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Metabolic Syndrome and Associated Factors Among HIV-infected Patients at Bafoussam Regional Hospital, Cameroon

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Abstract: The use of highly active antiretroviral therapy (HAART) transformed HIV infection to a chronic disease, and the complexity of the physiological disorders generated leads to the disruption of body fat distribution and insulin resistance. The resulting metabolic syndrome has rarely been investigated among people living with HIV/AIDS in Cameroon. The aim of the current work was to determine the prevalence of metabolic syndrome and associated factors among people living with HIV/AIDS under HAART at the Bafoussam Regional Hospital in Cameroon. A retrospective, cross-sectional study was conducted to collect demographic, clinical and therapeutic data from 371 people living with HIV/AIDS and who are under HAART at the Bafoussam Regional Hospital from November 2017 to February 2019. Abbott Real-time HIV-1 system, FACSCOUNT cytometer and FULLYSMART automates were used to determine HIV RNA level, CD4 cell count and biochemical parameters respectively. The metabolic syndrome was defined according to the International Diabetes Federation (IDF) and the National Cholesterol Education Program -Adult Treatment Panel III (NCEP-ATPIII) criteria. The overall prevalence of metabolic syndrome was 37.74% by IDF and 28.84% by ATPIII. Among patients with metabolic syndrome, HDL-hypocholesterolemia was the most prevalent feature (92.14%). We found that aging (OR, 1.05; p, 0.005), HIV RNA level (OR, 3.42; p, 0.001), family history of metabolic and coronary heart disease (OR, 2.24; P, 0.04), alcohol consumption (OR, 4; P, 0.004) and nutritional supplements (OR, 3.5; P<0.001) were the independent predictors of metabolic syndrome. Male sex (OR, 0.22; p,<0.001), use of traditional medicines (OR, 0.28; P<0.001), Cotrimoxazole prophylaxis (OR, 0.45; p, 0.007) and Lamivudine-Tenofovir-Efavirenz antiretroviral regimen (OR, 0.26; p<0.001) were protective factors. The prevalence of metabolic syndrome is on the increase among people living with HIV/AIDS in our study population. Both HIV related factors and traditional risk factors were associated with metabolic syndrome.

Keywords: Metabolic Syndrome, People Living with HIV/AIDS, HAART, Traditional Risk Factors

1. Introduction

Metabolic syndrome has become a public health issue with the westernization of lifestyles [1]. It is a condition that regroups a set of risk factors for type II diabetes and cardiovascular diseases, starting with a pro-inflammatory condition, visceral adipogenesis and insulin resistance [2, 3]. Two definitions of metabolic syndrome are used worldwide and all include the following metabolic disorders: high blood glucose level, high triglyceride level, low HDL cholesterol level, high blood pressure and obesity [1].

During HIV infection, metabolic co-morbidities including components of metabolic syndrome have been observed [4, 5]. Indeed, HIV infection is characterized by chronic activation of the immune system, progressive destruction of lymphoid tissue architecture with disturbances of the intestinal microbiota and chronic systemic inflammation [6, 7]. Furthermore, micronutrient deficiencies that promote an inflammatory state and adipogenesis have been generally reported during HIV infection [8, 9]. More important, high burden of risk factors for coronary disease including lipodystrophies, dyslipidemia and hypertension, have been reported among HIV patients receiving or not antiretroviral treatments [10, 11].

Although HAART has significantly reduced mortality and morbidity associated with HIV infection, it is also responsible for toxicities ranging from simple grade 1 or 2 intolerance to long-term life-threatening side effects [12, 13]. Dysmetabolic protease inhibitors (PIs) are associated with dyslipidemia and insulin resistance [14, 15]. Reverse transcriptase inhibitors have sometimes been associated with metabolic disorders; they are associated with impaired mitochondrial function, manifested by an increase in blood lactate levels [16, 17]. Stavudine is most frequently involved [14].

