

Prevalence of Metabolic Syndrome in Adult Men of the Dschang Health District in Western-Cameroon

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Abstract In developing countries, increasing urbanization and lifestyle changes are helping to increase the prevalence of the metabolic syndrome among the population through the development of cardiometabolic diseases. The objective was to determine the metabolic syndrome prevalence of men aged from 30 to 60 years. A total of 254 male, initially in apparent good health who consented freely were divided into three age groups: 30-40, 41-50 and 51-60 years. They were randomly selected in 5 urban areas and 5 rural areas. After obtaining ethical clearance, patterns of diet and physical activity, data on socio-demographic conditions, alcoholism and smoking were identified by a questionnaire in a survey. Nurses measured anthropometric parameters, blood pressure and fasting blood glucose. Transaminases, uric acid, creatinine and lipids were assayed. The data collected was submitted to the EPI-Info™ software version 7.1.5.0. The metabolic syndrome prevalence was 38.98% in the Dschang Health District and we found 31.97% and 48.6% in the rural and urban areas respectively. This prevalence of metabolic syndrome among the participants in this study showed a close association with the lifestyle, as in the drinkers with a prevalence of 71.53% and 41.67% among smokers. Only 19.3% of the university with the metabolic syndrome were identified, while those with high salt consumption had a prevalence of 34.93%. A significant number of participants had metabolic syndrome in the Dschang Health District. This high prevalence might be related to tobacco consumption, alcoholism, reduced physical activity, low educational level and poor diet.

Keywords: *metabolic syndrome, prevalence, lifestyle, men, Cardiometabolic disease, Cameroon*

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1. Introduction

The Metabolic Syndrome, as indicated by its name is not a specific disease but a syndrome. A syndrome is a recognized set of symptoms with no obvious cause. The Metabolic Syndrome is a specific state of morbidity characterized by the association of several factors contributing to the increased risk on individuals of cardiometabolic disease (coronary heart and type 2 diabetes mellitus) and stroke [1,2]. A tendency to group several metabolic abnormalities in the same individual has been observed, giving rise to the Metabolic Syndrome concept [3]. This constellation of factors globally associates hyperglycaemia, obesity, hypertriglyceridemia, decreased high density lipoprotein cholesterol (HDL-c) and high blood pressure. The cardiometabolic risk (CMR) is the set of all risk factors for cardiovascular disease and type 2 diabetes, including both traditional and emerging risk factors [4]. The increase in the global prevalence of this syndrome affects both developed and developing countries [5]. Chronic diseases such as cardiometabolic diseases (CMD) are the leading cause of death in the

world, and the worldwide prevalence of metabolic syndrome varies from 13.6% to 46%, depending on the diagnostic criteria being applied and the population being evaluated [6]. In short, an emergence of non-communicable diseases related to nutrition and sedentary lifestyle, themselves characteristic of a rapid nutritional transition [7,8]. Cardiometabolic diseases are now considered one of the most important public health problems of our time with 17.5 million deaths a year in the world. They represent the leading cause of early mortality and the first health expenditure item in the world at the beginning of the 21st century [9,10]. If nothing is done by 2030, close to 23.6 million people will die of a cardiometabolic disease and it will remain the first killer in the world [11]. In Africa, precisely in the developing countries, the impact of this situation on human and economic development is more important [12]. This high economic and social cost of cardiometabolic diseases in these countries is a brake on their growth, as they progress more rapidly in the developing countries than in the developed countries [13,14]. Cameroon is a low-income country [15], severely affected by the cardiometabolic diseases. The result is an increase of stroke (24% deaths per year), myocardial infarction (18% deaths per year),

diabetes (10% of deaths per year) and hypertension affecting 35% of the adult population [16]. It is at the average age of 30 that young people gain employment in Cameroon and retire at around 60 years old. The United Nations Program of Development also indicates that entry into the active life is synonymous of regular financial accessibility particularly in Cameroon. It conducts very often to the rapid acquisition of harmful lifestyles linked to changes in diet and physical activity patterns. This new environment imposes a nutritional transition, a modification of the ways of eating and moving with consequences on body composition [7]. The originality of this research is based on the determination of the prevalence of the metabolic syndrome in male adults of Dschang Health District (DHD)-Cameroon. It is characterized by an unhealthy diet in the same environment, the same society, the same family, and even in the same person depending on several factors such as culture, traditions or the socio-economic and intellectual level [17].

2. Materials and Methods

2.1. Context and Background of the Study

Our study was conducted in the Dschang Health District with 22 integrated health areas. The DHD is located at about 1420 m of altitude, with a tropical climate of Sudano-Guinean type, tempered by the altitude. Its annual rainfall is about 2000 mm of precipitation with an average temperature of 20°C [18].

2.2. Ethical Considerations

This study was carried out after obtaining the ethical clearance of the "Cameroon Bioethics Initiative" as well as the administrative authorization. The free written acceptance of a person was the key to participate in this study. Participants with detected metabolic abnormality were referred to the DHD for a more in-depth medical consultation which would allow a more accurate diagnosis. Results were returned to participants through their hospitals as soon as the laboratory made them available.

2.3. Study Population, Inclusion and Exclusion Criteria

Our participants consisted of apparently healthy male subjects between the ages of 30 and 60 who had lived in the Health District for at least six months, regardless of religious, ethnic or social affiliation, who consented freely by writing to participate in the study. Foreign nationals, those over the age of 60, subjects under 30 and women have not been included and will be the subject of further research. The refusal to participate was also a criterion of exclusion.

