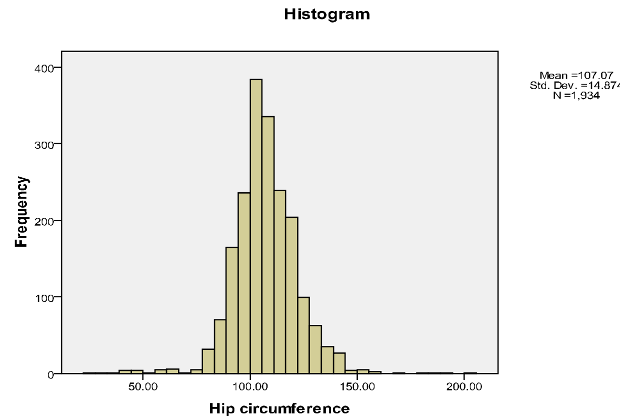
Of the 2068 patients initially sampled, 1994 actually responded appropriately of which 1974 (733 males and1241 females) were validated for analysis, giving an overall response rate of 95.45%. Thus data from 1974 participants from urban (1222) and peri-urban (752) were analyzed. From the case summary statistics, the means are very close to the medians. This is confirmed by the distribution test whereby values of Shapiro-wilk statistics are very close to 1 and those of Kolmogorov-Smirnov close to 0 for all the variables except Fasting Blood sugar (FBS) simply because it is highly skewed. These statistical trends indicate that the data is approximately normally distributed (Figure 1). The background indicators and distribution pattern of the components or indicators of MS are shown in Table 1. There was a significant difference between males and females for the age and all MS indicators except fasting blood sugar:

