Journal of Biosciences and Medicines, 2019, 7, 35-50
http://www.scirp.org/journal/jbm
ISSN Online: 2327-509X
ISSN Print: 2327-5081

# Characterization of Dyslipidemia and Assessment of Atherogenic Risk amongst Cameroonian Living in Yaounde: A Cross Sectional Study

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**How to cite this paper:** Yangoua, H.C.M., Azantsa, B.G.K., Kuate, D., Ntentie, F.R., Nguedjo, M.W., Nkougni, J.T., Tchuente, B.R.T., Ngondi, J.L. and Oben, J. (2019) Characterization of Dyslipidemia and Assessment of Atherogenic Risk amongst Cameroonian Living in Yaounde: A Cross Sectional Study. *Journal of Biosciences and Medicines*, **7**, 35-50.
https://doi.org/10.4236/jbm.2019.77004

**Received:** June 6, 2019
**Accepted:** July 8, 2019
**Published:** July 11, 2019



## Abstract

**Background:** This study was conducted to evaluate the lipid profile in nutritional categories, to characterize dyslipidemia and assess cardiovascular risk, to describe association between anthropometric markers, incidence of dyslipidemia and cardiovascular risk in Cameroonian adults. **Methods:** A cross-sectional survey was conducted in Yaoundé from April 2014-June 2015. It included 1986 individuals, aged 20 - 65 years, both males (30.7%) and females (69.3%). Blood pressure, anthropometric measurement including weight, height, body fat, waist and hip circumference were performed. BMI was used to define nutritional status. Blood analysis included total cholesterol, HDL-cholesterol and triglycerides, insulin. Dyslipidemia was defined as hypercholesterolemia, hypertriglyceridemia, low HDL-cholesterolemia and combined dyslipidemia. Atherogenic indexes were calculated for assessment of the cardiovascular risk. **Results:** Out of the 1986 participants, 544 (27.4%), 616 (31%), and 826 (41.6%) were normal weight, overweight and obese respectively. In obese, lipid profile varied according to gender ($p < 0.05$). In addition, total cholesterol ($p < 0.05$), LDL-c ($p < 0.05$) level, total cholesterol/HDL-cholesterol and LDL-c/HDL-c were higher among obese than normal weight individuals. Hypercholesterolemia (19.3%), hypertriglyceridemia (11.64%), combined dyslipidemia (3.40%) and the atherogenic profile (Total cholesterol/HDL-cholesterol ratio > 5) was (40.50%). Low HDL-cholesterolemia (75.4%)

was the main lipid abnormality found, independently of gender, age, fat location. Waist circumference (WC) unlike body mass index (BMI) and body fatness was associated to hypercholesterolemia. **Conclusion:** Low HDL-cholesterolemia and high atherogenic risk profile are more prevalent amongst Cameroonian adults. Promotion of healthy lifestyle including good eating habits shall be encouraged to reduce mortality from cardiovascular disease complications.

## Keywords

Dyslipidemia, Obesity, Atherognic Risk, Lipid Markers, Cameroon

## 1. Introduction

Evidence of sudden and unexpected death is common in Cameroon amongst apparently healthy people, probably due to cardiovascular diseases (CVD) [1] [2]. CVD have been reported to be responsible for at least two-thirds of cardiovascular deaths in sub-Saharan Africa, with hypertension, smoking and obesity being the leading team [2]. The prevalence of obesity and metabolic disorders is increasing across Africa [3] [4] [5] and in Cameroon [6] [7]. Obesity in Cameroon affects children [8] and adults [9] [10] in both urban and rural areas [6]. Defined as a condition with excessive fat accumulation that adversely affected health and well-being [11] [12], obesity constitutes global public health problem due to its association with several diseases [13], and reduced lifespan [14] [15]. Obesity results from complex interaction of genetic, lifestyle, dietary habits, energy expenditure, nutritional and metabolic factors as the adipocyte metabolism [15] [16]. Fat accumulation and location constitute risk factors for diabetes, cardiovascular diseases [2] and dyslipidemia [17]. Dyslipidemia is a condition of an abnormal lipid or lipoprotein concentration in the blood. Dyslipidemia includes elevated cholesterol, high triglycerides and lower high-density lipoprotein (HDL-c) cholesterol levels which have been reported to increase cardiovascular risk [18] [19]. Evidence reports that dyslipidemia profile differs according to race or ethnicity of the populations. In fact, ethnicity determines different adipose tissues distribution and responses to the cardio-metabolic risks [20]. For instance, the Framingham and Examination Surveys (NHANES) from 2003-2006 study [21] have shown hypercholesterolemia and high LDL-Cholesterolemia as key features of dyslipidemia that cause lesions in the US population. Low HDL cholesterolemia as main dyslipidemia was reported in China [17] and in Nigeria [5]. Evidence further proved that even in the same population, lipid profile differs in subgroup of obese individuals, with different metabolic and cardiovascular risk profiles [22]. Therefore, the attempt to manage dyslipidemia and reduce cardio-metabolic risk of a patient requires better understanding of the population specificities for better and adequate treatment approaches. Cameroon like many other low-income countries is undergoing social, economic and dietary changes, resulting from increased urbanization with a potentially negative impact on health-related behaviors [2] [6] [19]. Given that only few data document dyslipidemia profile and their incidence on cardiovascular risk of Cameroonian, this study was carried out to describe lipid profile across BMI categories, to identify the most common dyslipidemia, to examine the association between anthropometric markers, dyslipidemia and cardiovascular risk in apparently healthy adults living in Yaoundé.