According to previous studies, the prevalence of metabolic syndrome among PLWHA, particularly those under HAART, is increasing [14, 16]. The treatment protocol for PLWHA recommends systematic monitoring of metabolic complications. In Cameroon, limited financial resources do not allow systematic monitoring of all these complications in HIV care centres and very limited studies has been done to assess the impact of metabolic syndrome and the associated factors among PLWHA, while prescription of metabolically neutral drugs and healthy lifestyles should improve life quality of these patients. We hypothesized that certain treatment regimens and lifestyles would be associated with a high prevalence of metabolic syndrome in our study population of PLWHA. In the present study we aimed to assess the prevalence of metabolic syndrome in HIV-infected patients at a major hospital designated for HIV care in West region of Cameroon and to evaluate the association between the use of two main drug regimens made up of PIs, nucleoside reverse transcriptase inhibitors (NRTIs) and non-nucleoside reverse transcriptase inhibitors (NNRTIs) and traditional risk factors with the development of metabolic syndrome.

2. Materials and Methods

2.1. Study Design and Ethical Consideration

This is a retrospective, cross-sectional study that took place from November 2017 to February 2019 in the HIV care centre of BRH. It was approved by the National Committee on Research Ethics for Human Health (reference number: 2017/11/955/EC/CNERSH/SP) and was conducted in accordance with the Declaration of Helsinki on Good Clinical Practice. Participants gave written informed consent. They were all part of the national cohort of PLWHA and were regularly followed up by physicians of HIV care centre of Bafoussam Regional Hospital (BRH) according to the national treatment guidelines for adults with HIV infection. They were recruited base on the following inclusion criteria: have a complete medical record, being HIV-positive on HAART for at least 12 months, be between 18 and 55 years old, have no history of co-infection with hepatitis B or C viruses, do not receive any other form of chemotherapy except Cotrimoxazole, do not use contraceptive hormones. The exclusion criteria were as follows: pregnancy, incomplete measurement and laboratory test results, willingness of the patient to withdraw from the study at any stage.

2.2. Data Collection

The data collection was carried out during routine visits of patients with the assistance of physicians in charge of their follow-up and laboratory technicians of BRH. A standardized questionnaire and patient medical records were used to investigate the therapeutic history, demographic, clinical, and other associated factors of metabolic syndrome including dietary habits. Demographic (gender, age, ethnicity, place of residence, occupation), therapeutic history (post-exposure prophylaxis, HAART regimens, traditional treatment), lifestyles and dietary habits (consumption of food supplements, tobacco, alcohol, carbohydrate, fat and protein intakes assessed from a simplified consumption frequency questionnaire) were recorded. Therapeutic compliance was assessed using Morisky's standardized questionnaire [18]. Physical activity was evaluated using the International Physical Activity Questionnaire [19] and special reports of the American College of Sports Medicine and the American Heart Association [20]. The duration of HIV infection and that of HAART and medical history were obtained from the patient's medical record. HAART was determined through the recording of the last 12 months and defined as the use of at least three agents from three classes of ARVs agents according to the national treatment guidelines for adults with HIV infection; NRTIs, PIs and NNRTIs.

2.2.1. Measurement of Anthropometric Parameters

All anthropometric measurements were performed by a single investigator and in accordance with WHO standards [21]. Height was measured to the nearest 0.5 cm, with the participant standing without shoes, heels together and head in the horizontal plane using a height gauge. Weight was measured to the nearest 0.1 kg using a SECA scale. The waist

circumference was taken to the nearest 0.5 cm. It was measured midway between the lower margin of the ribs and the iliac crest in the horizontal plane. Body mass index (BMI) was calculated as weight in kg divided by the square of the height in m. Blood pressure was taken with an OMRON electronic sphygmomanometer (M6, Japan). After the patient reached HIV care for his medical examination and rested for at least 10 min, two measurements were taken at 10 min intervals on the right arm with the patient seated. The average of the measurements was calculated and used in the analyses.

