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Risk Factors Associated with Overweight and Obesity in HIV-Infected Cameroonian

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Abstract

Introduction: Multiple endocrine and metabolic abnormalities, particularly overweight and obesity, have emerged as significant global public health concerns. This paper examines the impact of these conditions on health outcomes and underscores the necessity for comprehensive strategies to address them. **Background:** Overweight and obesity have been observed in patients with human immunodeficiency virus (HIV) both before and after the initiation of antiretroviral therapy. This study investigates the risk factors associated with overweight and obesity in HIV-infected patients. **Methods:** A total of 492 HIV-infected patients, both treatment-naïve and those undergoing treatment, were recruited from Yaoundé Central Hospital in Cameroon. Demographic, anthropometric, and biochemical data were collected from each patient. Blood pressure and abdominal fat measurements were also taken. Metabolic syndrome was defined according to IDF criteria. Patients were categorized into two weight status groups: underweight/normal weight and overweight/obese. **Results:** The prevalence of overweight and obesity was found to be 27.5% and 8.5%, respectively, with only 6.1% of patients being underweight. Abdominal obesity, systolic/diastolic blood pressure, metabolic syndrome, and CD4 cell counts were associated with risk factors in overweight and obese patients. These parameters should be considered when investigating metabolic disorders in HIV-infected patients, as in the general population. **Conclusion:** Our study indicates a high risk of developing metabolic syndrome among overweight/

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obese individuals, who were 5.7 times more likely to have metabolic syndrome compared to those of normal weight/underweight. These findings support the hypothesis that overweight and obesity are also prevalent in HIV-infected patients and they are risk factors that have to be taken into consideration to better manage this issue. These results may provide essential information on the fact that being underweight is not the only issue to take into consideration in these patients but that overweight/obesity is now present. Prevention and management strategies should consider both aspects.

Keywords

Overweight/Obesity, HIV-Infected Patients, HIV-Related Factors, Sociodemographic and Biochemical Factors

1. Introduction

Obesity is an abnormal or excessive accumulation of body fat in adipose tissue caused by a continuous imbalance between an individual's energy intake and expenditure, which can be detrimental to health [1]. It is one of the leading causes of morbidity and mortality, and it is increasing exponentially worldwide. Overweight/obesity is an emerging problem in the general population, associated mostly with increased urbanization and Westernized lifestyles, which in turn have led to the emergence of a nutritional transition characterized by a shift to a higher-calorie diet [2]. Hence, it is an independent risk factor for cardiovascular disease (CVD) and one of the main causes of the increased risk of metabolic diseases such as dyslipidemia, insulin resistance, hypertension, and atherosclerosis [3]. Sub-Saharan Africa (SSA) is not at rest, with a double public health burden of communicable diseases (malaria, HIV/AIDS, and tuberculosis) and a rising incidence of non-communicable diseases (NCD), especially cardiovascular disease (CVD) [1].

Obesity is characterized by the abnormal or excessive accumulation of body fat in adipose tissue, resulting from a prolonged imbalance between energy intake and expenditure, which can negatively impact health. It is a leading cause of morbidity and mortality and is rising at an alarming rate worldwide. Overweight and obesity have become increasingly prevalent in the general population, largely due to urbanization and the adoption of Westernized lifestyles, which have driven a shift toward higher-calorie diets. Consequently, obesity has emerged as an independent risk factor for cardiovascular disease (CVD) and a major contributor to metabolic disorders such as dyslipidemia, insulin resistance, hypertension, and atherosclerosis. Sub-Saharan Africa (SSA) faces a dual public health burden, grappling with both communicable diseases (such as malaria, HIV/AIDS, and tuberculosis) and the growing incidence of non-communicable diseases (NCDs), particularly cardiovascular disease (CVD).

On the other hand, HIV itself can cause lipid abnormalities because the natural course of HIV infection is characterized by reductions in HDL cholesterol and

LDL cholesterol and by an increase in triglycerides (TG) [4]. However, the introduction of potent antiretroviral therapy (ART) has resulted in a dramatic reduction in morbidity and mortality associated with HIV people infected with HIV are now living longer. This longer lifespan has exposed them to the effects of aging and other host and environmental factors known to increase the risk of obesity, diabetes, and cardiovascular disease (CVD) in the general population [5]. This antiretroviral therapy also causes more pronounced atherogenic changes in lipid profile, including increases in TG, and LDL cholesterol, and decreases in HDL cholesterol [4].