## 2. Materials and Methods

### 2.1. Study Design and Setting Population

A cross-sectional survey was carried out from April 2014 to June 2015 on 2500 eligible individuals living in Yaounde, the city capital of Cameroon. Participants were informed through radio announcement, flyers and posters displayed around town. They were invited to attend nutrition education programs organized by the Cameroon Nutrition Science Society hosted by Laboratory of Nutrition and Nutritional Biochemistry (LNNB), University of Yaounde 1. The study follows the workflow chart in Figure 1.

### 2.2. Inclusion and Exclusion Criteria

Inclusion criteria for study participation were: 1) Individuals aged 20 to 65 years, diagnosed by a physician as being physically healthy (absence of hospitalization); 2) stable body weight (±2 kg) for at least three months, without use of medication known or suspected to affect body weight or appetite; 3) BMI above 18.5 kg/m$^2$; 4) no weight loss attempts through dietary intervention over the three months; 5) non-diabetic; 6) nonsmoker; and 7) ability to competently understand

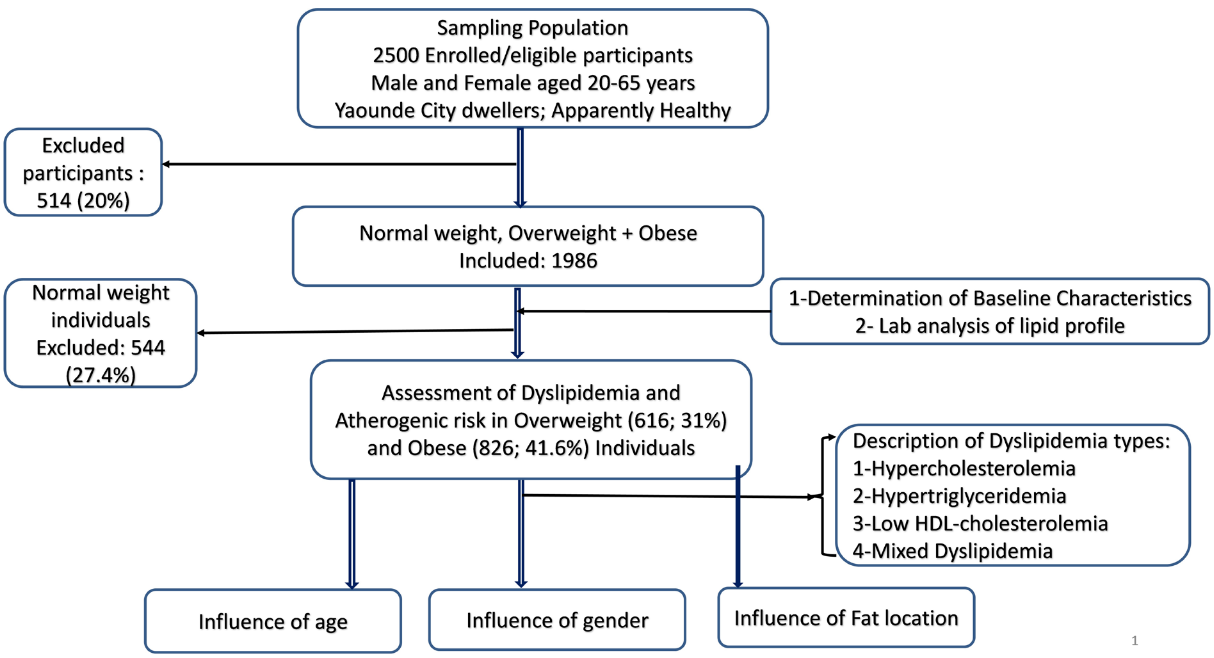



Figure 1. Work flowchart of the study.