2.2.2. Measurement of Biological Parameters

Total cholesterol, HDL-cholesterol, LDL-cholesterol, triglycerides and glycemia were measured using 12 hours fasting blood through a biochemical analysis robot (FULLYSMART, Japan) by colorimetric methods. HIV RNA level and CD4 cell count were measured using the Abbott m2000rt Real-Time HIV-1 system (CA, USA) (limit of detection, 40 copies/mL) and the FACSCOUNT cytometer (Becton Dickinson, USA) respectively. All assay have been validated by quality control.

2.3. Definition of Metabolic Syndrome

The definition of the International Diabetes Federation (IDF) [1] and that of the National Cholesterol Education Program-Adult Treatment Panel III (NCEP-ATP III) [22] were used. According to the IDF criteria, metabolic syndrome involves; a waist circumference ≥ 94 cm for men and ≥ 80 cm for women, or a BMI ≥ 30 Kg/m^2 for the population of sub-Saharan Africa (mandatory criterion) with two other of the following criteria: blood pressure $\geq 130/85$ mmHg, fasting blood glucose ≥ 1 g/L, fasting triglyceridemia ≥ 1.50 g/L and HDL cholesterolemia<0.40 g/L (men) and<0.50 g/L (women) or specific treatments. According to the ATPIII criteria, the presence of at least 3 of the 5 aforementioned biological parameters is required with the waist circumference threshold ≥ 102 cm (men) and ≥ 88 cm (women).

2.4. Statistical Analysis

The data were analysed using EPI Info version 7.1.5. We were able to derive frequencies and proportions from the descriptive analysis, logistic regressions allowed us to determine factors associated with metabolic syndrome. A significance level of 0.05 and a relative risk value compared to one (1) allowed us to conclude on the relationship between the dependent variable and the independent variables of the study.

3. Results

3.1. Socio-demographic and Clinical Characteristics of Patients

The univariate analysis excluding the 5 IDF criteria for metabolic syndrome showing socio-demographic and clinical characteristics of the studied population are presented in Table 1. 99% of the population participated in more than 150 minutes of weekly walking. Bamileke ethnic group represented 60.92% of the population, urban dweller 59% and night workers 16.71%. The high majority of patients 324 (87.33%) were currently receiving HAART regimens including two NRTIs and one NNRTIs while 90.29% of patients were receiving dietary advice. Patients in this study tended to be older, with 270 patients (72.78%) being over 40 years. Patients with age ≥ 40 years also had a significantly higher frequency of metabolic syndrome (p=0.01). We noticed a predominance of women 267 (71.97%) with a sex ratio W/M of 2.6. Women also had a significantly high frequency of metabolic syndrome (p<0.001). Patients not receiving Cotrimoxazole prophylaxis (p=0.002) and patients receiving nutritional supplements (p=0.003) had a significantly high frequency of metabolic syndrome. Alcohol consumers (p=0.004), day-worker (p=0.001) and patients with a family history of metabolic and coronary heart diseases were more likely to have metabolic syndrome (p<0.001).

Furthermore, patients with a duration of HIV infection and duration of HAART more than 6 years (P=0.01 and p=0.008 respectively), HIV RNA level > 40 copies/mL (p=0.03), CD4 cell count > 350 cells/mm^3 (p=0.04), patients who had started HAART at stage I of HIV infection (p=0.002) and patients receiving antiretroviral regimens including PIs (p=0.009), were more at risk of metabolic syndrome. Nevertheless, compared with patients receiving antiretroviral regimens including Efavirenz, those receiving Nevirapine were more likely to have metabolic syndrome (p<0.001). Additionally, a significantly high proportion of patients with poor treatment compliance had metabolic syndrome (p=0.04).

3.2. Biological Characteristics of Patients

The prevalence of metabolic syndrome and its individual components are shown in table 2. The overall prevalence of metabolic syndrome were 37.74% and 28.84% according to IDF and ATP III criteria, respectively. The prevalence of individual components were shown to be: high waist circumference 68.46% (36.34% men and 80.90% women) using IDF threshold value, low HDL-cholesterol levels 64.15% (44.23% men and 71.91% women), high fasting glucose levels 40.6% (with 14.82% diabetes), high triglyceride levels 36.66% and, high blood pressure 33.42%. 29.11% of patients had no metabolic abnormality, 8.36% had one metabolic abnormality, 24.80% had two metabolic abnormalities, 21.83% had three metabolic abnormalities, 7.00% had four metabolic abnormalities and 8.89% had five metabolic abnormalities.