2.4. Sampling Technique

This is a random sampling, stratified and proportionate; based on a survey using both the questionnaire and the blood samples for the analyses. Thus, we conducted our study on 254 subjects in 10 health zones, five in urban

areas and five in rural areas randomly selected. Our participants were stratified in each health area according to age (30-40, 41-50 and 51-60 years). After the working sessions with the Head of the Random Health Area, a wide awareness and information campaign in all villages and neighbourhoods, the population was invited to the main health centre for free and voluntary detection of CMD. All the villages and neighbourhoods of a health area were eligible for our survey with the subpopulation of adults aged 30 to 60 years.

2.4.1. Sample Size and Data Collection

The ideal sample size of 246 subjects was obtained from the LORENZ formula. The study included three phases: a training phase for investigators and nurses, a preparatory step before each collection and a data collection phase in a hospital of the chosen health area.

2.4.2. Finalisation of the Questionnaire

The questionnaire on socio-economic situation, physical activity evaluation [19,20], alcohol status [21], smoking status [22], eating habits [23,24,25], were designed for adults and adapted to the context. Also, two nurses and six interviewers were trained for data collection. The nurses were responsible for measuring the clinical parameters and taking the blood while the investigators facilitated the understanding of the questions in French, English and/or the local language and filled the questionnaire themselves.

2.4.3. Training Phase for Investigators and Nurses

A two-day training session was organized; one day of theory and one of practice between the principal investigator, a doctor, six investigators and two nurses. When the questionnaire was finalized, before going on the field, a pre-test was carried out on approximately 21 randomly selected people in urban areas to appreciate the acceptability and the comprehension of the questionnaire. Changes have been made, including the length of the questionnaire and the synonyms of certain terms in order to facilitate its understanding.

2.4.4. Questionnaire Administration

The survey consisted of a face-to-face interview with the respondent in order to present the importance and objectives of the study, the various authorizations and to request its signature as a guarantee of its consent. The collection dates on forbidden days were fixed mutually with the health committee president of each health area, sensitisation was made with megaphones in the various villages and neighbourhoods by the presidents of health committee, two banners were fixed one week before at two strategic points in the health area, which reinforced the sensitisation to invite more participants at 7:30 am on the day indicated.

2.5. Data Collection, Measurement and Assay

2.5.1. Blood Sample

Samples of 5 ml of blood in labelled sterile venject tubes were collected by venepuncture at the elbow crease on our participants. A drop of blood was immediately used for blood glucose testing. Nutritional counselling and

education session were organized by a group of five participants at the end of the sampling to invite them to improve their lifestyle. The blood was transported to the laboratory and centrifuged at 3500 rpm for 10 minutes. The serum obtained was stored at -20°C until biochemical analyses. The remaining syringes, test tubes, needles, blood, serum and all contaminated equipment used were sterilized in an autoclave labelled Sonaclav at 121°C for 20 minutes at a pressure of 1.2 bars before throwing into a pit to avoid any risk of contamination.

2.5.2. Measurement of Blood Pressure and Fasting Blood Glucose

Blood pressure was taken twice by an "Arm-type Fully Automatic BP-103H Blood Pressure Monitor". It was measured at the right arm in a sitting position after 10 minutes at rest, performed with an interval of 10 minutes by the same nurse and the arithmetic mean of the two measures was taken into account. Blood glucose was measured from an Accu-Chek® Active reader with a Roche-branded (mg/dl). Hyperglycaemia has been reported for blood glucose levels above 110 mg/dl.

2.5.3. Assessment of General Obesity

The weight and size were measured using a Sinbo QE-2003B Max 150kg/100g digital scale and a locally manufactured wooden gauge in fasting subjects without shoes. The body mass index (BMI = weight ratio in kilograms on the square of the height in meters) was calculated and classified according to WHO standards in 2007 as follows: normal < 25 , overweight 25 to 30, obesity 30 to 35 and massive obesity > 35 .

2.5.4. Evaluation of Abdominal Obesity

The waist circumference in centimetres was measured in a standing position by a nurse using the tailor meter, halfway between the last rib and the upper iliac crest, so the waist circumference ≥ 94 cm was used to define abdominal obesity.

2.5.5. Determination of Biochemical Parameters

Biochemical tests were performed using the reference commercial kits (Innesco GmbHCE, Wiedtalstr.11-53577, and Neustadt/Wied-Germany) to measure the levels of total cholesterol, HDL-c, triglycerides, creatinine and uric acid, aspartate aminotransferase, alanine aminotransferase. The LDL-c level was calculated using the modified Friedewald formula: $\text{LDL-c (mg/dl)} = \text{Non-HDL-c} \times 90\% - \text{TG} \times 10\%$ with $\text{Non-HDL-c} = \text{TC} - \text{HDL-c}$ [26]. On the other hand, TC/HDL-c ratio enables us to indicate the atherosclerotic index.

2.5.6. Evaluation of Metabolic Syndrome

One of the challenges associated with measuring the prevalence of MetS is the existence of several criteria and definitions for the diagnosis of this syndrome. A new definition of the metabolic syndrome has been proposed by the IDF. It is intended to harmonize the concept by a more flexible definition. Five parameters are used to characterize metabolic syndrome according to the IDF: blood pressure, fasting glucose concentration, waist circumference, raised triacylglycerol levels and

reduce HDL-c. The MetS implies the presence of abdominal obesity and at least two other risk factors [27].

2.6. Statistical Analysis

The data collected were submitted to the EPI-Info™ software version 7.1.5.0. Analysis of the variance was used and when there were significant differences, the Chi Square test permitted us to compare the frequencies and the Fischer Exact Test to compare the means.

