

(RESEARCH ARTICLE)



## Evaluation of risk factors for obesity among HIV positive adults on antiretroviral therapy in Delta State, Nigeria

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### Abstract

A substantial shift in the causes of morbidity and mortality among HIV-infected humans has been reported in recent times. Literature reports on the biomarkers of immunity have been reported in nations most severely hit by the HIV epidemic. Information on the health indicators of obesity and HIV, and their associated risk factors is scarce. This study evaluated the risk factors for obesity in HIV positive adults (18-50years) on antiretroviral therapy in Central Hospital, Warri Nigeria. A total of 500 records from 2018 to 2022 were included in this study. Obtained data includes clinical (CD<sub>4</sub> count in cells/mm<sup>3</sup>) and anthropometric parameters (body weight in kg, height in meters, and body mass index in kg/m<sup>2</sup>). A multivariate analysis of obtained data was used to determine the risk factors for obesity among patients. The number of adults whose BMI is more than 30 increases progressively from commencement of this study. The observed differences were statistically significant (p<0.05). Female gender (OR 2.2; 95% CI: 1.81 - 2.67), low baseline BMI 16.99-18.49kg/m<sup>2</sup> (OR 1.9; 95% CI: 1.3 -2.2), and baseline CD<sub>4</sub> count less than 200cells/mm<sup>3</sup> (OR 1.51; 95% CI: 1.31 - 2.09) were associated with development of obesity at multivariate analysis. Patients' age, marital status, level of education, identifiable risk for HIV transmission, social class, and opportunistic infections were not associated with obesity after controlling for confounding variables. Hence, programs aimed at preventing obesity should be incorporated into the national guideline, with more focus on women, and other patients with the identified risk factors.

**Keywords:** Obesity; HIV Positive Adults; Antiretroviral Therapy

### 1. Introduction

A major shift in the causes of morbidity and death among HIV-infected individuals has occurred as a result of increasing access to antiretroviral medication [1]. HIV infection, which was once fatal, is now a chronic medical condition that can be managed [3, 30, 31]. Patients with stable HIV infection are increasingly reporting obesity and accompanying cardiovascular consequences [4, 21, 22]. These considerably contribute to the rise in non-communicable disease-related illnesses and fatalities among stable HIV patients [4-5].

A number of articles have documented an increase in obesity among the general population, as well as more recently among stable HIV positive individuals [6, 10, 13, 22]. Although there has been a reported rise in non-communicable diseases among HIV positive individuals, information on risk factors for obesity among HIV positive adults is scarce. This is notably true in low- and middle-income countries where HIV infection rates are the highest worldwide [7, 8]. Significant design, sample size, and focus on wasting alone portrayed serious challenges on findings from these identified studies [10-13]. HIV-infected individuals are living longer [14, 15]. They are also experiencing lower rates of wasting syndrome associated with acquired immunodeficiency syndrome (AIDS), and may develop overweight or

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obesity at a rate comparable to the general population [16-18]. Hence, much thanks to the increased accessibility to highly active antiretroviral therapy (HAART).

It is possible that HIV and its treatment are related to obesity, as evidenced by the increased number of overweight and obese HIV positive people who are receiving treatment in recent studies [2, 26, 27]. These identified studies are from high income countries where population of individuals infected with HIV is relatively small [27]. Lack of research on the risk factors for development of obesity among HIV positive adults in nations with high HIV prevalence is another possible problem. With reference to the number of people receiving antiretroviral medication, Nigeria has the second-largest global HIV infection pool and the number of adults on antiretroviral therapy [13]. The objective of this study is to investigate risk factors for obesity among HIV positive adults on antiretroviral therapy in Nigeria

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## 2. Methods

This study was conducted on 500 HIV-positive adults (18-50 years) on anti-retroviral therapy (ART) from 2018 to 2022 in central hospital Warri, Nigeria. The study population comprised patients who receive ART in the facility within the study period regardless of their age. The study retrospectively fetched baseline CD4 count (cells/mm<sup>3</sup>), anthropometric parameters; weight (kg), height (meters) and BMI (kg/m<sup>2</sup>) from patients' records.

The study location is one of the 25 tertiary health institutions in Nigeria that started the Federal Government of Nigeria ART access programs in the year 2002 [2]. It is also one of the centers for comprehensive HIV care, treatment and support for over 10,000 patients [2, 19]. Comprehensive HIV treatment and laboratory services were provided across all senatorial districts of Delta State Nigeria in collaboration with the National Agency for the Control of AIDS (NACA) – the agency regulating the control of HIV/AIDS under the Nigeria Federal Ministry of Health [12, 19]. About forty-five percent of patients come within the state, while the remaining fifty-five percent come on referral from other neighboring states' government approved HIV counseling and testing centers.

Participants in this study comprised only HIV positive Nigerian adults between 18-50 years, who were enrolled and completed the follow-up in the Nigerian national HIV treatment program. They were on antiretroviral drugs over the last 5 years (2018-2022). Participants were included in this study regardless of their CD<sub>4</sub> and choice of ART chosen by their attending physicians.