3.3. Factors Associated with Metabolic Syndrome

The results of the logistic regression of factors associated with metabolic syndrome are shown in Table 3. After multivariate analysis, alcohol consumption, aging, family history of metabolic and coronary heart disease, consumption of nutritional supplements and detectable HIV RNA level were the independent predictors of metabolic syndrome. While, 3TC-TDF-EFV regimen, use of traditional medicines, Cotrimoxazole prophylaxis and male sex appear as protective

factors against metabolic syndrome.

Table 1. *Socio-demographics and clinical characteristics of the study population according to metabolic syndrome status.*

Variables	Modalities	All patients N=371 N (%)	Metabolic syndrome n	%	No metabolic syndrome N	%	P value
Sex	Men	104 (28.06)	18	17.31	86	82.69	<0.001
	Women	267 (71.97)	122	45.69	145	54.31	
Age	<40	101 (27.22)	28	27.72	73	72.28	0.01
	≥ 40	270 (72.78)	112	41.48	158	58.52	
Ethnic group	Bamileke	226 (60.92)	91	40.27	135	59.73	0.21
	Other	145 (39.08)	49	33.79	96	66.21	
Residence	Rural	152 (40.97)	61	40.13	91	59.87	0.43
	Urban	219 (59.03)	79	36.07	140	63.93	
Family history of MCHD	Yes	173 (46.63)	81	46,82	92	53.18	<0.001
	No	198 (53.40)	59	29.8	139	70.2	
Work time	Day	309 (83.29)	126	41.72	176	58.28	0.001
	Night	62 (16.71)	14	20.29	55	79.71	
Physical activity (min/week)	≥ 150	368 (99.19)	139	37.77	229	62.23	/
	<150	3 (0.81)	1	3.33	2	66.67	
Dietary advice	Yes	335 (90.29)	115	34.33	220	65.67	<0.001
	No	36 (9.71)	25	69.44	11	30.55	
Fruit and vegetable	≤ 4/day	336 (90.57)	128	38.10	208	61.90	0.66
	> 4/day	35 (9.43)	12	34.29	23	65.71	
Nutritional supplement	Yes	74 (19.95)	39	52.70	35	47.30	0.003
	No	297 (80.05)	101	34.01	196	65.99	
Meat	White meat only	38 (10.24)	14	36.84	24	63.16	0.90
	All	333 (89.76)	126	37.84	207	62.16	
Fat	Refined oil only	44 (11.86)	16	36.36	28	63.64	0.84
	All	327 (88.14)	124	37.92	203	62.08	
Sugar	Slow only	51 (13.75)	25	49.02	26	50.98	0.07
	All	320 (86.25)	115	35.94	205	64.06	
Smoking	Yes	65 (15.52)	25	38.46	40	61,54	0.89
	No	306 (82.48)	115	37.58	191	62.42	
Alcohol	Yes	41 (11.05)	24	58.54	17	41.46	0.004
	No	330 (88.95)	116	35.15	214	64.85	
HIV screening context	Routine	101 (27.22)	47	46.53	54	53.47	0.19
	Illness	209 (56.33)	71	33.97	138	66.03	
	Pregnancy	61 (16.44)	22	36.07	39	63.93	
Stage at the HAART initiation	Stage I	154 (41.51)	72	46.75	82	63.25	0.002
	Stage II	94 (22.64)	30	35.71	54	64.29	
	Stage=> III	133 (35.85)	38	28.57	95	71.43	
Duration of HIV infection	[1-2] years	63 (16.98)	16	25.40	47	74.60	0.01
	[3-5] years	41 (11.05)	11	26.83	30	73.17	
	[6--] years	267 (71.97)	114	42.70	153	57.30	
Duration of HAART	[1-2] years	80 (21.56)	20	25.00	60	75.00	0.008
	[3-5] years	57 (15.36)	22	38.60	35	61.40	
	[6--] years	234 (63.07)	98	41.88	136	58.12	
CD4 cell count (cells/mm^3)	≤ 350	52 (14.01)	13	25.00	39	75.00	0.04
	> 350	319 (85.99)	127	39.81	192	60.19	
HIV RNA level (copies/mL)	≤ 40	222 (59.84)	74	33.33	148	66.67	0.03
	> 40	149 (40.16)	66	44.30	83	55.70	
Antiretroviral regimens	Use of NNRTIs	324 (87.33)	114	35.19	210	64.81	0.009
	Use of PIs	47 (12.67)	26	55.32	21	44.68	
3TC-TDF-EFV	Yes	245 (66.04)	75	30.61	170	69.39	<0.001
	No	126 (33.96)	65	51.59	61	48.41	
3TC-TDF-NVP	Yes	44 (11.86)	28	63.64	16	36.36	<0.001
	No	327 (88.14)	112	34.25	215	65.75	
3TC-AZT-NVP	Yes	28 (7.55)	8	28.57	20	71.43	0.30
	No	343 (92.45)	132	38.48	211	61.52	
3TC-TDF-LPV/r	Yes	17 (4.58)	6	35.29	11	64.71	0.83
	No	354 (95.41)	134	37.85	220	62.15	
3TC-AZT-LPV/r	Yes	11 (2.96)	8	72.73	3	27.27	0.025
	No	360 (97.04)	132	36.67	228	63.33	
3TC-TDF-ATV	Yes	13 (3.50)	9	69.23	4	30.77	0.03
	No	358 (96.50)	131	36.59	227	63.41	
Cotrimoxazole	Yes	208 (56.06)	64	30.77	144	69.23	0.002
	No	163 (43.94)	76	46.63	87	53.37	