3. Results

3.1. Main Demographic Characteristics of the Study Population

Table 1 and Table 2 present the demographic characteristics of the rural and urban areas, respectively. Participants at all ages were significantly more educated in urban area (42.06% of the secondary level and 43.93% of the university level) compared to those in rural area (38.78% of secondary school and 6.80% of university level) ($P=0.001$). On the other hand, manufacturers and strength activity regardless of age were significantly more numerous in the rural area (74.15% and 14.29%) (Table 1). In addition, participants of all ages in both areas were well informed about the occurrence of stroke and heart attacks in their environment (95.33% in rural area at $P=0.584$ of Table 1 and 98.64% in the urban area at $P=0.267$ of Table 2).

3.2. Cardiometabolic Profile of the Study Population

3.2.1. Indicator of Cardiometabolic Risk According to Age and Environment

Table 3 presents the indicators of CMR according to age and living environment. This table showed that diastolic and systolic tensions did not differ significantly between age groups in both rural and urban areas ($P>0.05$). However, SBP was higher in the 51-60 years group (136.72 ± 22.18 mmHg at $P = 0.299$ in rural areas and 145.48 ± 25.34 mmHg at $P = 0.062$ in urban areas). BMI and WC showed no significant differences between age groups in the two areas. The BMI in rural areas was higher in the group 30-40 year (26.94 ± 1.29) with no significant difference compared to other age groups; whereas in the urban area it was the 41-50 age group (27.51 ± 2.44) which was high ($P>0.05$). In the same way, the WC was higher in the same area in the group 41-50 years (97.24 ± 8.13 cm) ($P>0.05$). Glycaemia in the urban area was significantly higher ($P>0.001$) in the 51-60 years group (1.31 ± 0.46 g/l) compared to the 30-40 years group (1.02 ± 0.28 g/l) and 41-50 years group (1.04 ± 0.22 g/l). In the rural area, it was 1.42 ± 0.34 g/l in the 41-50 years group but with no significant difference compared to the groups 30-40 years (1.39 ± 0.35 g/l) and 51-60 years (1.34 ± 0.41 g/l). Lipids in general were high in the 30-40 years group in both areas with a low HDL-c in rural (25.81 ± 22.23 mg/dl) and urban area (18.01 ± 5.24 mg/dl). This implied an increase of atherosclerosis index (AI), especially in the 30-40 age

group, (3.81 ± 1.42 and 4.27 ± 2.89 respectively in rural and urban areas). Lipids in general were elevated in 30-40 age groups in both zones with a low HDL-c (25.81 ± 22.23 mg/dl in rural areas and 18.01 ± 5.24 in urban areas).

Table 1. Demographic Characteristics of the Rural Population

Characteristics	Rural area (n = 147)				p-value
	30-40	Age group		%n	
	17.01%	41-50	51-60		
	%	%	%		
Level of study	Non educated	10	10	80	6.80
	Primary	14.29	17.14	68.57	47.62
	Secondary	17.54	19.30	63.16	38.78
	University	4	20	40	6.80
Marital status	Single	85.71	0	14.29	9.52
	Married	10.08	19.38	70.54	87.76
	Divorced	0	100	0	0.68
	Widower	0	0	100	2.04
Occupation	Bureaucrat	0	0	100	11.56
	Manufacturing	19.27	19.27	61.47	74.15
	Strength activity	19.05	23.81	57.14	14.29
Information on stroke and heart attacks	Yes	17.24	17.93	64.83	95.33
	No	0	0	100	4.67

Table 2. Demographic Characteristics of the Urban Population

Characteristics	Urban area (n = 107)				p-value
	30-40	Age group		%n	
	29.91%	41-50	51-60		
	%	%	%		
Level of study	Non educated	0	0	100	1.87
	Primary	7.69	23.08	69.23	12.15
	Secondary	6.67	28.89	64.44	42.06
	University	59.57	19.15	21.28	43.93
Marital status	Single	92.86	0	7.14	13.08
	Married	18.68	27.47	53.85	85.05
	Divorced	100	0	0	1.87
	Widower	0	0	0	0.0
Occupation	Bureaucrat	42.37	20.34	37.29	55.14
	Manufacturing	13.89	33.33	52.78	33.64
	Strength activity	16.67	8.33	75	11.21
Information on stroke and heart attacks	Yes	30.39	24.51	45.10	98.64
	No	20	0	80	1.36

% = percentage by characteristic, * = p-value comparing characteristics and age groups, ** = p-value comparing characteristics, %n = total percentage in area.

Table 3. Variation of Cardiometabolic Risk Indicators According to Age and Living Environment