and sign the consent form. Excluded were pregnant or breast-feeding women, individuals with known endocrine disorder particularly hypothyroidism, liver and kidney diseases. Based on the above criteria, 20.56% (514) were excluded and 1986 (609 men and 1377 women) consenting volunteers were selected to participate in the study (**Figure 1**). Questionnaires were administered, anthropometric measurements performed, and blood sample collected from patients.

### 2.3. Ethics Approval and Consent to Participate

The study was conducted according to protocol No. 2014/08/488/CE/CNERSH/, approved by the Cameroon National Ethics Committee for Research on Human Health. All participants were treated according to the Helsinki declaration. They provided written and signed a consent form.

### 2.4. Study Questionnaire

A structured questionnaire conceived from WHO STEPwise Instrument for chronic diseases v2.1. was used to collect socio-demographic data, family history, clinical symptoms, and medical treatment for various chronic diseases, smoking and alcohol consumption. LNNB Researchers were trained to administer questionnaires, through a face-to-face interview with participants.

### 2.5. Anthropometric Measurements

Height was measured with a wall mounted stadiometer, which was calibrated against the Cameroon's Department of National Security identification scale. Body weight and body fatness (BF), were assessed using a Tanita™ BC-418 Segmental Body Composition Analyzer/Scale based on bioelectrical impedance principle. Waist circumference (WC) was measured at the mid-point between the highest part of the iliac crest and the lowest part of the ribs margin of the median axial line. Body mass index (BMI) was calculated by dividing the weight in kilograms by the height in $m^2$. Blood Pressure was measured as well. Briefly, the participants left arm was placed at the level of the heart in a sitting position and blood pressure was measured with a digital two of three readings sphygmomanometer (Omron 770A, Omron Corporation, Kyoto, Japan). The averages of the two last three systolic and diastolic pressures were recorded and the first reading was excluded.

### 2.6. Laboratory Data and Analysis

After a 12-hour overnight fast, venous blood was collected in EDTA test tubes, then centrifuged at 4500 G for 10 min, plasma obtained was stored in aliquots. Reagents from the same batch were used to minimize laboratory variability [23]. Samples were analyzed to determine total cholesterol, high-density cholesterol (HDL-c) and triglycerides using Chronolab test kits with semi-automated spectrophotometer in accordance with the international quality standard. Fasting blood glucose (FBG) was measured based on glucose-oxidase method using a glucometer and test strips (One-touch plus). Fasting plasma insulin was determined with ELISA method and microplate reader spectrophotometer. Plasma LDL cholesterol was calculated using Friedewald's equation, except when triglycerides exceeded 400 mg/dL [24].

### 2.7. Definitions

Dyslipidemia: The classification of the reference values for total cholesterol, triglycerides, LDL-C, and HDL-C followed the criteria of the Adult Treatment Panel III of the National Cholesterol Education Program (NCEP-ATPIII) [25] on dyslipidemia, Hypertriglyceridemia was defined as plasma concentration triglycerides ≥ 150 mg/dL or 1.7 mmol/L; hypercholesterolemia was defined as plasma concentration ≥ 200 mg/dL or 5.17 mmol/L; low HDL-c levels were defined as HDL cholesterol concentration < 40 mg/dL or 1.03 mmol/L in men or <50 mg/dL or 1.29 mmol/L in women and mixed/combined dyslipidemia defined (triglycerides ≥ 150 mg/dL and total cholesterol ≥ 200 mg/dL). Atherogenic risks were calculated with three indexes: Atherogenic Index of Plasma (AIP) as Log10 (TG/HDL-c); total cholesterol/HDL-c ratio and LDL-cholesterol/HDL-c ratio [26]. Individuals with Total cholesterol/HDL-c ratio > 5 or LDL-cholesterol/HDL-c ratio > 4 were considered at high risk of CVD. Nutritional status was defined based on BMI [27] using World Health Organization cut-off points as: normal weight (18.5 - 24.9 kg/m$^2$), overweight (25 - 29.9 kg/m$^2$) and obesity (≥30 kg/m$^2$). Criteria for fat location and adiposopathy included: waist circumference ≥ 102 cm in men or ≥88 cm in women defined abdominal obesity and Waist to Hip ratio (WHR) was used to define global or general obesity [25]. Normal-weight individuals were excluded at this stage.

