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Metabolic Abnormalities and Metabolic Syndrome among Cameroonian Women: Comparative Study between Pre- and Post-Menopausal Women

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Abstract

The high prevalence of non-communicable diseases is a challenging problem in the Cameroonian population and women are the most affected. The aim of the present study was to determine and compare the prevalence of metabolic abnormalities and metabolic syndrome (MetS) among pre- and post-menopausal women living in urban areas in Cameroon. A total of 499 women were recruited during a mass health campaign in 2018. Metabolic abnormalities were diagnosed using International Diabetes Federation (IDF) criteria. MetS was defined using IDF criteria with slight modification (total cholesterol used instead of HDL cholesterol). Logistic regression was used to estimate the association between menopausal status and metabolic abnormalities and MetS in age control and non-control models. The prevalence of high waist-to-hip ratio (56.8% vs 36.3%, p < 0.001), elevated fasting blood glucose (glycemia ≥ 100 mg/dL) (38.7% vs 26.9%, p = 0.006); diabetes (14.6% vs 5.7%, p = 0.001); high triglycerides level (29.7% vs 17.1%, p = 0.002); hyperlipidemia (high total cholesterol and or triglycerides levels) (45.0% vs 30.8%, p = 0.002); and elevated blood pressure (67.9% vs 56.1%, p = 0.007) were higher among post-menopausal than pre-menopausal women. The overall prevalence of MetS was 30.1% and post-menopausal women were more affected (33.8% vs 25.0%; p = 0.034). The odds ratio of MetS was 1.888 (95% CI: 1.016 - 3.507) when age was covariate, but was slightly reduced without age control (OR = 1.532; 95% CI: 1.031 - 2.275). Metabolic abnormalities seem to be a major

health problem among Cameroonian women and menopausal status increased the risk of developing a cardiovascular event.

Keywords

Metabolic Abnormalities, MetS, Menopausal Status, Cameroonian Women

1. Introduction

Metabolic syndrome (MetS) is a constellation of factors that promote the development of cardiovascular diseases (CVD), diabetes mellitus type 2 and all-cause mortality [1] [2]. The prevalence of MetS is increasing worldwide and African populations are not spared with female populations more affected as compared to males [3] [4] [5]. This prevalence of the MetS increases with menopause and may partially explain the apparent increase in CVD after menopause [6]. Previous studies have shown that MetS and CVD are more common in women above 55 years of age with significant increase in individual risk factors in the post-menopausal phase [7] [8]. However, controversy exists about whether menopause increases the risk of CVD independent of normal aging. Some studies have demonstrated increased risk of CVD after menopause and others have not [9] [10] [11]. Menopause with its incidental hormonal changes appears to increase the risk of CVD independently of normal aging. Also, premenopausal women may be protected against CVD compared to men and postmenopausal women of a similar age group suggesting that estrogen deficiency causes a rapid acceleration in CVD risk [12]. Moreover, many of the features of the MetS (central obesity and dyslipidemia with elevated TG, reduced HDL, and small dense LDL particles) emerge with estrogen deficiency in postmenopausal women, which may explain the acceleration of CVD in women after menopause [6]. It has been reported that menopause is closely related to insulin resistance and cardiovascular risk factors [13]. But the influence of menopause on blood pressure (BP) is difficult to evaluate because menopause coincides with aging. Some studies have reported a strong association between BP and menopause, but others not [10] [11]. However, the emergence of metabolic risk factors in post-menopausal phase may be a direct result of ovarian failure with estrogen deficiency. Decrease in estrogen production is thought to be responsible for a substantial proportion of increased cardio-metabolic risk factors in post-menopausal women [14]. Changing hormonal milieu with decreasing estrogen and alteration of its ratio to testosterone has been implicated as a causal factor for the emergence of MetS at menopausal transition [15] [16]. In fact, menopausal status is accompanied by unfavorable levels of cardiovascular risk factors, like changes in body fat, distribution from gynoid to android pattern, abnormal plasma lipids, increased sympathetic tone, endothelial dysfunction, vascular inflammation and increased blood pressure [17]. The causal effect of menopause on MetS is still unclear even

if few studies have investigated the effect of menopause on the development of the MetS independently of age [14] [16] [18] [19] [20]. To our knowledge, there are few studies [21] on the effect of menopause on the development of MetS and data on an association between the MetS and menopausal status among Cameroonian women are very scarce or inexistent. The reason why the present study has been initiated aiming at evaluating and comparing the prevalence of MetS and its individual components among a set of pre and post-menopausal women living in urbanized areas.