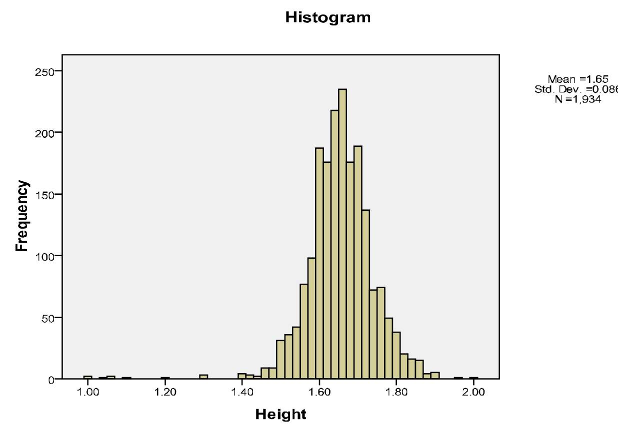


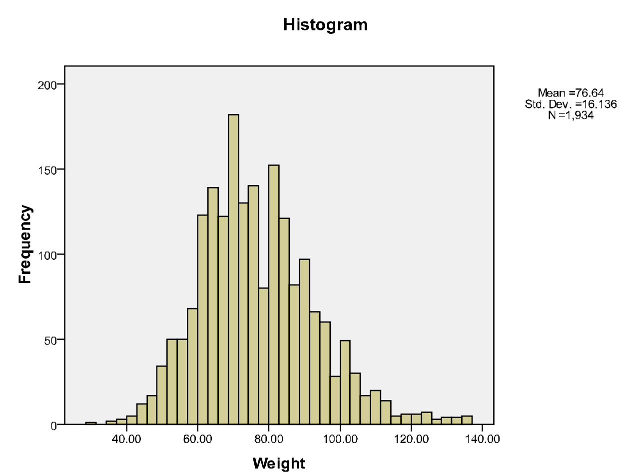












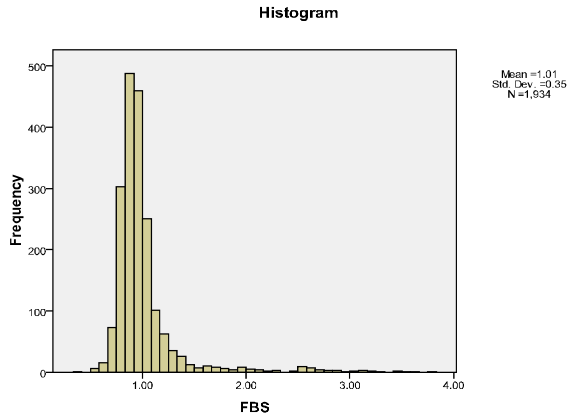
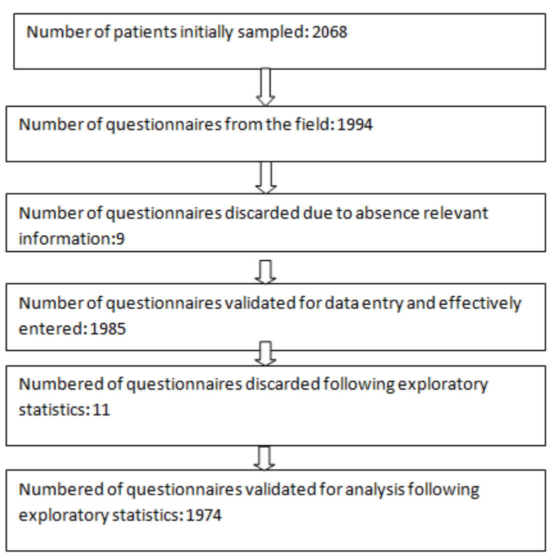


Figure 1: Histograms of the distribution of the components of metabolic syndrome. All show a normal distribution except the fasting blood sugar.

SAMPLE FLOW CHART



As far as the population age is concerned, the youth group (18-36 years) constituted 38.5%, the middle age (37-55) 45.2% while those 56years and above constituted only 16.5% of the sampled population. The most prevalent component of the metabolic syndrome was high waist circumference: Elevated diastolic blood pressure also had a high prevalence. The IDF 2005 definition gave the highest prevalence estimate of 8.4% while the WHO, 1999 definition gave the lowest estimate of 1.9% (Table 2). Using the IDF 2005 consensus definition which was the main definition adopted for the study, the prevalence in the urban was always higher than in the peri-urban as shown in Figure 2. The prevalence of the metabolic syndrome (WHO 1999 definition) was 1.9% (95% confidence interval [95%CI] 1.3%-2.6%). Prevalence was higher in urban than peri-urban (2.4% vs. 1.1%). Prevalence of the components [male: female] were: central obesity, 16.0% [5.3:24.7]; High blood pressure, 6.7% [10.8:3.3]; elevated glucose, 1.2% [2.1:0.4]. Based on the IDF 2005 definition, the prevalence of the metabolic syndrome was 8.4 [95% C I] 7.2%-9.7%) The NCEP-ATP III definition gave a prevalence rate of 2.5% [95% C I] 1.8%-3.3%). For all the three definitions of Metabolic Syndrome, the prevalence estimates increased with age [18-36years:0.3%;37-55years 1.7% and >56years 6.2%]. There was a significant difference in the prevalence of the MS between the three age groups for all the different definitions (p<0.001) .No significant difference in the prevalence of MS between males and females for all definitions was observed. The prevalence of all the components of the MS also increased with age. Using the BMI as the dependent variable, there was a very significant correlation with diastolic blood pressure, waist hip ratio, and waist circumference for all the subjects. The males showed significant correlations between BMI and systolic and diastolic blood pressures but this was absent in females. For the urban dwellers, there was significant correlation between BMI and waist circumference, WHR and age while the peri-urban dwellers showed a significant correlation with diastolic pressure (Table 3). The Binomial Logistic Regression Model was used to appraise the explanatory power of the various components of the metabolic syndrome. The component 'Determinant of MS' had the highest explanatory power (EP=80.5%) toward Metabolic syndrome followed by 'Background indicators' (EP=16.6%). The Integrated Value Mapping (IVM) combining all the components of the model explained roughly 86.7% of the variability of Metabolic Syndrome. Thus, based on this model, the indicators involved in this study explained only 86.7% of the variability of the Metabolic Syndrome. This simply implies that there are other factors which contribute to Metabolic Syndrome which are not explained by this model (Table 4).