### 2.8. Statistical Analysis

Results were expressed as Mean ± standard deviation. Frequencies and prevalence were expressed as percentages. Statistical package for social sciences (SPSS) for Windows 20.0 was used for analysis of data. Descriptive analysis included the estimation of mean values and standard deviations for continuous variables. Categorical variables were presented as frequencies and Chi square test was used for comparisons. Continuous variables were compared with Student *t* test and one way analysis of variance (ANOVA) followed by a Bonferroni test as post-hoc test. The odds ratios (OR) adjusted for sex, age at 95% confidence intervals (CI) for triglyceridemia, hypercholesterolemia and atherogenic indexes were determined using multivariable logistic regression model. Body fat, BMI, and waist circumference were expressed as independent variables. All tests were two-sided and statistical significance was set at $p < 0.05$.

## 3. Results

### 3.1. Study Population

Out of 2500 eligible participants, 20.56% (514) were excluded from the study, because they didn't meet the inclusion criteria. One thousands nine hundred and eighty six (1986) individuals were included and consented to participate (**Figure 1**). According to BMI categories defining nutritional status, 544 (27.4%), 616 (31%), and 826 (41.6%) individuals were ($p = 0.04$) normal-weight, overweight and obese, respectively.

The general characteristics of the study population are summarized in **Table 1**. Participants were relatively young men (36.08 ± 0.59 years, n = 609, 30.7%) and women (36.13 ± 0.37 yrs, n = 1377, 69.3%); giving a gender ratio (M/F) of 0.44. Women had the highest mean BMI values, body fatness and waist circumference. There was no difference found with diastolic Blood pressure and insulin levels of men compared to women. Also, it was observed that 11.1% of men consumed alcohol at least once a month compared to 2.4% women.

## 3.2. Lipid Profile and Atherogenic Index in Nutritional Subgroups

**Table 2** shows the mean concentrations of total cholesterol (TC), HDL cholesterol (HDLc), LDL cholesterol (LDL-c) and triglycerides (TG) in defined subgroups: normal-weight, overweight and obesity. It was observed that mean values of triglycerides, total cholesterol and LDL cholesterol were within the reference range set for North Americans. However, compare to normal-weight, obese individuals had significantly higher levels of total cholesterol (158.20 mg/dL vs 146.90 mg/dL; $p < 0.05$) and LDL cholesterol (108.46 mg/dL vs 92.28 mg/dL $p < 0.05$). A different trend was observed with triglyceride and HDL-c levels, which were lower ($P < 0.05$) among obese than normal-weight individuals. In addition, Total Cholesterol and HDL-Cholesterol were higher in obese women than men ($p < 0.05$). Atherognic index of plasma (AIP) was higher in obese compared to

**Table 1.** General characteristics of the study population.

| Parameters | Men | Women | p-values |
|---|---|---|---|
| Sample size | 609 (30.70%) | 1377(69.30%) | 0.001 |
| Age (years) | 36.08 ± 0.59 | 36.13 ± 0.37 | 0.06 |
| Body Mass Index (kg/m$^2$) | 25.68 ± 0.18 | 30.43 ± 0.19 | 0.001 |
| Body fatness (%) | 20.91 ± 0.35 | 38.80 ± 0.26 | 0.001 |
| Waist circumference (cm) | 83.84 ± 0.53 | 91.96 ± 0.47 | 0.001 |
| Systolic BP (mmHg) | 125.50 ± 10.25 | 129.02 ± 9.50 | 0.03 |
| Diastolic BP | 81.78 ± 14.97 | 83.21 ± 15.49 | 0.06 |
| Heart rate (pulse/min) | 75.97 ± 12.10 | 71.18 ± 12.70 | 0.23 |
| Hip circumference (cm) | 109.87 ± 17.12 | 99.31 ± 12.52 | 0.04 |
| Waist to hip ratio (WHR) | 0.83 ± 0.09 | 0.86 ± 0.08 | 0.05 |
| Glycaemia (mg/dL) | 94.72 ± 11.70 | 91.52 ± 6.35 | 0.26 |
| Insulin (mIU/L) | 13.26 ± 1.77 | 10.16 ± 2.47 | 0.17 |
| Alcohol consumption | 68 (11.1%) | 33 (2.4%) | 0.04 |

Results are expressed as mean ± standard deviation, BP: Blood pressure, WHR: waist to hip ratio.