2. Methodology

2.1. Description of Population and Area of Study

During nutritional surveys organized by the Cameroon Nutritional Society in 2018 in some urbanized cities of Cameroon (Nkongsamba, Foumban, Maroua, Dschang), Cameroonian women aged 35 years and above were randomly recruited and categorized according to their hormonal status obtained using questionnaire. Women were defined as post-menopausal if they had reported their last menses to be at least 12 months prior to the survey meanwhile pre-menopausal were defined as such if they had an unchanged and regular menstrual pattern during the last five years, without typical climacteric complaints [22]. Pregnant, lactating, under contraceptive or hormone replacement therapy (HRT) women, as well as those who had undergone menopause due to hysterectomy or cessation of periods other than by a natural cause were excluded from the study. Those under any treatment against metabolic diseases were also excluded.

2.2. Sample Size Determination

At the end of the nutritional survey, 642 women were recruited, 30 were pregnant, 37 were lactating, 71 were under contraceptive, 05 had undergone a hysterectomy. A total of 499 apparently healthy women regrouped as pre-menopausal (n = 212, 35 - 48 years) and post-menopausal (n = 287; 42 - 70 years) were eligible and included to the study.

2.3. Questionnaire

A questionnaire inspired from "WHO steps instrument for chronic diseases" relative to age, menopausal status, main income, lifestyle habits (cigarette, alcohol, level of physical activities, fruits and vegetable consumption), parental and personal medical history of CVD, use of any medication was conceived and a pre-test was realized to test their validity and reliability prior to the survey. Under the assistance of well-trained and qualified interviewers, each woman was subjected to a face-to-face interview using the validated questionnaire.

2.4. Anthropometric Measurements

Weight was recorded to the nearest 0.1 kg using an electronic balance (Tanita™ BC-418 Segmental Body Composition Analyzer/Scale) to light clothing women.

Height was measured with a Harpended™ stadiometer to the nearest 0.1 cm. Waist circumference was taken at the mid-point between the bottom rib and the hip bone without restrictive garments and hip circumference was measured as the maximum circumference at the level of the buttocks. All measurements were recorded to the nearest cm using a flexible non-expandable tape measure. Waist-to-hip ratio (WHR) was computed as well as Body mass index (BMI) using the formula: BMI = Weight (kg)/Height^2 (m) and expressed in kg/m^2.

2.5. Arterial Blood Pressure Measurements

Three measurements of BP were taken with an Automatic Blood Pressure Monitor with Heart Sense$^®$ (Samsung) in a sitting position. The first measurement was taken after a 10 minutes rest in a sitting position and was followed by two subsequent measurements in the middle and at the end of the interview. The average of the three measurements was used to assess the presence or absence of elevated blood pressure.

2.6. Blood Sampling

After a 12-hours overnight fast, about 4 ml of venous blood was collected in EDTA tubes by venipuncture in the hand of each woman. The plasma was obtained by centrifugation of the collected sample and aliquots were frozen at −20˚C for further biochemical analyses.

2.7. Biochemical Analyses

Fasting blood glucose was the first parameter to be measured at the beginning of the activities of the survey by the Glucose Oxidase-Peroxydase (GOP-POD) method [23] using a glucometer (GlucoPlusTM) and glucose test strips (GlucoPlusMD). Total cholesterol [24] and triglycerides [25] levels were performed by standard enzymatic spectrophotometric methods using ChronoLab Diagnostic Kits in the laboratory.