In addition, HIV itself can cause lipid abnormalities, as the natural progression of HIV infection is typically associated with reduced levels of HDL cholesterol and LDL cholesterol, along with elevated triglycerides (TG). The introduction of potent antiretroviral therapy (ART) has significantly reduced HIV-related morbidity and mortality, allowing individuals with HIV to live longer. However, this extended lifespan exposes them to aging-related factors and other environmental influences that increase the risk of obesity, diabetes, and CVD, commonly among the general population.

All metabolic abnormalities due to HIV, accentuated by taking ARTs, as well as the obesogenic environment (high-fat diet and physical inactivity) in which these people live are at the origin of the increasing prevalence of overweight and obesity in this population [6]. The increase in weight among these people has been attributed to a condition of "return to health" in which appetite is gained and more food is consumed. This combined with reduced physical activity, contributes to the rise in obesity. [7].

Several studies across African countries are exploring this growing issue. For instance, in Kenya, a study of HIV-infected patients reported a higher prevalence of overweight in women (20.7%) compared to men (11%), indicating gender as a risk factor, particularly for abdominal obesity [8]. In South Africa, 36.4% of people on ART were found to be overweight, while 8.9% were underweight. In Eastern Nigeria, Anyanbolu *et al.* (2016) reported a high prevalence of overweight (38.4%) and obesity (21.5%) [9]. However, in Cameroon, research on the prevalence of overweight and obesity among HIV-infected individuals and their associated risk factors is limited. This study aims to identify the factors contributing to overweight and obesity, mostly the host factors, socio-demographic and biochemical factors in a cohort of HIV-infected patients in Cameroon.

2. Materials and Methods

2.1. Study Design

We performed a cross-sectional study from January to September 2010 in a cohort of HIV-infected patients coming for their checkup at the day Hospital of the Central Hospital in Yaoundé. This hospital is a reference for taking care of HIV-infected patients. It is a structure assigned for the management of HIV-infected patients including counseling, ART administration, and biochemical analyses. All patients willing to participate in the study have been allowed to pass through all the steps of the study, since they are a vulnerable population, any frustration can affect them psychologically. But after that, only the patients meeting our criteria have been included in the study (the inclusion and exclusion criteria section gives more details on that). Data were collected at one point in time for each participant. After giving their informed consent, all participants were asked to complete a self-administered pre-tested questionnaire with information regarding age, sex, level of education, marital status, profession, and characteristics related to HIV infection (ART duration, being on treatment or not); confirmation was done using medical records. The study involved men and women aged ≥20 years old and the presence of metabolic disorders was described according to the BMI.

2.2. Sample Size Determination

At the end of the data collection, 492 patients were interviewed. The sample size was calculated based on the prevalence of HIV-infected patients in Cameroon using the Magnani (1997) [10] formula:

$$n = \left(t^2 \times p\left(1 - p\right)\right) / m^2$$

where n is the required sample size; t is the 95% confidence interval (standard value of 1.96); p is the estimated prevalence of HIV in Cameroon (4.3%) [11], and m is the margin of error at 5% (standard value of 0.05). Thus, 64 subjects were obtained after calculations. However, considering a probable loss of about 10% of the sample and the huge population of HIV-infected patients hosted in the Central hospital in Yaoundé, a reference in taking care of HIV-infected patients, we focused on 500 participants, and 492 were obtained. The study was implemented in the Centre region of Cameroon.

2.3. Inclusion and Exclusion Criteria

Participants included in the study were HIV-infected patients coming to the Central Hospital of Yaoundé either for follow-up or to be enrolled as newly diagnosed HIV-infected patients. Each participant included in the study had met the following criteria: 1—had given informed consent; 2—was 20 years of age; 3—had come for a check-up at the day hospital of the central hospital of Yaoundé; 4—had lived in the city of Yaoundé and its surroundings. Those not included were: 1—Pregnant or breastfeeding women; 2—participants on medications that can affect carbohydrate and lipid metabolism; 3—seriously ill participants (bedridden or in terminal phase with AIDS); 4—with developmental disabilities.