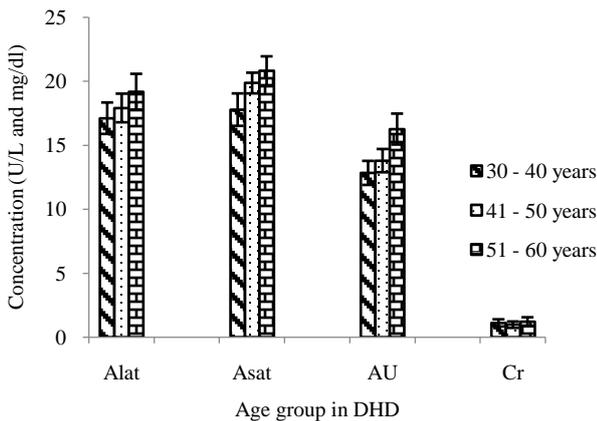
Characteristics	Rural area			p-value	Urban area			p-value
	30-40	41-50	51-60		30-40	41-50	51-60	
	Mean ±SD	Mean±SD	Mean±SD		Mean±SD	Mean±SD	Mean±SD	
SBP (mm/Hg)	129.08±19.61	136.27±17.45	136.72±22.18	0.299	133.22± 13.42	135.76± 11.28	145.48±25.34	0.062
DBP(mm/Hg)	75±9.52	86.35±13.37	85.30±13.92	0.097	82.66±12	82.88±11.68	87.24±16.17	0.262
BMI(kg/m ²)	26.94±1.29	24.42±2.21	24.99±1.55	0.421	25.42±1.47	27.51±2.44	25.75±1.72	0.096
WC(cm)	89.36±7.10	86.35±8.53	92.71±8.72	0.623	88.06±7.21	97.24±8.13	96.42±6.93	0.804
Gly(g/l)	1.39±0.35	1.42±0.34	1.34±0.41	0.574	1.02±0.28	1.04±0.22	1.31±0.46	< 0.001
TC(mg/dl)	306.72±110.04	287.49±129.58	293.16±128.17	0.849	274.19±114.04	271.82±103.73	296.50±122.52	0.582
HDL-c(mg/dl)	25.81±22.23	38.79±30.60	38.04±27.81	0.124	18.01±5.24	19.53±7.96	25.12±23.48	0.139
TG(mg/dl)	270.48±172.97	280.39±175.89	303.91±177.13	0.637	243.94±169.45	233.13±144.30	293.42±207.35	0.309
LDL-c(mg/dl)	225.77±107.02	195.79±126.17	199±114.14	0.552	206.16±106.01	203.75±93.37	214.90±114.22	0.892
AI	3.81±1.42	3.14±1.54	3.21±1.58	0.195	4.27±2.89	3.92±1.76	4.30±1.83	0.760

AI = Atherosclerosis Index, LDL-c = Low Density Lipoprotein, TG = Triglycerides, HDL-c = High Density Lipoprotein, TC = Total Cholesterol, Gly = Glycaemia, WC = Waist Circumference, BMI = Body Mass Index, DBP = Diastolic Blood Pressure, SBP = Systolic Blood Pressure.

This implied an increase of AI in the same age group, (3.81 ± 1.42 and 4.27 ± 2.89 respectively in rural and urban areas). The rate of TG increased with age in the rural area but was very high in the 51-60 years group (303.91 ± 177.13 mg/dl) but without significant difference ($P=0.637$) compared to 30-40 years (270.48 ± 172.97 mg/dl) and 41-50 years (280.39 ± 175.89 mg/dl).

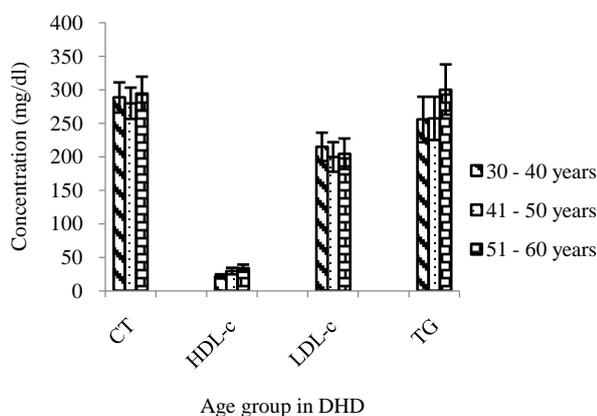
3.2.2. Variation of Certain Biochemical Parameters According to Age in DHD

Figure 1 showed the evaluation of liver and kidney function in the Dschang Health District by age. It appeared that the level of transaminases (AST and ALT) increased with age. The AST rate in the 51-60 year group (20.84 ± 1.13 U/L) was significantly higher ($P<0.05$) compared to that of 30-40 year group (17.8 ± 1.27 U/L). The ALT rate in all age groups was not significantly different ($P>0.05$). Uric acid also had a significant difference ($P<0.05$) between the 51-60 year group (16.28 ± 1.21 mg/dl) compared to the 30-40 years group (12.85 ± 0.94 mg/dl) and 41-50 years (13.81 ± 0.91 mg/dl). Creatinine values, according to the standard (0.6 to 1.3 mg/dl), showed no significant differences between the three age groups.



ALT = Alanine aminotransferase, AST = Aspartate aminotransferase, AU = Uric Acid, Cr = Creatinine, DHD = Dschang Health District

Figure 1. Variation of certain biochemical parameters according to age in DHD



TC = Total Cholesterol, HDL-c = High density lipoprotein, LDL-c = Low density lipoprotein, TG = Triglycerides, DHD = Dschang Health District, CMR = Cardiometabolic risk

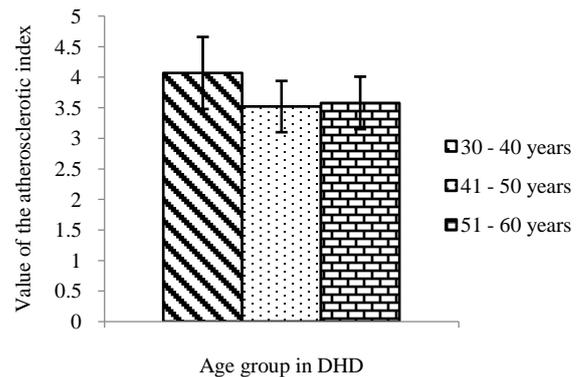
Figure 2. Variation of lipids level according to age in DHD

3.2.3. Variation of Lipid Level Related to CMR According to Age in DHD

In Figure 2, which showed the variation of lipid levels associated with cardiometabolic risk according to age in the District, total cholesterol was observed to be above the normal level (<200 mg/dl) and this in all age groups but without any significant difference ($P>0.05$). HDL-c remained low in general although it was higher in the 51-60 year group (33.61 ± 5.41 mg/dl) with a significant difference ($P<0.05$) compared to the 30-40 year group (21.43 ± 3.11 mg/dl). The LDL-c level was also high in all age groups but the differences were insignificant. A very high triglyceride level (300.32 ± 37.47 mg/dl) was observed in the 51-60 year group compared to the normal value (<150 mg/dl) but remained insignificant compared to other age groups.