Variables	Modalities	All patients N=371	Metabolic syndrome		No metabolic syndrome		P value
		N (%)	n	%	N	%	
Traditional medicines	Yes	143 (38.54)	46	32.17	97	67.83	0.08
	No	228 (61.46)	94	41.23	134	58.77	
HAART compliance	Good	99 (26.68)	29	29.29	70	70,71	0.04
	Poor	272 (73.32)	111	40.81	161	59.19	

MCHD: metabolic and coronary heart disease; 3TC: Lamivudine; TDF: Tenofovir; EFV: Efavirenz; NVP: Nevirapine; AZT: Zidovudine; LPV/r: Lopinavir boosted with Ritonavir; ATV: Atazanavir; NNRTIs: non-nucleoside reverse transcriptase inhibitors, PIs: Protease inhibitors.

Table 2. *Biological characteristics of the study population.*

Variables	Modalities	patients (n)	Percentage (%)
Blood Pressure (mmHg)	≥ 130/85	124	33.42
	<130/85	247	66.58
BMI (Kg/m^2)	<25	113	30.46
	≥ 25<30	158	42.59
	≥ 30	100	26.95
Glycemia (g/L)	<1	222	59.84
	≥ 1<1.26	94	25.34
	≥ 1.26	55	14.82
Triglyceride (g/L)	<1.5	235	63.64
	≥ 1.5	136	36.66
Total Cholesterol (g/L)	<2	267	71.97
	≥ 2	104	28.04
LDL Cholesterol (g/L)	<1.6	322	86.79
	≥ 1.6	49	13.21
HDL Cholesterol (g/L)			
Men	≤ 0.4	46	44.23
	> 0.4	58	55.77
Women	≤ 0.5	192	71.91
	> 0.5	75	28.09
ATPIII Waist Circumference (cm)			
Men	<102	91	87.5
	≥ 102	13	12.5
Women	<88	87	32.58
	≥ 88	180	67.42
IDF Waist Circumference (cm)			
Men	<94	66	63.44
	≥ 94	38	36.34
Women	<80	51	19.1
	≥ 80	216	80.9
Metabolic Syndrome score	0	108	28.84
	1	31	8.36
	2	92	24.80
	3	81	21.83
	4	26	7.00
	5	33	8.89
Metabolic syndrome prevalence			
IDF	/	140	37.74
ATPIII	/	107	28.84

BMI: body mass index; LDL: low density lipoprotein; HDL: high density lipoprotein: IDF: International Diabetes Federation: ATP III: Adult Treatment Panel III.