Biochemical Indicators of MS

The biochemical indicator used was the elevated fasting blood sugar levels. The prevalence of this component increased with age [2.6% for the age group 18-36 years; 11% for 37-55 years and 29.2 for those above 56 years]. This is the normal trend for all the indicators except for diastolic hypertension .Lowering the fasting blood sugar from 2.6 mg/dl to 1.0 mg/dl raised the prevalence rate of MS from 2.4% to 8.4%.

DISCUSSION

The present study is the first to report on the prevalence of the metabolic syndrome in the Littoral region of Cameroon. Of the individual components, elevated abdominal circumference suggestive of android obesity was the most common and this is consistent with the results reported by other investigators (15 Fezeu *et al.*, 2007) but in South Africa, 18 Motala *et al.* (2011) reported that low HDL-c in women and hypertension in men were the most frequent determinants. Whether this prevalent central obesity is responsible for the increasing incidence of cancers (breast in females and prostate in males) and cardiovascular diseases is unclear and requires further investigation.. However a large proportion of participants (54%) exhibited at least one metabolic syndrome component. Using the Binomial Logistic Regression Model the Integrated Value Mapping (IVM) combining all the components of the model (Background indicators, lifestyle options, family history and determinants or determinants) explained roughly 86.7% of the variability of Metabolic Syndrome. This suggests other factors not included in this study account for the remaining 13.3% of the variability of the MS. Background indicators, lifestyle options and family history explain only 20.1% of the variability of the MS suggesting that the components of the MS are the principal factors that explain the variability of the MS.

Diastolic blood pressure, waist circumference and waist to hip ratio showed the strongest correlation with the Body Mass Index (BMI).
The frequency of the MS increased with age and was almost always higher in men than women for a given age and this is consistent with results from other studies (21 Balkau *et al.*, 2002). The age-standardized prevalence of metabolic syndrome was 9.8% (95% CI 9.0-10.6) in men and 17.8% (16.6-19.0) in women. The prevalence of the metabolic syndrome and overweight was higher in northern than in southern China, and higher in urban than rural residents (19 Gu *et al.*, 2005). One study (15 Fezeu *et al.*, 2007) reporting on the prevalence of the metabolic syndrome among adults in Cameroon reported very low prevalence of the metabolic syndrome in both rural and urban populations. The same study using the IDF criteria reported a prevalence of the metabolic syndrome of 1.5% and 1.2% among urban women and men respectively; while

Table 1. Distribution pattern of all the MS indicators and a Background indicator-age

Indica-tors	Sex		IST-test (p values)	Total	Sample size		
	Male (mean ± SE)	Female (mean ± SE)			N (M)	N (F)	N
Age	43.79 ±0.50	41.53 ± 0.37	<0.001	42.37 ± 0.30	730	1233	1963
SBP	130.35 ± 0.79	125.93 ±0.65	0.001	127.57 ± 0.51	733	1241	1974
DBP	80.89 ± 0.57	78.63 ± 0.43	<0.001	79.47 ± 0.34	733	1241	1974
Pulse	72.27 ± 0.42	75.03 ± 0.32	0.001	74.01 ± 0.26	733	1241	1974
WC	90.471 ± 0.57	92.82 ± 0.45	<0.001	91.95 ± 0.36	731	1233	1964
HC	102.81 ± 0.45	109.56 ±0.43	0.001	107.05 ± 0.33	731	1233	1964
Height	1.70 ± 0.01	1.62 ± 0.01	0.001	1.65 ± 0.01	726	1232	1958
Weight	78.15 ± 0.56	75.76 ± 0.47	0.002	76.65 ± 0.36	730	1232	1962
FBS	1.01 ± 0.01	1.00 ± 0.01	0.429	1.01 ± 0.01	731	1235	1966
BMI	27.17 ± 0.21	28.90 ± 0.19	<0.001	28.26 ± 0.15	723	1224	1947
WHR	0.88 ± 0.01	0.85 ± 0.01	<0.001	0.86 ± 0.00	730	1232	1962