2.8. Ethical Considerations

The Helsinki declaration on medical ethics was respected. Approvals were obtained from the National Ethics Committee and all the participants gave their consent prior to enrolment to the survey.

2.9. Diagnosis of Metabolic Abnormities and MetS

Nutritional status was evaluated using WHO criteria as follows: overweight was defined as a BMI between 25 - 29.9 kg/m^2 and obesity as a BMI ≥ 30 kg/m^2 [26]. Abdominal obesity was diagnosed with a waist circumference ≥ 80 cm [27]. Concerning glucose metabolic abnormalities, prediabetes and diabetes were diagnosed with a fasting blood glucose level between 110 - 125 mg/dL and ≥ 126 mg/dL respectively according to WHO definition [28]. Women with Systolic BP ≥ 130 mmHg and or Diastolic BP ≥ 85 mmHg were considered as having ele-

vated BP according to NCEP ATP III criteria [29]. Meanwhile, those with Systolic BP ≥ 140 mmHg and or Diastolic BP ≥ 90 mmHg were classified as hypertensive [30]. For lipid disturbances, women with total cholesterol level ≥ 200 mg/dL and or triglycerides level ≥ 150 mg/dL were considered hyperlipidemic [29]. The MetS was diagnosed using IDF criteria [27] which has been shown to be the more appropriate for the Cameroonian population [31]. This IDF definition is based on waist circumference ≥ 80 cm and two or more of any of the following: fasting triglycerides level ≥ 1.5 mg/dL; fasting HDL cholesterol < 50 mg/dL; SBP ≥ 130 mmHg and/or DBP ≥ 85 mmHg; fasting blood glucose level ≥ 100 mg/dL. Since total cholesterol has been shown to be directly related to mortality from coronary heart diseases even in populations with low cholesterol concentrations, we used total cholesterol (≥200 mg/dL) instead of HDL-C as previously reported in other studies [32] [33].

2.10. Data Analyses

Data were entered in Excel spread sheet and double checked for errors. Statistical analyses were done using Statistical Package for Social Sciences (SPSS) 20.0 for Windows. Descriptive analysis results were presented as mean values ± standard deviations for continuous variables or as percentage for categorical variables. Student t-test was performed to compare continuous variables while Chi-square test was used to compare categorical variables between pre and post-menopausal women. Logistic regressions were performed to evaluate the risk of developing metabolic abnormalities and MetS. Two types of models were used: the first model was the crude model without any adjustment and the second model was adjusted for age (age as covariate). Moreover, pre-menopausal women were taken as reference group. For p-values ≤ 0.05 results were considered as statistically significant.

3. Results

3.1. Description of the Study Population

The general description of the study population presented in Table 1 shows that among the 499 women recruited, 211 (42.5%) were pre-menopausal and 287 (57.5%) were post-menopausal. According to marital status, 72.2% were in a relationship while 27.8% were not living in couple. A proportion of 6.6% of participants were smokers. For alcohol consumption, 32.9% were abstainers, 59.3% were moderate and 7.8% were heavy alcohol consumers. The family history of a CVD was positive in 30.5% of participants. As concerns eating habits, 48.3% and 63.1% of participants were low vegetable and fruit consumers respectively with no statistical difference between pre and post-menopausal women with the Chi-square test. Participants were classified into two groups according to their level of physical activities and 34.1% of them had low level of physical activities versus 65.9% with moderate level of physical activities. Regarding sources of income, it was noted that 59.4% of women had their income from assistance, 11% had a

Table 1. General Characteristic of the study population.