Table 3. *Logistic regression of factors associated with metabolic syndrome.*

Variable	Odd Ratio (95% CI)	P value
Age	1.05 (1.02-1.09)	0,005
Sex (Men/Women)	0.22 (0.1-0.45)	<0.001
Family history of MCHD (Yes/No)	2.24 (1.28-3.92)	0.004
Nutritional supplements (Yes/No)	3.5 (1.75-7)	<0.001
HIV RNA level > 40/≤ 40)	3.42 (1.92-6.95)	0.001
Alcohol (Yes/No)	4 (1.54-10.94)	0.004
Traditional medicines (Yes/No)	0.28 (0.14-0.54)	<0.001
Cotrimoxazole (Yes/No)	0.45 (0.25-0.8)	0.007
3TC-TDF-EFV (Yes/No)	0.26 (0.12-0.57)	<0.001

CI: confidence interval; MCHD: metabolic and coronary heart disease; 3TC: Lamivudine; TDF: Tenofovir; EFV: Efavirenz.

4. Discussion

We found a high prevalence rate of metabolic syndrome and its associated risk factors in the study population compared with reported prevalence among different groups of people in the general population in Cameroon. However, the prevalence rate was similar to that of a study conducted earlier on a well-matched population of HIV-infected people using IDF criteria [23]. Traditional factors, HAART and HIV-related factors were associated with metabolic syndrome.

Among the 371 patients involved in this study, we found the predominance of women, usually described in the population of PLWHA [24]. Demographic and several other socio-cultural factors could be an explanation [25]. Contrary to the observation during the decades of the beginning of the pandemic where young adults were more heavily affected by HIV [26], this study is consistent with the finding of Mapoure *et al*. [24] with the predominance of adults over 40 years. The quality of upstream response systems, which determines the epidemiological evolution of HIV disease, could explain this trend towards an aging population of PLWHA [27].

Considering either IDF or ATP III criteria, the prevalence rate of metabolic syndrome and its individual components were high in the study population compared with those reported in different groups of Cameroonian HIV-uninfected [28, 29]. However, there was a significantly low prevalence rate of metabolic syndrome by ATP III criteria (28.84%) compared with the prevalence rate by IDF criteria (37.74%) in the present work. On the other hand, the work conducted by Dimodi *et al*. [23] among PLWHA showed prevalence of metabolic syndrome very close to our results. Some patients with metabolic syndrome according to ATP III criteria had no metabolic syndrome as per IDF criteria in the present study. This result was not consistent with the observation made by Elgalib *et al*. [15]. The observe discrepancy revealed the importance of the criteria adopted for estimating the prevalence rate of metabolic syndrome in a given population.

In this study, a HIV RNA level > 40 copies/mL was found to be a predicting factor of metabolic syndrome [OR 3.42 (1.92 - 6.95); p=0.001]. Previous evidence indicates an association that can be modified by HAART between viral replication and CD4 cell count [30], on the other hand Bernal *et al*. [31] have reported a positive association between metabolic syndrome and an undetectable HIV RNA level.

HAART has already been pointed out to explain the high prevalence rate of metabolic disorders in PLWHA [14-16]. However HAART was not an independent predictor of metabolic syndrome in the present study. Our observation is consistent with a previous report from Brazil [32]. Nevertheless, the antiretroviral regimen 3TC-TDF-EFV was positively associated with metabolic syndrome [OR, 0.26 (0.12-0.57); p,<0.001]. 3TC-TDF-EFV including metabolic neutral ARVs compound [30] is the first intention antiretroviral regimen mostly prescribed at the HIV care centre of BRH and this could explain this result.