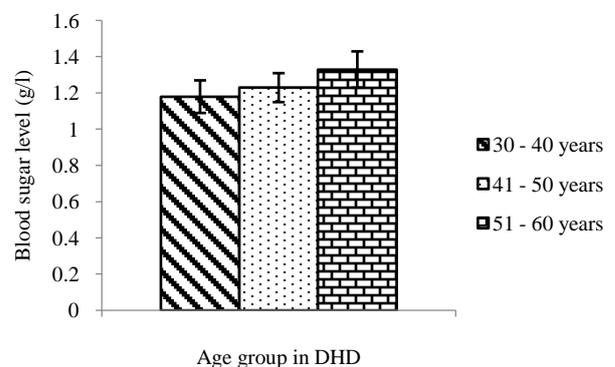
3.2.4. Variation of Atherosclerosis Index Related to CMR According to Age in DHD

Figure 3 presented the atherosclerosis index in the DHD according to age. This index in all age groups was within the norm (< 5), however the 30-40 year group had the higher index (4.07 ± 0.59) although the difference was not significant with the 41-50 year group (3.52 ± 0.42) and 51-60 year group (3.58 ± 0.43) ($P>0.05$).



DHD = Dschang Health District

Figure 3. Variation of the atherosclerosis index according to age in DHD



DHD = Dschang Health District

Figure 4. Changes in blood glucose according to age in DHD

3.2.5. Variation of Blood Glucose Levels Related to CMR According to Age in DSD

The mean blood glucose level associated with cardiometabolic risk according to age were presented in Figure 4 and showed that blood glucose increased with

age ($P>0.05$). The 51-60 year group had a higher blood glucose level (1.33 ± 0.1 g/l) than the standard (1.26 g/l) but no significant difference compared to the 41-50 year group (1.23 ± 0.08 g/l) and 30-40 year group (1.18 ± 0.09 g/l).

3.3. Metabolic Syndrome (MetS) in Dschang Health District

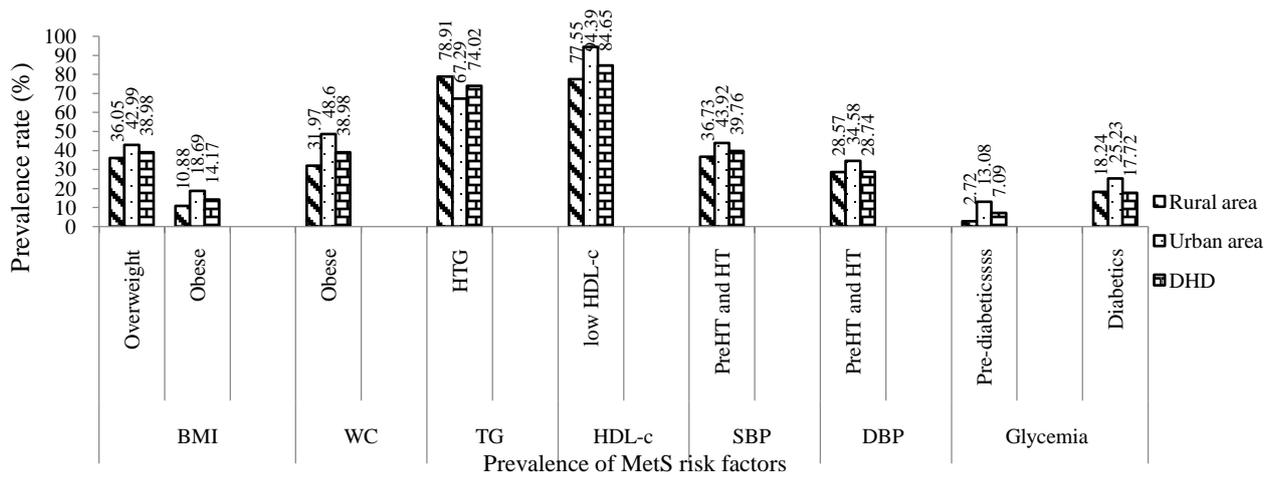
3.3.1. Effect of the Environment on the Prevalence of MetS Risk Factors

Figure 5 presented the prevalence of risk factors of the MetS according to the living environment. It was observed with the body mass index that the urban area was more at risk with 42.99% of overweight and 18.69% of obese whereas with the measurement of the waist circumference, the urban area recorded 48, 6% compared to the 38.98% of obese throughout the DHD. In the rural area, 78.91% had hypertriglyceridemia, and 74.02% in the whole district. Hypertension was higher in the urban area (43.92% systolic hypertensive and 25.23% diastolic hypertensive) compared to the rural area (36.73% systolic hypertensive and 28.57% diastolic hypertensive) and the whole District (39.76% systolic hypertensive and 28.74% diastolic hypertensive). This table also showed that the

urban area had more diabetics (25.23%) compared to the rural area (18.24%) and the whole district (17.72%).