2.4. Ethics Approval and Consent to Participate

The Cameroon National Ethics Committee for Research on Human Health approved the study at N˚138/CNE/SE/09 and the Ministry of Public Health at D30 47/AAR/MINSANTE/SG/DROS/CRC/CEAI. Jan 2010. An approval letter was obtained from the hospital authority (the General Manager). Informed written consent was obtained from the individual respondents before the beginning of the research. It was explained to them the voluntary nature of their participation, their freedom to withdraw from the study at any time, the confidentiality and privacy measures maintained by assigning a code to each participant, and venous blood collection. The participants with more severe conditions of obesity were referred to the endocrine unit of the same hospital. The study protocol and conduct adhered to the principles of the Declaration of Helsinki.

2.5. Study Questionnaire

A structured questionnaire based on the WHO's STEPwise instrument for chronic diseases v 2.1. was used to collect socio-demographic data (age, sex, educational level, marital status), HIV characteristics (ART status (on treatment or not) and ART duration), smoking status, alcohol consumption, and level of physical activity. The questionnaires were prepared in French and translated into English so English-speaking participants could understand. The pre-testing was done on five volunteer patients. The modifications were made after that to make the questions more understandable. Trained personnel administered the questionnaires through a face-to-face interview with the participants. The following socio-demographic data were obtained. Concerning physical activity, the participants auto-reported their level of physical activity as intense, moderate, or light activity, which had been put into two sections: current physical activity, and no physical activity. Alcohol consumption was categorized as no consumption (no consumer) and current consumption (consumer). The smoking status was also categorized as no smoking and current smoking. The education level was classified into four categories: no education, primary education, secondary education, and higher education level (university). In the marital status, five categories were observed: widower, divorced, single, married, and cohabiting. Concerning HIV characteristics, the patients self-reported their treatment status (being on treatment or not), and their duration of treatment, which was classified into four categories: on treatment for less than one year, between one and two years, between two and four years, and more than four years. These self-reported responses were confirmed using the patient's medical reports.

2.6. Blood Pressure Assessment and Anthropometric Measurements

Blood pressure was assessed using a validated electronic device (OMRON) after the subjects were seated and rested for at least 10 minutes. The tight-fitting clothing of the upper left arm was removed, and the arm was positioned so that the cuff was leveled with the heart. The measure was then automatically taken. The higher blood pressure was evaluated according to the International Diabetes Federation (IDF) definition, as systolic blood pressure was greater and equal to 130 mmHg, and diastolic blood pressure was greater and equal to 85 mmHg. Height was determined using a portable stadiometer to the nearest 0.1 cm. The patient was made to remove his/her footwear, and stand feet together and arms at the sides. The heels, buttocks, and upper back were against the straight edge in a completely upright position. Measurements were taken into centimeters and then expressed in meters. Weight and body fat were measured with an electronic Tanita impedance device (Tanita UM073). Participants were standing on the weighing scale wearing barefoot and light clothes. The weight in kilograms was obtained. Three measurements were done and the average was taken. Body mass index (BMI) was calculated as weight in kilograms (kg) divided by the square of the height in meters (m). Patients were categorized according to their nutritional status as underweight (<18.5 kg/m^2), normal weight (18.5 - 24.9 kg/m^2), overweight (25 - 29.9 kg/m^2), and obese (≥30 kg/m^2). From these four groups, we divided our study population into two groups as these are our targeted values: the underweight/normal weight category and the overweight/obese category. The waist circumference was measured with a flexible inelastic tape placed at the midpoint between the lower rib margin and the iliac crest in a perpendicular plane to the long axis of the body without restrictive garments. The measurements were recorded to the nearest cm using a flexible non-expandable tape measure. The presence of abdominal obesity was evaluated using IDF definitions: according to IDF criteria, we have abdominal obesity when waist circumference is >80 cm in women and >94 cm in men [12].