		Overall n = 499 (%)	Pre-menopausal n = 212 (42.5%)	Post-menopausal n = 287 (57.5%)	P-value
Marital status	Single	32 (6.4)	18 (8.5)	14 (4.9)	<0.001
	Maried	360 (72.2)	186 (82.0)	186 (64.8)	
	Widowed/divorced	107 (21.4)	87 (9.5)	87 (30.3)	
Source of income	Assistance	296 (59.4)	140 (66.2)	156 (54.3)	0.018
	Permanent	55 (11.0)	27 (12.9)	28 (9.9)	
	Temporary	148 (29.6)	45 (20.9)	103 (35.8)	
Tobacco use	Yes	6.6 (33)	3.8 (8)	8.7 (25)	0.081
Alcohol consumption	Abstainers	164 (32.9)	60 (28.1)	104 (32.2)	0.108
	Moderate	296 (59.3)	134 (63.4)	165 (56.5)	
	High	39 (7.8)	18 (8.5)	21 (7.3)	
Family history of	HTN	104 (20.9)	48 (22.9)	56 (19.7)	0.429
	Diabetes	74 (14.8)	31 (14.6)	43 (15.0)	0.950
	CVD	152 (30.5)	70 (33.0)	82 (28.5)	0.330
Fruits consumption	Low	315 (63.1)	122 (57.7)	193 (67.2)	0.1210.
	Regular	184 (36.9)	90 (42.3)	94 (32.8)	
Vegetable consumption	Low	241 (48.3)	118 (55.5)	123 (42.8)	0.286
	Regular	258 (51.7)	94 (44.5)	164 (57.2)	
Level of physical activities	Low	170 (34.1)	84 (39.7)	86 (29.9)	0.069
	Moderate	329 (65.9)	128 (60.3)	201 (70.1)	

permanent income while 29.6% had a temporary salary with a significant difference between pre and post-menopausal women (Table 1).

3.2. Anthropometric, Clinical and Biochemical Characteristics of the Study Population

Table 2 presents anthropometric, biochemical and hemodynamic characteristics of the study population stratified by menopausal status. The mean age (56.06 ± 6.90 years), SBP (139.17 ± 25.07 mmHg), DBP (87.23 ± 16.42 mmHg), WHR (0.86 ± 0.11), glucose level (106.54 ± 39.22 mg/dL) and triglycerides level (114.55 ± 66.42 mg/dL) were significantly higher among post-menopausal women meanwhile heart rate (80.07 ± 13.28 pulse/min) and hip circumference (107.89 ± 13.32 cm) were significantly higher in the pre-menopausal group.

3.3. Prevalence of Metabolic Abnormalities and Metabolic Syndrome According to Menopausal Status

Concerning metabolic abnormalities, results presented in Table 3 showed that post-menopausal women were the most affected by impaired glucose level (glycemia ≥ 100 mg/dL) (38.7%), diabetes (14.6%), hyperlipidemia (45.0%), high

Table 2. Anthropometric, biochemical and hemodynamic characteristic of the study population.

	Overall	Pre-menopausal	Post-menopausal	P-value
Age (years)	49.87 ± 9.21	41.50 ± 3.64	56.06 ± 6.90	0.0001
BMI (kg/m^2)	28.04 ± 6.53	28.20 ± 6.67	27.92 ± 6.44	0.631
SBP (mmHg)	134.14 ± 24.38	127.34 ± 21.69	139.17 ± 25.07	0.0001
DBP (mmHg)	85.57 ± 16.57	83.33 ± 16.55	87.23 ± 16.42	0.009
Pulse (pulse/min)	77.33 ± 13.82	80.07 ± 13.28	75.75 ± 13.91	0.002
Waist (cm)	89.78 ± 15.06	89.76 ± 13.03	89.79 ± 16.18	0.982
Hip (cm)	105.76 ± 13.86	107.89 ± 13.32	104.47 ± 14.04	0.016
WHR	0.85 ± 0.10	0.83 ± 0.08	0.86 ± 0.11	0.009
Blood glucose level (mg/dL)	102.14 ± 36.14	96.20 ± 30.60	106.54 ± 39.22	0.001
TC (mg/dL)	158.69 ± 68.14	156.77 ± 68.66	160.25 ± 67.80	0.594
TG (mg/dL)	106.80 ± 73.25	97.21 ± 80.06	114.55 ± 66.42	0.014

WHR: waist-to-hip ratio, TC: Total cholesterol, TG: triglycerides.