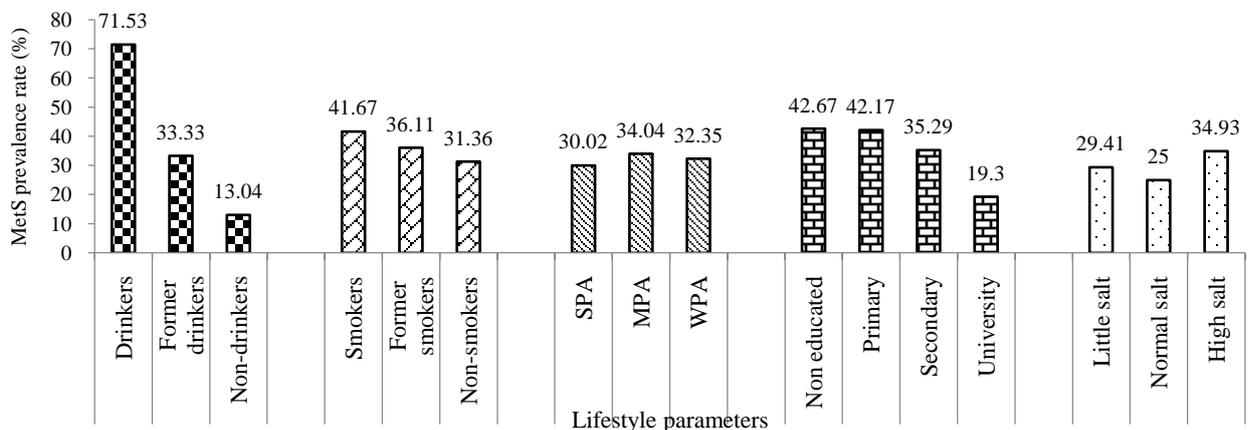
3.3.2. Prevalence of MetS as a Function of Lifestyle

Figure 6 revealed the prevalence of MetS in DHD according to lifestyle. It showed that alcohol consumers had a significantly high prevalence (71.53%) compared to former consumers (33.33%) and non-consumers (13.04%). Tobacco smokers (41.67%) were more at risk compared to former smokers (36.11%) and non-smokers (31.36%) ($P>0.05$). The group of people with moderate physical activity (34.04%), although higher, did not show any significant difference with those with strong physical activity (30.02%) and weak physical activity (32.35%) ($P>0.05$). It also appeared that the level of education had an impact on the metabolic syndrome because the rate decreased as the level of study increased, with 42.67% of non-educated, 42.17% in the primary level, 35.29% in secondary level and only 19.3% in university without any significant difference ($P>0.05$). Finally, a metabolic syndrome rate was observed in the high-salt consumers (34.93%) with no significant difference compared to moderate salt consumers (25%) and low salt consumers (29.41%).



BMI = Body Mass Index, WC = Waist Circumference, TG = Triglyceride, HDL-c = High density lipoprotein, SBP = Systolic Blood Pressure, DBP = Diastolic Blood Pressure, DHD = Dschang Health District, HTG = Hypertriglyceridemia, PreHT = Prehypertension, MetS = Metabolic Syndrome, HT = Hypertension

Figure 5. Prevalence of MetS risk factors in DHD

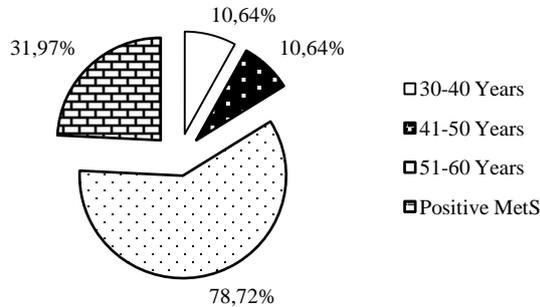


SPA = Strong Physical Activity, MPA = Moderate Physical Activity, WPA = Weak Physical Activity

Figure 6. Metabolic syndrome prevalence in DHD according to lifestyle

3.3.3. Metabolic Syndrome Prevalence in the Rural Area

The prevalence of the MetS in the rural area was presented in Figure 7 and showed that 31.97% of people were affected by the MetS with higher rate held in the 51-60 year group (78.72 %).



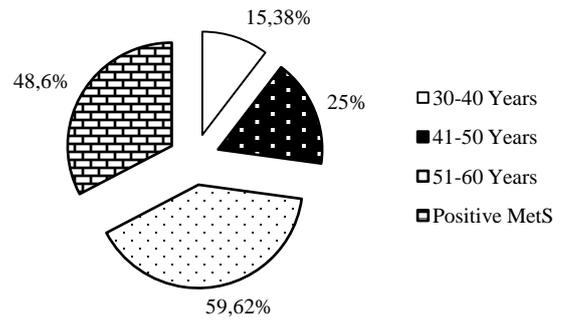
MetS = Metabolic Syndrome

Figure 7. Variation of metabolic syndrome prevalence according to age in rural area

3.3.4. Metabolic Syndrome Prevalence in the Urban Area

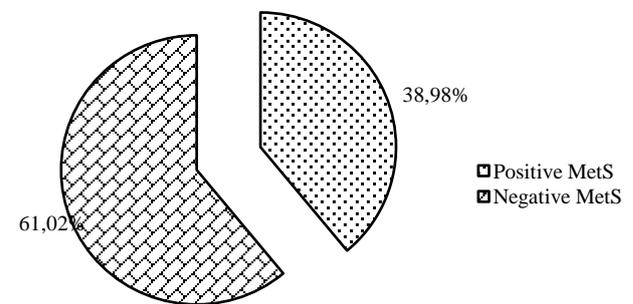
The MetS prevalence in the urban area was shown in Figure 8. It could be seen that the MetS increased with age and was higher in the 51-60 years group (59.62%). However, there were 48.60% of people affected by MetS in this zone.

presented in Figure 9. It showed that 38.98% suffer from the MetS in the Dschang Health District.