2.7. Blood Collection

The blood samples were taken after a fast of 12 hours by the Central hospital personnel. The venous blood was collected at the fold of the elbow using a Vacutainer (5 ml per tube), without anticoagulants, and two others with anticoagulants (heparin and citrate) for the plasma. Each tube before blood collection was assigned a code for each of the patients involved in the study. The plasma and serum were obtained after centrifugation at 3500 tours/minutes for 10 minutes. The biological material was fractionated into aliquots of 200 μl. One was used to immediately evaluate blood glucose level and the other was kept for further use. The collected aliquots were frozen at −20˚C for further biochemical analyses.

2.8. Biochemical Analyses

Glucose was measured using the Glucose Oxidase-Peroxidase (GOP-POD) method [13]. Total cholesterol [14], and triglycerides [15] were quantified by standard enzymatic spectrophotometric methods using ChronoLab Diagnostic Kits in the laboratory. HDL cholesterol was measured using a heparin manganese precipitation of Apo B-containing lipoproteins [14]. LDL cholesterol was calculated using the Friedwald equation [16]. CD4 cell count was obtained with flux cytometry.

Dyslipidemia was defined as total cholesterol ≥ 200 mg/dl and/or triglyceride ≥ 150 mg/dl, and/or HDL Cholesterol < 40 mg/dl in men, and <50 mg/dl in women, and/or LDL ≥ 160 mg/dl in men and ≥150 mg/dl in women [17]. Immunodepressed patients were those with a CD4 cell count of less than 350 cells/mm^3 and immunocompetent patients were those with a CD4 cell count equal to and greater than 350 cells/mm^3. The metabolic syndrome was evaluated using the International Diabetes Federation (IDF) as one of the appropriate definitions for the

Cameroonian population [18]. According to IDF criteria [12], waist circumference (≥80 cm in women and ≥94 cm in men) is a prerequisite in addition to ≥2 of the following components: fasting triglyceride levels ≥ 150 mg/dL, high-density lipoprotein (HDL) cholesterol level < 40 mg/dL for men and <50 mg/dL for women, fasting glucose levels ≥ 100 mg/dL, or hypertension (blood pressure ≥ 130/85mmHg or current receipt of medication for hypertension). Nutritional status was defined as follows: underweight (BMI < 18.5 kg/m^2), normal (BMI: 18.5 - 24.9 kg/m^2), overweight (BMI: 25.0 - 29.9 kg/m^2), and obese (BMI ≥ 30.0 kg/m^2) [17].

2.9. Data Analysis and Management

Data collected from the study participants were entered into an Excel spreadsheet and double-checked for errors. Data were analyzed using IBM SPSS (Statistical Package for Social Analysis) Statistics version 21.0 for Windows. The data were expressed as frequencies. The main dependent variable was body mass index (BMI), which showed the nutritional status and was divided into classes: 1 = underweight/normal weight, 2 = overweight/obese. The independent variables were socio-demographic parameters (age, gender, marital status, and educational level), behavioral risk factors (physical activity, alcohol consumption, and smoking status), and HIV-related characteristics (being on treatment or not, ART duration, CD4 cell counts). Age was categorized as less than forty years and greater and equal to forty years. Males and females constitute our study population. Before the analysis, the continuous variables were tested for normality. Visual inspection of the histogram was done. The study participants were characterized using descriptive statistics regarding socio-demographic factors, and HIV-related clinical factors using frequency. The association between nutritional status, the dependent variable and the other socio-demographic and clinical variables, and waist circumference were assessed using the Chi-square test (categorical variables), and their P-values were presented. The logistic regression model (bivariate analysis) was applied to measure the independent roles of different predictors or risk factors associated with overweight/obesity (calculating the crude odds ratio (OR) at 95% CI). The statistical significance was set as a P value of 0.05.

3. Results

3.1. Socio-Demographic and Anthropometric HIV-Related Characteristics of the Study Population

In this study, we had 492 patients, of which 338 were women (74.7%) and 117 men (25.3%); the most represented age group was 30 to 39 years old (41.9%). The prevalence of overweight and obesity in our study population was 27.5% and 8.1%, respectively, and 40.5% of patients had a high waist circumference. According to CD4 count cells, the patients who had a count of <350 cells/mm^3 were mostly represented. Frequent alcohol drinking was observed in 32.7% (n = 69) of patients. While 73.1% (n = 337) of patients had a low rate or had never done physical exercise. Regarding the educational level, secondary education was mostly represented (59.9%; n = 270). The married patients represented one-third of the study population (35.3%, n = 160). These are shown in Table 1.