Table 3. Prevalence of metabolic abnormalities and MetS among pre- and post-menopausal women.

Metabolic abnormalities	Overall n (%)	Pre-menopausal women n (%)	Post-menopausal women n (%)	P-value[a]
Overweight (BMI ≥ 25 kg/m^2)	318 (63.9)	138 (65.1)	180 (62.9)	0.620
Overweight (BMI: 25 - 29.9 kg/m^2)	146 (29.4)	60 (28.3)	86 (30.0)	0.981
Obesity (BMI ≥ 30 kg/m^2)	172 (34.6)	78 (36.8)	94 (22.8)	0.416
High waist circumference (WC ≥ 80 cm)	259 (56.6)	106 (56.4)	153 (56.7)	0.952
High waist-to-hip ratio (WHR ≥ 0.80)	240 (48.1)	77 (36.3)	163 (56.8)	< 0.001
Hyperglycemia (Blood glucose level ≥ 100 mg/dL)	168 (33.7)	57 (26.9)	111 (38.7)	0.006
Prediabetes (110 - 125 mg/dL)	75 (15)	33 (15.6)	42 (14.6)	0.857
Diabetes (glycemia ≥ 126 mg/dL)	54 (10.8)	12 (5.7)	42 (14.6)	0.001
Hyperlipidemia (hyper TC and or hyper TG)	170 (38.6)	61 (30.8)	109 (45.0)	0.002
Hypercholesterolemia (TC ≥ 200 mg/dL)	81 (18.4)	32 (16.2)	49 (20.2)	0.271
Hypertriglyceridemia (TG ≥ 150 mg/dL)	104 (24.1)	33 (17.1)	71 (29.7)	0.002
Elevated blood pressure (SBP ≥ 130 mmHg and/or DBP ≥ 85 mmHg)	314 (62.9)	119 (56.1)	195 (67.9)	0.007
Hypertension (SBP ≥ 140 mmHg and/or DBP ≥ 90 mmHg)	230 (46.1)	89 (42.0)	141 (49.1)	0.113
MetS	150 (30.1)	53 (25.0)	97 (33.8)	0.034

Results were expressed as percentage (%) and number of participants (n). a = p-value obtained by chi-square test

triglycerides level (29.7%), elevated blood pressure (67.9%) and HTN (49.1%) compared to pre-menopausal women (P < 0.05). The most frequent metabolic abnormality among post-menopausal women was elevated blood pressure meanwhile overweight (BMI ≥ 25 kg/m^2) was the most frequent metabolic abnormality among pre-menopausal women. The prevalence of MetS was 30.1% in the overall study population and post-menopausal women remained more affected with 33.8% versus 25% for pre-menopausal women (p = 0.034) (Table 3).

3.4. Risk of Developing Metabolic Abnormalities and Metabolic Syndrome with or without Age Adjustment

Table 4 shows odds ratio (OR) and 95% confidence interval (CI) of metabolic abnormalities and MetS among post versus pre-menopausal women in two models: the first without age as covariate and the second with age as covariate. Under age control, post-menopausal women were more likely to be overweight (BMI ≥ 25 kg/m^2) (OR = 1.900 95% CI: 1.034 - 3.489) and have high waist circumference (2.1 times) but this was attenuated and became non-significant without age control. The observation was not the same for high TG level and MetS where risk were 2.3 and 1.8 times respectively with age control and were slightly reduced but remained significant without age control (OR = 2.049 and

Table 4. Odd ratio of metabolic abnormalities and MetS among post-menopausal unadjusted and adjusted to age.