MetS = Metabolic Syndrome

Figure 8. Variation of metabolic syndrome prevalence according to age in urban area



MetS = Metabolic syndrome, DHD = Dschang Health District

Figure 9. Metabolic syndrome prevalence in Dschang Health District.

3.3.5. General Prevalence of the Metabolic Syndrome in DHD

The general prevalence of the MetS in the DHD was

Table 4. Correlations Between Cardiometabolic Parameters in Dschang Health District

		BMI	WC	SBP	DBP	Gly	TC	HDL	LDL	TG	AI	ALT	AST	UA	Cr
BMI	cc	1													
(n = 254)	sig	/													
WC	cc	0.79	1												
(n = 254)	sig	<0.001	/												
SBP	cc	0.11	0.19	1											
(n = 254)	sig	0.08	0.00	/											
DBP	cc	0.13	0.22	0.72	1										
(n = 254)	sig	0.04	0.00	<0.0001	/										
Gly	cc	0.42	0.43	0.37	0.48	1									
(n = 254)	sig	0.29	0.25	0.73	0.04	/									
TC	cc	0.88	0.84	0.84	0.85	0.88	1								
(n = 254)	sig	0.08	0.52	0.51	0.38	0.12	/								
HDL-c	cc	0.63	0.68	0.71	0.72	0.65	0.66	1							
(n = 254)	sig	0.80	0.38	0.16	0.08	0.62	0.58	/							
LDL-c	cc	1	1	1	1	1	1	1	1						
(n = 254)	sig	0.000	0.000	0.000	0.000	0.000	0.000	0.000	/						
TG	cc	0.86	0.88	0.87	0.81	0.86	0.84	0.90	0.85	1					
(n = 254)	sig	0.44	0.22	0.37	0.92	0.48	0.75	0.10	0.56	/					
AI	cc	1	1	1	1	1	1	1	1	1	1				
(n = 254)	sig	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	/				
ALT	cc	0.29	0.28	0.28	0.28	0.34	0.20	0.23	0.21	0.31	0.22	1			
(n = 254)	sig	0.26	0.30	0.26	0.35	0.03	0.96	0.79	0.89	0.12	0.85	/			
AST	cc	0.21	0.26	0.22	0.21	0.25	0.24	0.21	0.23	0.35	0.45	0.28	1		
(n = 254)	sig	0.85	0.37	0.82	0.84	0.56	0.66	0.84	0.71	0.01	0.000	0.21	/		
UA	cc	0.72	0.71	0.77	0.74	0.82	0.74	0.79	0.74	0.82	0.62	0.68	0.71	1	
(n = 254)	sig	0.81	0.87	0.33	0.65	0.03	0.68	0.15	0.66	0.04	0.99	0.97	0.88	/	
Cr	cc	0.27	0.26	0.21	0.28	0.22	0.32	0.39	0.31	0.30	0.44	0.26	0.36	0.25	1
(n = 254)	sig	0.62	0.75	0.98	0.52	0.94	0.20	0.005	0.28	0.34	0.000	0.69	0.03	0.81	/

cc = Correlation Coefficient, n = Sample size, sig = p-value, BMI = Body Mass Index, WC = Waist Circumference, SBP = Systolic Blood Pressure, DBP = Diastolic Blood Pressure, Gly = Glycaemia, TC = Total Cholesterol, TG = Triglyceride, AI = Atherosclerosis Index, UA = Uric Acid, Cr = Creatinine, AST = Aspartate Aminotransferase, ALT = Alanine Aminotransferase, HDL-c = High Density Lipoprotein, LDL-c = Low Density Lipoprotein.

3.4. Correlations between Cardiometabolic Parameters

Table 4 showed the various correlations between cardiometabolic parameters. Body mass index (BMI), waist circumference (WC), systolic blood pressure (SBP), diastolic blood pressure (DBP), blood glucose (BG), total cholesterol, HDL-c and triglycerides (TG) had a very strong correlation with LDL-c ($R^2 = 1$) and atherosclerosis index ($R^2 = 1$) ($P < 0.001$). However, BMI and WC had a strong correlation with total cholesterol ($R^2 = 0.88$ and $R^2 = 0.84$ respectively) and TG ($R^2 = 0.86$ and $R^2 = 0.88$ respectively) $P > 0.05$. SBP and DBP also showed a strong correlation with total cholesterol ($R^2 = 0.84$ and $R^2 = 0.85$ respectively) and TG ($R^2 = 0.87$ and $R^2 = 0.81$ respectively) at $P > 0.05$; total cholesterol, HDL-c and LDL-c also showed a strong correlation with TG ($P > 0.05$). It was also observed that uric acid also had a strong correlation ($R^2 = 0.82$) with TG ($P = 0.04$). On the other hand, there were some weak correlations such as SBP and DBP with BMI ($R^2 = 0.11$ and $R^2 = 0.13$ respectively). Also, creatinine had a low correlation with BG ($R^2 = 0.22$).

4. Discussion

This study of two populations living in rural and urban areas showed that the level of education, occupation and even marital status have an influence on diet, physical activity, alcoholism, smoking and consequently on the occurrence of cardiometabolic diseases in the Dschang Health District. These results are comparable to those obtained and showed that there is an association between lifestyle explosion [28], BMI, blood pressure, blood glucose and the occurrence of cardiometabolic diseases. In general, the level of information on the occurrence of cardiometabolic diseases such as stroke and heart attacks is very high and comparable in rural and urban areas, regardless to the age (95.33% and 98.64% in rural and urban areas respectively). This would be due to the resurgence of these pathologies in a given population in which a personal observation has been established between 2012 and 2017 at the University of Dschang where about fifteen deaths and/or invalids occurs due to strokes, heart attacks and sudden death.