Table 2. Gender specific peri-urban & urban characteristics (unadjusted prevalences and age adjusted odds ratios) for components and definitions of the metabolic syndrome

Components and definition of the metabolic syndrome	WOMEN					MEN				
	Unadjusted prevalences			Age adjusted ORs		Unadjusted prevalences			Age adjusted ORs	
	Urban	Peri-urban	P	Urban	Peri-urban	Urban	Peri-urban	P	Urban	Peri-urban
Elevated blood sugar	9.1	9.8	0.731	0.30(0.21-0.44)*	0.62(0.37-1.03)	10.4	11.0	0.824	0.31(0.19-0.516)*	0.60(0.33-1.09)
BMI≥30kg/m²	38.1	39.0	0.772	1.59(1.28-1.97)*	1.26(0.96-1.66)	21.4	31.2	0.006	1.66(1.17-2.35)*	1.36(0.98-1.88)
WHR	41.8	41.2	0.574	2.41(1.92-3.02)*	1.90(1.44-2.51)*	41.9	39.3	0.503	3.10(2.22-4.30)*	1.83(1.34-2.50)*
Elevated WC	18.5	23.1	0.058	3.36(2.37-4.75)*	1.77(1.27-2.46)*	57.1	39.9	0.427	2.50(1.80-3.40)*	1.44(1.10-1.95)*
HBP(WHO def)	17.2	5.8	<0.001	0.34(0.26-0.46)*	0.41(0.23-0.74)*	22.9	8.8	<0.001	0.42(0.30-0.60)*	0.76(0.45-1.28)
HBP(IDF 2005)	26.0	13.2	<0.001	0.33(0.26-0.43)*	0.31(0.20-0.48)*	39.1	17.6	<0.001	0.44(0.33-0.61)*	0.63(0.43-0.94)
WHO definition	2.5	0.7	0.026	0.15(0,07-0.32)*	0.42(0.08-2.17)	2.2	1.6	0.552	0.16(0.05-0.5.0)*	0.44(0.12-1.60)
NCEP-ATPIII definition	3.6	1.4	0.025	0.20(0.11-0.37)*	0.28(0.08-1.02)	2.4	1.3	0.255	0.18(0.06-0.53)*	0.35(0.08-1.62)
IDF definition (1.26)	3.7	1.4	0.020	0.19(0.11-0.34)*	0,28(0.8-1.02)	3.9	1.9	0.119	0.25(0.11-0.55)*	0.51(0.16-1.59)
IDFdefinition (1.0)	10.0	6.2	0.003	3.40(2.39-4.83)*	4.05(2.14-7.66)*	10.6	4.4	0.002	2.94(1.82-4.75)*	1.83(0.87-3.87)

A subset is at significant risk with respect to a given indicator if the OR is above 1 and the lower bound of the CI does not go below I. If the risk is present in two subsets (urban and peri-uban), the one with the higher OR is more at risk. - If P is less than 0.05, the prevalence is significantly different between the two setting types.
HT = Hypertension; BMI = Body Mass Index; WC=Waist circumference; IDF=International Diabetes Federation; : NCEP/ATP-III= National Cholesterol Education Program-Adult Treatment