Table 1. Socio-demographic and anthropometric characteristics of the study population.

Variables		Participants (n)	Frequency (%)
Sex	Men	117	25.3
	Women	338	74.7
Age (years)	<40	306	62.2
	≥40	186	37.8
Nutritional status	Underweight	29	6.1
	Normal weight	273	57.8
	Overweight	130	27.5
	Obesity	40	8.5
Waist status	Normal	173	59.5
	Abdominal obesity	118	40.5
CD4 count cells (cells/mm^3)	<350	371	87.5
	≥350	53	12.5
Smoking status	No	439	94.7
	Current	23	5.05
Alcohol consumption	No	142	67.3
	Current	69	32.7
Physical exercise	No	337	73.1
	Current	124	26.9
Educational level	No education	20	4.4
	Primary	101	22.4
	Secondary	270	59.9
	University	60	13.3
Marital status	Widower	60	13.2
	Divorced	17	3.8
	Single	139	30.7
	Married	160	35.3
	Cohabiting	77	17.0

3.2. Anthropometric, Sociodemographic, Clinical, and Biological Characteristics of the Participants According to Nutritional Status

Table 2 shows the relationship between BMI and selected risk factors. There was a significant association between nutritional status and abdominal obesity

Table 2. Anthropometric, clinical, and biological characteristics of the participants according to nutritional status.

Parameters		Underweight <18.5 kg/m² and Normal weight 18.5 ≤ BMI < 24.9 kg/m² n = 302	Overweight 25 ≤ BMI < 30 kg/m² and Obesity BMI ≥ 30 kg/m² n = 170	p value
Sex	Men	186 (61.6)	116 (38.4)	0.415
	Women	103 (60.6)	67 (39.4)	
Age	<40	192 (65.1)	103 (34.9)	0.292
	≥40	110 (62.1)	67 (37.9)	
Marital Status	Widower	35 (12.6)	23 (8.6)	0.363
	Divorced	10 (3.6)	6 (3.8)	
	Single	91 (32.7)	43 (27.2)	
	Married	99 (37.3)	56 (35.4)	
	Cohabiting	43 (15.5)	30 (19.0)	
Educational level	No education	12 (4.3)	7 (4.5)	0.458
	Primary	66 (23.8)	34 (21.7)	
	Secondary	162 (58.5)	97 (61.8)	
	University	37 (13.4)	19 (12.1)	
Waist size	Abdominal obesity	38 (23.3)	69 (63.9)	0.001*
Blood pressure (mmHg)	Systolic Blood Pressure	37 (23.1)	40 (37.0)	0.007*
	Diastolic Blood Pressure	51 (31.9)	49 (45.4)	0.012*
Hyperglycemia mg/dl		46 (27.9)	41 (37.3)	0.050
Hypocholesterolemia HDL mg/dl		168 (56.6)	99 (58.9)	0.310
Hypercholesterolemia LDL mg/dl		56 (23.7)	31 (22.3)	0.376
Hypertriglyceridemia mg/dl		153 (54.1)	95 (57.9)	0.214
Total hypercholesterolemia mg/dl		124 (41.1)	71 (41.8)	0.440
MetS		30 (17.8)	61 (55.5)	0.0001*
CD4 count cells (cells/mm³)	<350	239 (90.59)	115 (82.1)	0.007*
	≥350	25 (9.5)	25 (17.5)	
Duration of treatment (years)	<1	110 (51.9)	57 (44.5)	0.214
	1 - 2	36 (17.0)	20 (15.6)	
	2 - 4	40 (18.9)	30 (23.1)	
	> 4	26 (12.3)	21 (16.4)	
Treatment	Under-treatment	101 (37.1)	42 (29.2)	0.052
	Without treatment	171 (62.9)	102 (70.8)	
Alcohol consumption	No-consumer	90 (67.7)	50 (68.5)	0.452
	Consumer	43 (32.3)	23 (31.5)	
Physical activity	Irregular	205 (72.4)	78 (27.6)	0.279
	Regular	120 (75.0)	40 (25.0)	