Table 2. Lipid profile and atherogenic index in BMI categories.

| BMI categories | Population (n = 1986) | Men (n = 609) | Women (n = 1377) |
|---|---|---|---|
| **Triglycerides (mg/dL)** | | | |
| Normal-weight | 97.75 ± 2.88 | 98.00 ± 6.89 | 96.92 ± 2.79 |
| Overweight | 86.42 ± 2.35 * | 83.70 ± 2.23** | 89.15 ± 3.59* |
| Obese | 91.89 ± 2.00* | 90.50 ± 2.26* | 93.02 ± 4.71 |
| **Total Cholesterol (mg/dL)** | | | |
| Normal weight | 146.90 ± 2.26 | 143.77 ± 3.06 | 150.03 ± 2.24 |
| Overweight | 149.69 ± 2.33 | 145.90 ± 8.4 | 153.49 ± 4.17* |
| Obese | 158. 20 ± 2.20** | 152.30 ± 5.96* | 164.11 ± 2.06**[a] |
| **HDL-Cholesterol (mg/dL)** | | | |
| Normal weight | 39.55 ± 1.02 | 37.72 ± 1.22 | 41.38 ± 1.02 |
| Overweight | 37.33 ± 0.90* | 39.28 ± 1.79 | 35.38 ± 0.90* |
| Obese | 34.94 ± 0.89* | 32.26 ± 1.88* | 37.62 ± 0.78**[a] |
| **LDL-Cholesterol (mg/dL)** | | | |
| Normal-weight | 92.28 ± 2.42 | 90.36 ± 3.21 | 94.20 ± 2.37 |
| Overweight | 98.24 ± 2.39 | 102.11 ± 4.28* | 94.37 ± 2.51 |
| Obese | 108.46 ± 5.28* | 104.75 ± 2.25** | 112.17 ± 2.08** |
| **Atherogenic Index of Plasma (AIP)** | | | |
| Normal-weight | 0.39 ± 0.21 | 0.42 ± 0.14 | 0.37 ± 0.09 |
| Overweight | 0.37 ± 0.12 | 0.33 ± 0.10*a | 0.40 ± 0.26 |
| Obese | 0.42 ± 0.15* | 0.44 ± 0.17* | 0.39 ± 0.12* |

Values are expressed as Mean ± SD; **P < 0.01 compared to normal weight individuals; *p < 0.05 compared to normal-weight individuals; a. P < 0.05 in comparison between women and men.

overweight and normal individuals.

### 3.3. Determination of the Prevalence of Dyslipidemia and High Atherognic Risk

The prevalence of hypercholesterolemia, hypertriglyceridemia and mixed hyperlipidemia determined among overweight and obese of the study population were relatively low: 19.30%, 11.64%, and 3.40%, respectively. Mixed hyperlipidemia was not associated to the gender (Table 3). Despite low levels of LDL-c, the prevalence of cardiovascular risk was high in the population between 37.50% to 40.30% for TC/HDL-c > 5 and LDLc/HDL-c > 4, respectively. It was also observed a very high prevalence of low HDL cholesterolemia (75.4%); higher in women than men. The cardiovascular risk was high with both indexes LDL-C/C-HDL > 4 (37.5%) and TC/ HDL-c > 5 (40.30%).

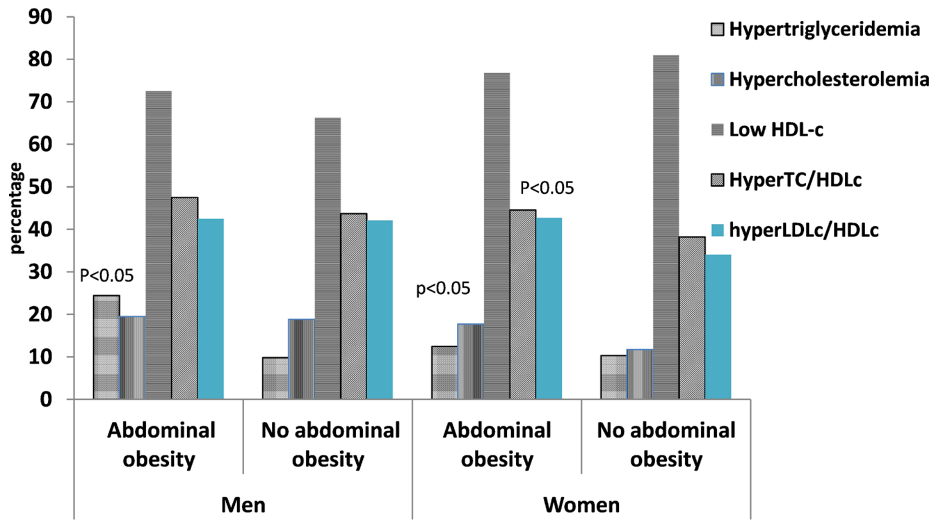
### 3.4. Dyslipidemia and Fat Location or Adiposopathy