Metabolic abnormalities	Pre-menopausal	Post-menopausal OR (95% CI) Without age control	P-value	Post-menopausal OR (95% CI) with age control[a]	P-value
Overweight (BMI ≥ 25 kg/m^2)	1	0.911 (0.629 - 1.319)	0.620	1.900 (1.034 - 3.489)	0.039
Overweight (BMI: 25 - 29.9 kg/m^2)	1	1.013 (0.650 - 1.580)	0.981	1.844 (0.850 - 4.000)	0.121
Obesity (BMI ≥ 30 kg/m^2)	1	1.205 (0.789 - 1.839)	0.416	1.989 (0.991 - 3.994)	0.053
High waist circumference (WC ≥ 80 cm)	1	1.012 (0.695 - 1.473)	0.952	2.117 (1.150 - 3.896)	0.016
High waist-to-hip ratio (WHR ≥ 0.80)	1	2.201 (1.436 - 3.375)	<0.001	1.396 (0.723 - 2.694)	0.320
Elevated fasting blood glucose (glycemia ≥ 100 mg/dL)	1	1.715 (1.166 - 2.522)	0.006	1.226 (0.991 - 1.056)	0.510
Prediabetes (glycemia 110 - 125 mg/dL)	1	1.047 (0.635 - 1.726)	0.857	0.817 (0.360 - 1.857)	0.630
Diabetes (glycemia ≥ 126 mg/dL)	1	2.879 (1.468 - 5.646)	0.001	2.135 (0.813 - 5.607)	0.124
Hyperlipidemia (high TC and or high TG)	1	1.841 (1.241 - 2.729)	0.002	1.174 (0.937 - 3.320)	0.079
High TC (TC ≥ 200 mg/dL)	1	1.317 (0.806 - 2.153)	0.271	0.889 (0.410 - 1.972)	0.742
High TG (TG ≥ 150 mg/dL)	1	2.049 (1.285 - 3.266)	0.002	2.384 (1.160 - 4.903)	0.018
Elevated blood pressure (SBP ≥ 130 mmHg and or DBP ≥ 85 mmHg)	1	1.656 (1.147 - 2.392)	0.007	1.233 (0.680 - 2.235)	0.490
Hypertension (SBP ≥ 140 mmHg and or DBP ≥ 90 mmHg)	1	1.335 (0.933 - 1.909)	0.113	1.065 (0.610 - 1.888)	0.829
Metabolic syndrome	1	1.532 (1.031 - 2.275)	0.034	1.888 (1.016 - 3.507)	0.044

BMI: Body Mass Index; TC: total cholesterol; TG: triglycerides; OR: odds ratio; CI: confidence interval; a: age was inserted as a continuous variable in a Multivariate logistic regression. The Odds ratio (OR) of developing metabolic abnormalities was evaluated among post-menopausal women comparatively to pre-menopausal women considered as reference group.

1.53 respectively). After age-adjustment, the risk of high waist-to-hip ratio, hyperglycemia, diabetes and hyperlipidemia were attenuated and became non-significant (Table 4).

4. Discussion

CVD remains one of the main causes of mortality worldwide and MetS increases the risk of CVD as well as morbidity of the disease. Studies have shown that women are at a lesser risk of developing CVD than their male counterparts before menopause, but this advantage is abolished after menopause. Also, female coronary heart diseases (CHD) morbidity rates accelerate more quickly than do those of males after the age of 45 years [34]. The present study, which aims at evaluating and comparing the effect of menopausal status on the outcome of metabolic abnormalities and MetS suggested that Cameroonian menopausal women were more at risk of CVD than pre-menopausal women. According to Kim *et al.* study on Korean women, post-menopausal women had significantly higher WC, SBP, pulse pressure, total cholesterol, LDL cholesterol, and triglyceride levels than pre-menopausal [19]. These observations were similar to our results (except for WC) where means of SBP, DBP, WHR, glucose and triglycerides levels were significantly higher among post-menopausal than pre-menopausal women (Table 2). During menopause, the pattern of hormone secretion changes and gradually causes fat accumulation in visceral tissues of abdomen and as a result central obesity. Estrogen promotes the accumulation of gluteo-femoral fat and the loss of estrogen with menopause is associated with an increase in central fat [35]. Also, the loss of ovarian function results in adverse changes in lipoprotein profile, glucose and insulin metabolism, body fat distribution, coagulation, fibrinolysis and vascular endothelial dysfunction [36] [37].