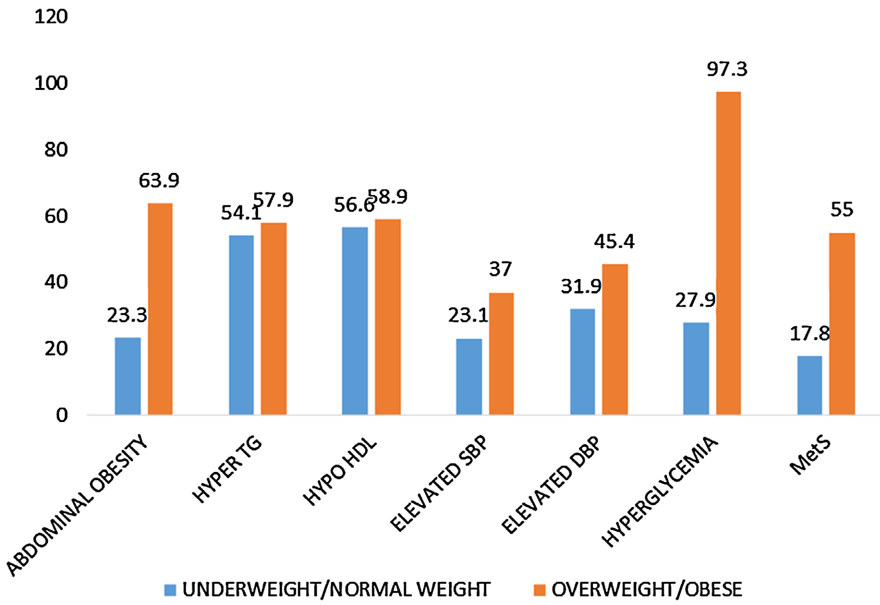
BMI: Body Mass Index; LDL-c: Low-density lipoprotein- cholesterol, HDL-c: High-density lipoprotein- cholesterol, MetS: Metabolic Syndrome *p < 0.05.

(p = 0.0001), systolic blood pressure (p = 0.007), diastolic blood pressure (p = 0.012), metabolic syndrome (p = 0.0001), and CD4 count cells (p = 0.007).

3.3. Predictors of Overweight and Obesity in the Study Population

3.3.1. Distribution of Metabolic Disorders According to Nutritional Status in the Population

It emerges from **Figure 1** that abdominal obesity, hyper-TG, hypo-HDL, elevated blood pressure, and hyperglycemia were more prevalent in overweight/obese patients than underweight/normal patients in the study population. The metabolic syndrome was also highly observed in patients with overweight/obesity compared to those who were underweight and of normal weight (55.5% and 17.8% respectively).



Hyper TG: Hypertriglyceridemia; Hypo HDL: Hypocholesterolemia; SBP: systolic blood pressure; DBP: Diastolic blood pressure; MetS: Metabolic syndrome (abdominal obesity prerequisite and two orders criteria)

Figure 1. Distribution of metabolic disorders according to weight status of the study population.

3.3.2. Independent Predictors of Overweight and Obesity in the Study Population

Table 3 shows independent predictors of overweight and obesity in our study population. The presence of abdominal obesity [p = 0.0001; OR: 5.820 (3.409 - 9.935)], elevated SBP [p = 0.014; OR: 1.955 (1.144 - 3.343)], CD4 count cells ≥ 350 [p = 0.016; OR: 2.078 (1.144 - 3.777)] and MetS [p = 0.0001; OR: 5.768 (3.344 - 9.948)], were positively associated with overweight/obesity. These factors may significantly increase overweight and obesity in our study population. We noted also that elevated DBP [p = 0.026; OR: 0.563 (0.340 - 0.933)] doesn't increase the risk of being overweight and obese, it is instead the absence of elevated diastolic increased risk, which is not common). Also, these factors have been analyzed

Table 3. Independent predictors of overweight and obesity in the study population