The prevalence of dyslipidemia profiles according to fat location is shown in Figure 2. It was observed that prevalence of hypertriglyceridemia in abdominal

Table 3. Prevalence of lipid abnormalities in obese and overweight individuals.

| Dyslipidemia profiles | Population (n = 1431) | Men (n = 319) | Women (n = 1112) |
|---|---|---|---|
| Hypertriglyceridemia(TG ≥ 150 mg/dL) | 11.64 | 10.38 | 12.90[a] |
| Hypercholesterolemia (TC ≥ 200 mg/dL) | 19.30 | 16.83 | 21.77[a] |
| Low HDL-cholesterol level (HDL-c < 40 mg/dL in men and < 50 mg/dL in women) | 75.4 | 69.76 | 81.04[a] |
| Mixed dyslipidemia (TC ≥ 200+ TG ≥ 150) | 3.40 | 3.3 | 3.5 |
| T C /HDL-c > 5 | 40.30 | 40.48 | 40.12 |
| LDL- c/HDL-c > 4 | 37.50 | 35.12 | 39.88 |

a. P < 0.01 in comparison between women and men; Results are expressed as percentage (%).




HDL-c: High Density Lipoprotein Cholesterol; Low Density Lipoprotein Cholesterol; CT: Total Cholesterol

Figure 2. Distribution of dyslipidemia according to fat location.

obesity was 2.5 times higher in men (24.4%) compared ($p < 0.01$) to individuals with generalized fat distribution or global obesity (9.80%). However, there was no difference ($p > 0.05$) in prevalence of triglyceridemia of women with abdominal obesity compared to men with total obesity. Hypercholesterolemia was found in 17.7% obese women with abdominal obesity, significantly higher compared to 11.7% found in obese women with total obesity. It has also been observed that independently of fat location and gender, low HDL-cholesterol was predominant in the study population. Prevalence of cardiovascular risk evaluated with two atherogenic indexes revealed an elevated risk ($p = 0.03$) with visceral accumulation of fat both in men and in women.

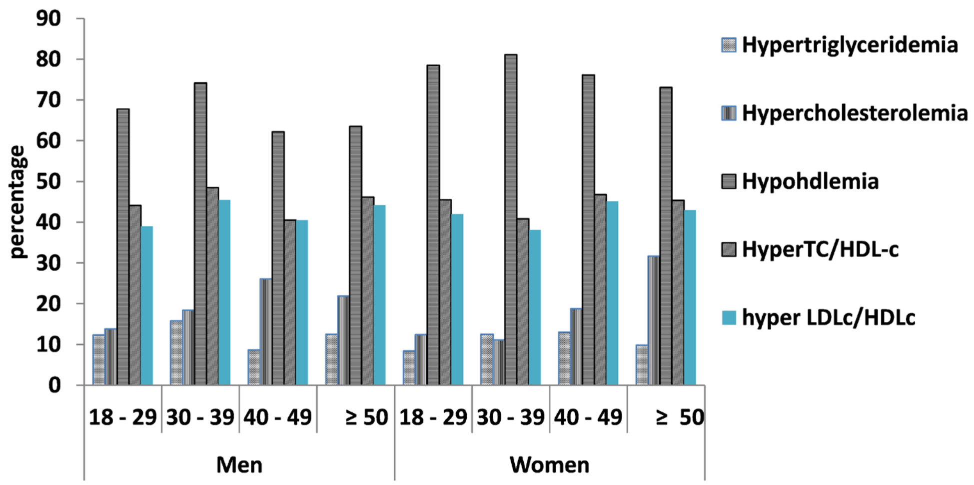
## 3.5. Variation of Dyslipidemia Profile with Age and Gender

It appears that independently of fat location, Low HDL-cholesterolemia remains the commonest dyslipidemia in the study population. Its prevalence was higher in men younger than 39 years (74.2%) compared ($p < 0.01$) to those above 39

(62.2%), while amongst women, the prevalence is higher as from 20 years (78.5%). Similar trend was observed with prevalence of cardiovascular risk. Higher atherogenic indexes were observed amongst individuals aged > 50 years (P > 0.05). Furthermore, men aged 30 - 39 years had significantly (p < 0.05) higher frequency of hypertriglyceridemia than men of other age groups, while higher frequency of hypercholesterolemia was observed in men aged 40-49 years, but in women (p < 0.05) older than 50 years (Figure 3).