An important finding in this work was the association of traditional medicines with metabolic syndrome as a protective factor [OR, 0.28 (0.14-0.54); p,<0.001], probably due to the wide range of health benefits attributed to the herbal drugs. Cotrimoxazole prophylaxis was a protective factor against metabolic syndrome [OR, 0.45 (0.25-0.8); p, 0.007], this might be due to the fact that, this antibiotic is prescribed to almost all immunological non-responders to prevent the occurrence of opportunistic co-morbidities that exacerbates inflammatory response during HIV infection [33].

Age was an independent predictor of metabolic syndrome [OR, 1.05 (1.02- 1.09) p, 0.005]. Previous evidence indicates high prevalence of metabolic disorders in aging people [13, 32]. Gender remains a highly controversial factor associated with metabolic syndrome due to unmatched socio-demographic characteristics involved in different studies. The high sex ratio (W/M) in our study population could justify the male sex appearing in this study as an important protective factor against metabolic syndrome [OR, 0.22 (0.1-0.45); p<0.001]. On the other hand, female sex had been reported as predicting factor of metabolic syndrome in many studies in Africa [23, 34].

Family history of metabolic and coronary heart disease was an independent predictor of metabolic syndrome in this study [OR, 2.24 (1.28-3.92); p, 0.004]. This finding is substantiate with a previous report [29]. The place of residence, ethnic group and smoking were not independent predictors of metabolic syndrome as reported by many authors [29, 35]. Adherence by 90% of the participants in this study to the nutritional education program as part of their follow-up at BRH would explain this result. However, strong association of alcohol consumption with metabolic syndrome in this study [OR, 4 (1.54-10.94); p, 0.004] is consistent with the literature [32, 34].

Another important finding in this study was that, the nutritional supplement was negatively associated with metabolic syndrome [OR, 3.5 (1.75-7); p,<0.001]. Nutritional supplements (classified as probiotics and prebiotics) are modulators of the intestinal microbiota and, involved in lipids, carbohydrates and proteins metabolism [36].

This study was confronted with several limitations. Firstly, some ethnic groups of participants had insufficient number of patients required for statistical analysis and we considered the Bamileke ethnic group on the one hand, and all other ethnic groups on the other hand. Moreover, the predominance of women in this study would influence the association between the metabolic syndrome and gender. Secondly, the prescription of antiretroviral drugs in fixed-dose combinations did not allow the confirmation of the independent effect of a specific class of ARVs. In addition, a previous history of antiretroviral treatment may not be complete in many patients who were referred from other hospitals. Therefore the effects of antiretroviral drugs on metabolic syndrome may have been underestimated in our study. Thirdly, insufficient information on the probiotic and prebiotic values of the foods used by patients in the formulation of nutritional supplements, as well as the plants used to prepare the decoctions consumed by our

patients limited the interpretation of the results. Fourthly, the internationally standardized questionnaires for assessing physical activity do not objectively define moderate and vigorous effort; therefore, the farm work that was one of the activities of almost all participants in this study, and that we considered vigorous physical effort may have been overestimated.

5. Conclusion

In conclusion, we were able to confirm the high prevalence rate of metabolic syndrome among HIV-infected patients at Bafoussam Regional Hospital in Cameroon. In this study, we found that Both HIV related factors and traditional factors are associated with metabolic syndrome. This work particularly highlights the association of the nutritional supplements and the traditional medicines with metabolic syndrome which appears as a pathological situation of multifactorial etiology and we recommend its systematic monitoring among all PLWHA.

Contributions of the Authors

J-RK, JPD, JMD and CWM participated in the design of study. JMD, CWM and AND collected the data. JMD, STL and EZM contributed to data analysis, interpretation and manuscript design. All authors contributed to the review and approved the final version.

Conflicts of Interest

All the authors do not have any possible conflicts of interest.

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