Table 3. Correlation of other determinant of MS with BMI as dependent variable

Models	Zero order correlation						
	All	Male	Female	Age <41	Age 41+	Urban	Peri-urban
Systolic blood pressure	r=0.189 p=0.074	r=0.201** p=0.006	r=0.206 p=0.801	r=0.172 p=0.801	r=0.138 p=0.120	r=0.221 p=0.095	r=0.162 0.181
Diastolic blood pressure	r=0.211** p=0.003	r=0.261*** p<0.001	r=0.206 p=0.521	r=0.187* p=0.027	r=0.183 p=0.140	r=0.238 p=0.514	r=0.195** p=0.006
FBS	r=0.098 p=0.427	r=0.100 p=0.750	r=0.105 p=0.197	r=0.132 p=0.950	r=0.043 p=0.366	r=0.107 p=0.299	r=0.089 p=0.878
Waist circumference	r=0.656*** p<0.001	r=0.579*** p<0.001	r=0.692*** p<0.001	r=0.627*** p<0.001	r=0.661*** p<0.001	r=0.801*** p<0.001	r=0.505*** p<0.001
Waist Hip Ratio	r=0.095*** p<0.001	r=0.096*** p<0.001	r=0.124*** p<0.001	r=0.106*** p<0.001	r=0.044*** p<0.001	r=0.180*** p<0.001	r=0.038*** p<0.001
Age	r=0.145 p=0.548	r=0.164 0.113	r=0.158 0.863	r=0.216 p=0.102	r=-0.082 p=0.816	r=0.191** p=0.003	r=0.080 p=0839.

* Correlation is significant at the 0.05 level
** Correlation is significant at the 0.01 level
*** Correlation is significant at the 0.001 level.

Table 4. Logistic Regression Model with MS as dependent variable

Components	Metabolic Syndrome		
	Chi-square statistics	Explanatory Power (Nagelkerke R Square)	n
1-Background indicators	<0.001	16.6%	1625
2-Life style options	<0.001	6.5%	1824
3-Family history	<0.001	4.6%	1109
4-Determinants of MS	<0.001	80.5%	1750
IVM (1 & 2)	<0.001	14.7%	1752
IVM (1 & 2 & 3)	<0.001	20.1%	989
IVM (1 & 2 & 4)	<0.001	82.1%	1579
IVM (1 & 2 & 3 & 4)	<0.001	86.7	904

[IVM=intergrated Value Mapping; EP=Explanatory power]

among the rural population prevalence among women was 0.3% and it was absent in men. The situation has since changed drastically according to the present study. The prevalence of metabolic syndrome among the littoral region dwellers in this study was estimated at 8.4% using the IDF 2005 criteria while other definitions gave lower estimates: NCEP/ ATP III [2.5%];WHO 1999 [1.9%]. It must be stated that our MS prevalence estimate in this study of 8.4% is an under estimation since not all the components of the metabolic syndrome were measured and besides the present study was hospital based. Our results thus confirm a rising trend for the prevalence of this syndrome in Cameroon. The prevalence rate was higher in the urban than the peri urban areas. Central obesity and diastolic hypertension were the most prevalent MS components. A recent study in Nigeria (20 Ogbu. and Chukwukelu, 2011) reported a prevalence rate of 10.2% among normal weight patients and the MS was attributed to the secretion of pro-inflammatory cytokines.

There were sex differences in the prevalence rates for all the Metabolic Syndrome definitions used. For the urban dwellers using the IDF 2005 definition [male vs. female] was 3.9%: 3.7%; while for the peri urban dwellers [male to female] was 1.9% vs 1.4%. This sex difference was not significant (p=0.895 and 0.592) for urban and peri-urban dwellers respectively. The frequency of the MS increased with age and was almost always higher in men than women for a given age. This might be attributed to alcohol consumption and also the due to the fact that with age the metabolism of the body slows down leading to the laying down of excess fats and increase in body weight especially in the sedentary individuals. In non-diabetic subjects the frequency of the MS using the WHO 1999 definition varied between 7% and 36% for men 40 to 55 years; for women of the same age, between 5% and 22% (21 Balkau *et al*, 2002). Working on African-American men, some investigators obtained substantially different prevalence estimates of 24.9% (using the WHO definition), compared with the NCEP/ATP III estimate of 16.5% (22 Ford and Gilles, 2003) 23 Ko *et al.,* 2005 working on Hong Kong Chinese reported a prevalence range of 6.1 to 13.4% depending on various diagnostic criteria. The present study shows a higher prevalence of MS in urban than peri urban setting, consistent with findings of other investigators (19 Gu *et al.*, 2005) who reported not only higher prevalence values in urban compared to rural, but also that the prevalence of MS and overweight was higher in Northern than Southern China. Using ATP III criteria, the prevalence of metabolic syndrome in this study was 2.5% [95%C.I.1.8-3.3]. A similar study but population survey in Cameroon gave a 0.0% prevalence rate in rural communities (15 Fezeu *et al*, 2007) while for Nigeria (all 3.0%; men 2.1% and women 2.7%).