### 3.6. Association between Anthropometric Parameters, Dyslipidemia and Atherogenic Risk

Following the assessment of the anthropometric parameters involved in the development of lipid abnormalities, univariate regression analyses revealed that increase of one unit of body mass index (1 kg/m$^2$), increase 1.034 time the risk to develop hypercholesterolemia. However, after age and gender adjustment, it appears in univariate analysis that BMI, WC, BF were strongly associated with hypertriglyceridemia and high atherogenic risk, meanwhile only Body mass index (BMI) and waist circumference (WC); but not body fatness (BF) were associated with hypercholesterolemia. Waist circumference was the main prediction factor in hypercholesterolemia and even remained as the only variable influencing the model in multivariate analyses adjusted for age and gender (Table 4).




HDL-c: High Density Lipoprotein Cholesterol; Low Density Lipoprotein Cholesterol; CT: Total Cholesterol.

**Figure 3.** Distribution of dyslipidemia according age and gender.

**Table 4.** Association between markers of obesity and lipid abnormalities.

| Variable | Hypertriglyceridemia OR (CI 95%) | Hypercholesterolemia OR (CI 95%) | High CT/CHDL OR (CI 95%) | High LDL-c/HDL-c OR (CI 95%) |
|---|---|---|---|---|
| BMI (kg/m$^2$) | 1.07 (1.04 - 1.09)* | 1.03 (1.01 - 1.06)* | 1.03 (1.01 - 1.05)* | 1.02 (1.01 - 1.04)* |
| Body fat (%) | 1.04 (1.02 - 1.06)* | 1.02 (1.00 - 1.03)$^{\$}$ | 1.02 (1.00 - 1.03)* | 1.02 (1.01 - 1.03)* |
| WC (cm) | 1.03 (1.019 - 1.04)* | 1.019 (1.10 - 1.03)* | 1.012 (1.01 - 1.02)* | 1.01 (1.01 - 1.02)* |

OR: odd ratio; CI: Confidence Interval; *p < 0.01; $ p < 0.1, BMI: Body mass index, WC: Waist circumference.

## 4. Discussion

Cardiovascular diseases and metabolic disorders including obesity, diabetes and their relationship with dyslipidemia have been poorly documented in Cameroon. Data published have been obtained from patients in hospital centers only [27] [28]. The present study reports on larger sample of apparently healthy participants, recruited randomly in Yaounde. The study population was made of relatively young individuals (**Table 1**) with men aged 36.08 ± 0.59 years, and women aged 36.13 ± 0.37 years. Up to seventy-two (72.6%) individuals (31% overweight and 41.6% obese) displayed pattern of malnutrition by excess vs 27.4% of normal-weight. This study revealed that levels of triglycerides, Total cholesterol and LDL-cholesterol were higher in obese than overweight and normal-weight individuals (**Table 2**). Increase of lipid markers with increasing BMI was in accordance with findings of Niroumand *et al.* [29] in Iranian population. From normal-weight to obese, lipid values obtained were relatively low when compared to other populations [25] [30]. This result is in accordance with Taga findings (2004) [31] on Cameroonian and supported by Glew *et al.* [32] who reported lower lipid profile amongst Africans compared to Caucasians [33].