The assessment of metabolic abnormalities revealed an increased prevalence of impaired glucose level (glycemia $\geq$ 100 mg/dL) (38.7%), diabetes (14.6%), hyperlipidemia (45.0%), high triglycerides level (29.7%), elevated blood pressure (67.9%) and HTN (49.1%) among post-menopausal compared to pre-menopausal women (P < 0.05) (Table 3). Results in Table 4 also confirmed increasing risk of some metabolic abnormalities among these post-menopausal participants. These results were consistent with many other studies [19] [38] [39] [40]. Ben Ali *et al.* [18] found that, except for hypertriglyceridemia, the frequency of central obesity, hyperglycemia, high blood pressure, and high total cholesterol level was significantly higher among post-menopausal than pre-menopausal Tunisian women. Jesmin *et al.*, [14] noted that prevalence of high blood pressure, elevated fasting blood glucose and high triglycerides level was significantly higher in post-menopausal women than pre-menopausal women (P < 0.05) among rural women in Bangladesh. Lack of estrogen is the main cause of these metabolic alterations. Apart from maintaining friendly lipid profile, estrogen changes the vascular tone by increasing nitrous oxide production. It stabilizes the endothelial cells, enhances antioxidant effects and alters fibrinolytic protein [41] [42]. In ad-

dition, estrogen engages several mechanisms that protect against HTN, such as activation of the vasodilator pathway mediated by nitric oxide and prostacyclin and inhibition of the vasoconstrictor pathway mediated by the sympathetic nervous system and angiotensin [43]. All these cardioprotective mechanisms are lost in menopause and post-menopausal women develop an increased risk for CVD as consequence [44].

As concerns the clustering of metabolic abnormalities known as MetS, the present study revealed that post-menopausal women (33.8%) were significantly more affected than pre-menopausal women (25%) (p = 0.034) (Table 3). This was also confirmed by results in Table 4. Post-menopausal women were 1.5 (95% CI: 1.031 - 2.275) times at risk of MetS compared to pre-menopausal women (reference group) in an unadjusted model, but when adjusted to age, the risk increased and became 1.9 times (95% CI: 1.016 - 3.507). The prevalence of MetS among post-menopausal women (33.8%) was higher than 16.5% (NCEP ATP III definition) obtained by Mandob *et al.*, [21] among a group of 206 post-menopausal women in Yaounde (Cameroon). The present results are in accordance with Ben Ali *et al.* study who found that Tunisian post-menopausal women (45.7%) were more affected by MetS than premenopausal women (25.6%) [18]. Jesmin *et al.* also noted that 39.3% of post-menopausal women had MetS as compared to pre-menopausal (16.8%) rural women in Bangladesh [14]. Additionally, the overall prevalence of MetS was 30.1% (Table 3). This prevalence was lower than 46.1% found by Marbou and Kuete [45] among Cameroonian women living in the West Region. The difference could be attributed to MetS definition used, in their study, they used standard IDF criteria while in our study, HDL was replaced by total cholesterol.

5. Conclusion

Our results show that post-menopausal status might be a predictor of metabolic abnormalities and metabolic syndrome. Thus, special attention needs to be paid to this group of population to reduce the outcome of cardiovascular events.

Limitations

Some limitations need to be mentioned. Firstly, an association derived from a cross-sectional study does not necessarily indicate causality. Secondly, menopausal status was self-reported and could have recall bias. Thirdly, total cholesterol was used instead of HDL-cholesterol assayed through the precipitation method which is known for its large variability.

Authors' Contributions

NFR designed the study plan and drafted the questionnaire; NFR, MAMA, AKBG, NWM, TTBR, MMO collected data and performed biochemical analysis; NFR analyzed the data and wrote the manuscript, NJL and OJE supervised the overall procedure. All authors read and approved the final manuscript.

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Conflicts of Interest

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

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