Predictors of overweight and obesity		OR (95% CI)	p-value
Sex	Woman	1	0.830
	Man	0.959 (0.652 - 1.409)	
Age	<40	1	0.520
	≥40	1.135 (0.771 - 1.671)	
Physical activity	Irregular	1	
	Regular	0.876 (0.563 - 1.364)	0.558
Alcohol consumption	No-consumer	1	
	Consumer	1.039 (0.563 - 1.917)	0.904
Abdominal obesity	No	1	
	Yes	5.820 (3.409 - 9.935)	0.001*
Systolic blood pressure	No	1	
	Yes	1.955 (1.144 - 3.343)	0.014*
Diastolic blood pressure	No	1	0.026*
	Yes	0.563 (0.340 - 0.933)	
Glycaemia	Normal	1	
	High	1.537 (0.919 - 2.973)	0.102
Total cholesterol	Normal	1	
	High	1.029 (0.703 - 1.508)	0.881
Metabolic syndrome	No	1	
	Yes	5.768 (3.344 - 9.948)	0.001*
Duration of treatment in years	<1	1	
	1-2	1.072 (0.569 - 2.020)	0.829
	2-4	1.447 (0.817 - 2.563)	0.205
	>4	1.559 (0.807 - 3.010)	0.186
CD4/count cells (cells/mm^3)	<350	1	0.016*
	≥350	2.078 (1.144 - 3.777)	

Independent predictors of overweight/obesity in our study population are abdominal obesity, high systolic, and low diastolic blood pressure, CD4/count cells, and metabolic syndrome; *$p < 0.05$.

using logistic binary regression.

4. Discussion

It emerges from this study that abdominal obesity, high systolic and low diastolic blood pressure, metabolic syndrome, and high CD4 count cells were associated with overweight/obesity in this cohort of HIV-infected patients.

Patients with human immunodeficiency virus (HIV)/acquired immunodeficiency syndrome (AIDS) frequently present alterations in lipid metabolism due to infection with HIV itself [19]. The natural course of this infection is characterized by reductions in HDL-cholesterol and LDL-cholesterol and an increase in triglycerides (TGs). The elevated TG levels are due to a combination of liver very-low-density lipoproteins (VLDL) in production and reduced clearance of TG [20]. HIV-positive individuals are prone to low-grade inflammation with a high level of inflammatory molecules such as Tumor Necrosis Factor α; this TNF-α interferes with free fatty acid metabolism (FFA) and lipid oxidation and attenuates the suppression of insulin-induced lipolysis. The nutritional status of patients with HIV infection, including weight loss and protein depletion, help lower HDL and LDL cholesterol levels [4].

After the introduction of antiretroviral therapy, more pronounced atherogenic changes in the lipid profile, including an increase in TG and LDL cholesterol and a decrease in HDL cholesterol, were observed [4]. The advent of antiretroviral therapies also reduced the prevalence of wasting; however, this was accompanied by an increasing proportion of overweight and obese HIV-infected individuals. Overweight and obesity are pieces of evidence in HIV-infected patients [6].

The prevalence of overweight and obesity was 27.5% and 8.5% respectively, while only a negligible proportion (6.1%) were underweight. Some authors associated the increase in weight among HIV-infected people on ART with a state of return to health in which appetite is gained and, more food is consumed, coupled with low physical activity and an obesogenic environment [7]. In our country, people with HIV patients are still subjected to discrimination, so they can be tempted to consume more food to hide their disease, which might lead to increasing weight. Furthermore, our results are lower than those obtained by Anyabolu in 2016 in Nigeria, which showed that the prevalence of overweight and obesity was 38.4% and 21% respectively [9] in this population. This difference can be explained by the fact that in the general Nigerian population, there is already an increase in overweight and obesity due to greater urbanization [21].