Change in anthropometry due to fat accumulation, is accompanied with disturbances of lipid metabolism called dyslipidemia [17]. Normal-individuals have normal proportions of lean and fat tissues, this justifies their exclusion in the assessment of dyslipidemia. Dyslipidemia in the study was characterized by relatively low prevalence of hypercholesterolemia (19.3%), hypertriglyceridemia (11.64%) and mixed hyperlipidemia (3.40%) contrasting with very high prevalence of low HDL-c (75.4%, $p = 0.01$) in both men and women (**Table 3**). Prevalence of hypertriglyceridemia was low compared to 32.5% found in Mexican American populations by Aguilar-salinas *et al.* [34]. Hypercholesterolemia was also lower than the 44% reported by Mac Lean *et al.*, [35] in Canada. Another finding from US National Health Nutrition survey 2003-2006 population reported high prevalence of high LDL-c (27%), Low HDL-C (23%) and high triglyceridemia and mixed dyslipidemia 21% [21] [36]. Disparities of genetic (ethnic), environmental and lifestyle can explain differences in prevalence. Predominance of low HDL-c was found high in the population at all age (**Figure 3**). This result confirms the study of Moor *et al.* [28] carried out on 264 patients in hospital based survey in Yaounde. Hypertriglyceridemia was observed in Men aged 30 - 39 years; hypercholesterolemia in those aged group 40 - 49 years. Amongst women of above 50 years, hypercholesterolemia was prevalent probably due to oestrogen disturbances and to post-menopausal status [37] [38] [39].

Visceral obesity has been associated to sick fat or adiposopathy develops due to ectopic fat accumulation when the adipose tissue cannot longer expand [40]. Abdominal fat has been associated to hypercholesterolemia, hypertriglyceridemia, lower HDL-C levels (**Figure 2**) and increased risk of cardiovascular diseases and complications [41] [42]. However, in the present study, low HDL-c was also predominant in the population, independently of fat location (**Figure 3**), even though regression analysis established waist circumference as the main variable in all dyslipidemia (**Table 4**) as previously demonstrated [43] [44]. The adnormally low level of HDL-cholesterol alters the entire lipid metabolism HDL-c is involved in the transfer of the excess cholesterol, which is further catabolized and excreted in the bile [17] [45] reducing its level. In addition, low level of HDL-cholesterol may compromise oxidative status and the immune system of an individual, given its proved anti-oxidative capacity, antithrombotic and anti-inflammatory properties [46] [47]. Low HDL-c has also been shown to strongly correlated atherogenic or CVD risks [17] as an independent predictor [48] [49] and probably justifies the high prevalence of atherogenic risk observed in this study. The prevalence high of low HDL-c amongst overweight and obese of this population is consequently responsible of the high prevalence of atherogenic risk (40.3%), in both men and women, at all age (**Figure 3**) and independently of the fat location (**Figure 2**); atherognic indexes LDL-c/HDL-c, TC/HDL-c, Log (TG/HDL-c) being mathematical relationship of lipid markers are strongly associated to increase risk of cardiovascular diseases [29] [50] such as carotid intima-media thicknesses and coronary artery disease [51] [52].

It is important to notice that this study is conducted on participants with no diabetes and no hypertension, all things that make them apparently healthy. However, such individuals characterized by predominance of Low HDL-c, are susceptible of developing a frank metabolic syndrome in the future (over 10 years) as proved by many researchers [53] [54] [55]. Therefore, strategies for prevention and surveillance should be encouraged by Cameroonian government, in order to extend life expectancy and reduce the incidence of CVD. In addition to lifestyle changes including diet, exercise, weight loss, smoking cessation to improve HDL-c levels [18] [56], implementation of therapeutic measures with statins or in combination with niacin should be accompanied by a supplementation of nutrition/diet with fruits, plants, herbs, spices; all rich antioxidant sources [17] [57].

## 5. Limitations of the Study

Enrollment of participants by public announcement was likely to develop a selection of adherents who do not reflect the general universe of the Yaounde adult population. Also, lack of reports on physical activities and eating patterns of participants limited discussion of results presented.

## 6. Conclusion

Low HDL-cholesterolemia (75.4%) was found to be the most common feature of metabolic syndrome present in both genders, at all age amongst Cameroonian adults with feature of malnutrition by excess living in Yaoundé. Low HDL-cholesterolemia also impacts on high cardiovascular risk (40.3%). Therefore, promotion of healthy lifestyle, including good eating habits shall be encouraged by authorities to increase HDL-c level and reduce mortality from cardiovascular disease complications.

## Acknowledgements

This work was partially supported by the Cameroon Ministry of Higher Education in the form of research modernization allowance granted to some investigators.

## Consent for Publication

Not applicable.

## Availability of Data and Material

Data and material are available upon request.

## Funding

Not applicable.

## Authors' Contributions

HCMY and BGKA conceived, designed the study and drafted the manuscript; BGKA, DK and FRN coordinated data collection and performed statistical analyses; HCMY, MWN, BRTT and JTN collected field data and conducted laboratory analyses; JLN and JO supervised the work, drafted and approved the final version of the manuscript.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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