Based on the IDF criteria, the prevalence though higher than for the NCEP/ATPIII and WHO was still low: 8.4% compared to similar study in South Africa with an overall prevalence of 23.3% (18 Mortala *et al*, 2011). A previous study in Cameroon (15-Fezeu *et al*, 2007) reported rather low prevalence rates (men 0.0% and women 0.3%). A study was reported in South Africa where the prevalence of MS with IDF and NCEP definitions was similar across groups of HIV positive patients (24 Awotedu *et al.*, 2010). The higher prevalence of metabolic syndrome in women in this study (urban-3.7% vs. peri-urban-1.4%) compared with previous studies in Cameroon is likely related to the higher prevalence of obesity (urban-38.1 % vs. peri-urban 21.4%) the role of other factors, namely that physical activity and dietary factors needs to be established. When compared with the trend in the USA, our prevalence estimates of 8.4% is rather low. The initial report of the prevalence of the metabolic syndrome in United States adults surveyed in 1988-1994 was approximately 47 million (2 Ford *et al.,* 2002) based on the original 2001 NCEP criteria. Since this initial survey, the prevalence of the metabolic syndrome in the United States has increased to approximately 35% using the NCEP/ATP III definition (25 NCEP ATP, 2002) and to almost 40% based on the IDF definition (9 Ford, 2005). More recently, a prevalence rate of 40% in patients with osteoarthritis and 21% in those without the condition has been reported (26 Joshi, 2010) still lower than the 35% reported by the American Heart Association (27 Medicalnewstoday, 2011). A slightly lower MS prevalence rate of 24.9% has been reported in Latin America (28 Márquez-Sandoval, 2011). In a different study involving African-American men, the WHO estimate was 24.9%, compared with the ATP III estimate of 16.5% (26 Ford and Gilles 2003). In another study involving non-diabetic subjects, the frequency of the metabolic syndrome(WHO) varied between 7% and 36% for men 40 to 55 years; for women of the same age, between 5% and 22% (21 Balkau *et al*, 2002). Other investigators reported different prevalence values of 15.6% (IDF-Europa) and 16.2 (IDF-Africa) both lower than the 14.4% from the NCEP-R/ATP.(29 Longo-Mbenza *et al*, 2009). Using ATPIII criteria, the prevalence of metabolic syndrome in this study was 2.5% [95%C.I.1.8-3.3]. An earlier study in Cameroon gave a 0.0% prevalence rate in rural communities (15Fezeu *et al*, 2007) while for Nigeria (all 3.0%; men 2.1% and women 2.7%) (30 Oladipo *et al*., 2010). The prevalence of MS was higher in the urban than the peri urban area. The probable reason is that the urban dwellers are more exposed to westernization of habits [dietary habits ,sedentary lifestyle] than their peri urban counterparts who mostly farmers and thus physically more active and living in a relatively more natural environment. It is expected that the MS prevalence rate in Yaoundé the administrative capital may be different from that of Douala, Cameroon's largest city and the commercial capital. Data from these two cities may permit generalization of the prevalence for the urban population of Cameroon, considering their multi-ethnic composition.

Conclusions

The IDF 2005 definition gave a prevalence rate of 8.4%. Prevalence of central obesity and diastolic hypertension were highest. Background indicators, lifestyle options, family history and determinants) explained roughly 86.7% of the variability of Metabolic Syndrome. The high prevalence of diastolic hypertension and central obesity observed might be caused by sedentary lifestyles and westernization of habits.

Authors' contribution

GKT contributed in designing the study, collecting data, running the laboratory work, analyzing the data, and drafted the paper. CSP, DJ and NA contributed in the pilot study and data collection. VPKT contributed in designing the entire project and supervised it all through. All the authors have read the final manuscript and approved the submission.

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