As in the general population, overweight/obesity is associated with several comorbidities in HIV-infected patients, such as abdominal obesity, high blood pressure, dyslipidemia, metabolic syndrome, and cardiovascular disease. This study confirms that, indeed, we also observed high systolic and low diastolic blood pressures as well as abdominal obesity in participants. A low diastolic pressure is common with HIV-infected patients with lower body weight. However, others present the fact that low diastolic pressure is a risk factor for cardiovascular disease, which is a complication of being overweight/obese. This is what we observed in our study. Concerning abdominal obesity, the prevalence was 40.5%. This result is very low compared to that obtained by Saito *et al.* in the Kenyan adult population living with HIV; they obtained a prevalence of 62.1% in women and 9.6% in men. This study also reported a significant association between abdominal obesity and female sex [8], but in our study, we did not directly assess the association between abdominal obesity and sex. However, it is pertinent to note the fact that our population was predominantly female (74.7%), this could influence the prevalence obtained in our study population. On the other hand, several studies have shown that there is a significant relationship between waist circumference, systolic and diastolic blood pressure, and overweight/obesity [22]. In our study, we observed a high prevalence of systolic blood pressure in overweight/obese individuals, 37% and 45.4% respectively, which could lead to hypertension in the long term due to a constant increase in systolic blood pressure, perhaps by combining the two factors. This suggests that a high prevalence of hypertension can be found in our study population, although a direct analysis was not done. Some studies have shown that in Africa, for example, the study done by Aridegbe *et al.*, 2019, in Nigeria, found a prevalence of 20.9% for hypertension in people living with HIV [23]. Recent studies have shown that intestinal microbial translocation has been implicated in the pathophysiology of hypertension in adults infected with HIV; lipopolysaccharide and soluble CD14 (sCD14), both markers of microbial gut translocation, are associated with hypertension in the context of HIV infection. In the general population, lipopolysaccharide has been associated with both arterial stiffness and endothelial cell apoptosis [24].

People living with HIV on antiretroviral therapy have a high risk of developing metabolic syndrome compared to the general population [25]; according to regression analysis, individuals with metabolic syndrome were 5.7 times more likely to be overweight/obese than individuals of underweight/normal weight (95% CI, 3.34-9.94, $p < 0.001$; **Table 3**). The prevalence of metabolic syndrome in the HIV-infected population varies from about 10% to over 50%, depending on the studied population and region [26]. We have also shown a high prevalence of metabolic syndrome (55.5%) in overweight/obese individuals in the study population. A high prevalence of metabolic syndrome (38.2%) was already seen in our general study population [27]. HIV infection is strongly associated with abnormalities in lipid metabolism, particularly hypercholesterolemia, an increase in VLDL and triglyceride levels, and a decrease in HDL cholesterol levels. There is thus a poor distribution of fat and insulin resistance; these various abnormalities promote the metabolic syndrome.

There is also a positive association between overweight/obesity and CD4 count in the multivariate model; participants with a CD4 count ≥ 350 cells/mm^3 had an average of 2.07 times more risk of developing obesity than those with a CD4 count < 350 cells/mm^3. These results are similar to those obtained by Sax *et al.*, in the USA, who showed that increase in CD4 count was associated with weight gain over time. The initiation of antiretroviral therapy (ART) in people living with HIV often results in weight gain. While some of this weight gain may be an appropriate return-to-health effect, excessive increases in weight may lead to obesity. Weight gain in people living with HIV is also a function of the type of antiretroviral therapy. Recent studies have reported weight gain in virologically suppressed persons living with human immunodeficiency virus (PLWH) switched from older antiretroviral treatment (ART) to newer integrase strand transfer inhibitor (INSTI)-based regimens; PWH initiating INSTI-based regimens gained, on average, more weight compared to NNRTI-based regimens. This phenomenon may reflect the heterogeneous effects of ART agents on body weight regulation that require further exploration [28]. The variables of the level of education and marital status were not associated with any of the outcomes. Similarly, other studies found no such association with the level of education [29]. Some limitations: the cross-sectional design of our study did not make it possible to assess the impact of overweight and obesity on several biological and clinical variables. The information on potential factors that may influence weight gain, such as the type of treatment, and dietary habits, were not reported in this paper.

5. Conclusion

We found that overweight and obesity are a reality in people living with HIV; management of these patients must take into account their lifestyle to avoid the occurrence of complications related to this pathology. This study provided valuable background information in developing appropriate strategies for the prevention and management of overweight and obesity in people living with HIV.

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Authors' Contributions

Conceptualization: Thérèse Henriette Dimodi (designed the study plan and drafted the questionnaire).

Collected the data: Thérèse Henriette Dimodi.

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Validation: The authors read and approved the final manuscript.

Conflicts of Interest

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

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