In general, the apparently good health of the participants is not confirmed by the results of the risk biomarker analysis and the questionnaire. The prevalence of MetS risk factors in DHD is high. In fact, there are 18.69% obese and 42.99% overweight people in the urban area according to the BMI. In the rural area only 10.88% of people are obese and 36.05% overweight. These could be the consequence of the increased in physical inactivity in urban area and to the excessive consumption of alcohol. It is the reason why class 41-50 years is more affected (19.61% obese) and this weight gain usually begins after entering the active life (around 30 years) and it increases with time. This rate of obesity is higher than what was reported by WHO [29] (9.6% of Cameroonians) and this increase of obese rate could be explained by the increasing urbanization and motorization associated to television, as mentioned by Fezeu *et al.* [30]. Similarly, Bitu *et al.* [31] in Cameroon established a general prevalence of obese

(23.4%) and overweight (49.1%) subjects by specifying that the most affected people were aged 45 years and more with alcoholism and overeating as the main causes.

Hypertriglyceridemia is remarkable in rural area (78.91%), this could be explained by the high consumption of unrefined palm oil, especially between October and March which is the period of rites and other traditional ceremonies, this oil contains 45 to 55% saturated fatty acids that increases the level of TG and cholesterol in the blood. HDL-c is lower in urban area (94.39%), and this could be a consequence of obesity, physical inactivity and even diabetes which contribute to reduce the level of HDL-c [32]. There are more hypertensives in urban area (43.92% SysHTA and 34.58% DiaHTA), these results are similar to those that obtained 40% of adults in Africa and 37% of Cameroonians and would be the consequence of the urban lifestyle [33,34]. Diabetes affects 25.23% and 18.24% in urban and rural areas respectively, which is justified by the high consumption of sweet foods in urban area. These rates are well above those found in 2016 by the Cameroon Heart Foundation (10%) and WHO (9%) in Cameroon. There is a strong correlation ($R^2 = 1$) between the atherosclerosis index and the LDL-c with BMI, waist circumference, blood pressure, blood glucose, TC, HDL-c and TG. There is also a high correlation ($R^2 = 0.84$) between TC and TG and between SBP and DBP ($R^2 = 0.72$). These strong correlations are comparable to those obtained on the cardiovascular parameters of two populations in Northern and Southern Cameroon ($R^2 = 0.82$ between SBP and DBP and $R^2 = 0.61$ between TC and TG) [35]. These high correlations could be the result of unhealthy eating habits, alcoholism, smoking and sedentary lifestyles.

According to the criteria of the International Diabetes Federation, the results of this study indicate that the prevalence of MetS varies with age and lifestyle; however, these subjects affected by MetS have a higher risk to develop CMD. The prevalence of MetS according to the lifestyle respectively for drinkers and smokers in DHD is 71.53% and 41.67%. These high rates suggest that alcoholism and smoking are practiced enough in this area. The level of education shows that university level is less affected by the MetS (19.3%), compared to 42.67% among those poorly educated, suggesting that those at university level are adequately informed about risk factors and the level of education would be a protective factor of the MetS. The high salt intake increases the prevalence of MetS in DHD (34.93%). Someone could think that in this zone the rate of hypertension is high and increases with age. These subjects do not also have the sense of measurement when consuming salt although the loss of sensitivity to taste is developed with age. In fact, a study found that in Africa the consumption of salt is often underestimated [13]. Some studies also showed that excessive salt intake is associated with an increase of cardiovascular diseases [36,37]. The lack of work on the MetS and the lack of consensus in the MetS diagnosis suggest that the populations in DHD are profoundly affected by the MetS (38.98%), with 48.60% of those affected in the urban area and only 31.97% in the rural area. The 51-60 years group is the most affected (78.72% in rural area and 59.62% in urban area). This could be explained by exposure to the

urban lifestyle. The MetS prevalence in DHD is higher than in Brazil (22.6%) [6], in Algeria (26.33%) [38], but is close to the 34.83% found by WHO among smokers worldwide and 44% among smokers in Cameroon [31]. These alarming rates are due to alcoholism, smoking, physical inactivity and an unhealthy diet to which these populations are exposed.

5. Conclusions

This work on the metabolic syndrome among Cameroonians in the Dschang Health District showed a prevalence of 38.98%, with 48.6% and 31.97% respectively in urban and rural areas, related to the increase of the risks of the cardiometabolic diseases. Our findings suggest that the poor lifestyle, physical inactivity, tobacco consumption, alcoholism, low educational level and poor eating habits are associated with the high prevalence of metabolic syndrome. Research on the metabolic syndrome in Cameroon remains a myth, while every day, many people fall victim to a cardiometabolic disease and sometimes under our helpless gaze.

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Statement of Competing Interests

The authors have no competing interests.

List of Abbreviations

AI: Atherosclerosis Index
 ALT: Alanine aminotransferase
 AST: Aspartate aminotransferase
 BG: Blood Glucose
 CMD: Cardiometabolic Disease
 CMR: Cardiometabolic Risk
 Cr: Creatinine
 DHD: Dschang Health District
 Gly: Glycaemia
 HT: Hypertension
 MetS: Metabolic Syndrome
 MPA: Moderate Physical Activity
 SPA: Strong Physical Activity
 UA: Uric Acid
 WPA: Weak Physical Activity

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