Information on clinical and anthropometric parameters as recorded by attending physicians was fetched; patients' CD4 count, height, and weight, while the BMI was deduced by Weight (kg)/Height (m<sup>2</sup>). The data retrieved transferred into program database by a trained data entry clerk and also verified by a senior data entry officer. For each patient, information on weight, height, and CD<sub>4</sub> counts at enrolment were extracted. The extracted data were analyzed using SPSS for Windows 10.0's graph pad prism (version 8.1). Using the student t-test, differences in mean for BMI were determined. The BMI was thereafter classified as underweight (16.99-18.49), normal weight (18.5-24.99), overweight (25-30), and obese (> 30). We performed a univariate analysis using relevant statistics to determine factors associated with obesity. A multivariate logistic regression was also used to identify independent risk factors for obesity after potential confounding variables were controlled. Non-obese HIV-positive adults (18-50years) were used as comparison group in this study. In the analysis, p-values < 0.05 was considered to be statistically significant. Approval for this study was obtained from the Ethics and Research Committee, Central Hospital Warri, Delta State. Informed consent was not obtained from the participants because this study only analyzed data on patients' records and ethical approval to take the data had already been taken by their respective attending physicians before implementation of treatment and care.

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## 3. Results

A total of 500 patients were included in this study. These patients were enrolled for treatment within year 2018 to 2022. The socio demographic characteristics are as shown in Table 1. The mean age of the patients was 34.0 ± 5.8 years (range 18 - 50 years). Majority of the patients were in the age group 31-50 years (50.8%). A total of 286 (53.6%) females were enrolled. Majority of the patients have BMI below normal range (18.5-24.99), while 19.4% were overweight and only 17.6% obese.

The baseline clinical parameters of the patients are shown in Table 2. The CD<sub>4</sub> cell counts ranged from 200-500cells/mm<sup>3</sup> with a mean of 262.11±143.2. Majority of the patients had CD<sub>4</sub> cell counts < 200 cells/mm<sup>3</sup> although the difference is insignificant in the year 2020.

The distribution of patients by their BMI at enrolment is as shown in Table 3. The number patients enrolled for care in 2022 is highest (n = 346) while that of 2018 lowest (n = 230). There is yearly increase in the prevalence of overweight and obesity from 2018 to 2022; the prevalence ranged from 10.3% in 2018 to 28.5% in 2022. The difference in prevalence across the years were statistically significant (p<0.05).

The univariate and multivariate analysis of a few selective patient characteristics are as shown in Table 4. The patients' age at enrolment between 31-50years (cOR: 1.33; 95% CI: 1.13-1.56), female gender (cOR: 2.09; 95% CI: 1.75-2.50), having less than secondary education (cOR:1.31; 95% CI: 1.07 - 1.60), low social class (cOR: 2.11; 95%CI: 0.13 - 8.32), BMI between 16.99 - 18.49 (cOR: 2.4; CI: 1.5 -2.9), and CD4 count <200 cells/mm<sup>3</sup> (cOR: 1.44; 95% CI: 1.18 - 1.76) were found to be associated with obesity at univariate analysis.

Patients' marital status (cOR: 0.76; 95% CI: 0.65 - 0.90), identifiable risk for HIV transmission (cOR: 1.21; 95% CI: 1.08 - 1.50 and cOR: 1.31; 95% CI: 1.04 -1.47), and presence of opportunistic infection (cOR: 0.72; 95% CI: 0.49 - 1.07) are not found to be associated with the development of obesity. Following controlling for possible confounding variables, only female gender (cOR: 2.2; 95% CI: 1.81 -2.67), BMI within 16.99 - 18.49 (cOR: 1.9; 95% CI: 1.3-2.2), and CD4 count <200 cells/mm<sup>3</sup> (cOR: 2.51; 95% CI: 2.13 - 3.09) retained their independent association with obesity.

This table shows the baseline socio-demographic characteristics of patients at enrolment

**Table 1** Baseline characteristics of study participants

Characteristic	Number (%)
Age (years)	
18 – 30	246 (49.2)
31 – 50	254 (50.8)
Range	18 – 50
Mean	34.0 ± 5.8
Gender	
Female	268(53.6)
Male	232(46.4)
Marital status	
Married	194 (38.8)
Single	247 (49.4)
Divorced/Separated	46 (9.2)
Widowed	13 (2.6)
Education	
Less than secondary (<12 years)	251 (50.2)
Secondary and above (≥12years)	249 (49.8)
Identifiable risk for HIV transmission	
Heterosexual	161 (32.2)
Intravenous drug use	170 (34.0)
Men having sex with men	2 (0.4)
Mother to child	7 (1.4)
Blood transfusion	132 (26.4)
Unknown	28 (5.6)

Social Class	
Low	233 (46.6)
Middle	187 (37.4)
Upper	80 (16.0)
Opportunistic Infections	
Yes	305 (61.0)
No	195 (39.0)
BMI	
< 16.99	102(20.4)
16.99 - 18.49	121(24.2)
18.5 - 24.99	92 (18.4)
25 - 30	97 (19.4)
>30	88 (17.6)

**Table 2** Baseline CD<sub>4</sub> count (2018-2022) of study participants

Year	CD4count (cells/mm <sup>3</sup> )	Number (%)
2018	< 200	212 (42.4)
	200 - 499	178 (35.6)
	≥500	110 (22.0)
2019	< 200	215 (43.0)
	200 - 499	159 (31.8)
	≥500	126 (25.2)
2020	< 200	183 (36.6)
	200 - 499	179 (35.8)
	≥500	138 (27.6)
2021	< 200	208 (41.6)
	200 - 499	189 (37.8)
	≥500	103 (20.6)
2022	< 200	218 (43.6)
	200 - 499	176 (35.2)
	≥500	106 (21.2)

**Table 3** Distribution of patients by their BMI at enrolment (2018-2022)

	Year of enrolment / Number of patients enrolled				
	2018 n = 230 (%)	2019 n = 255 (%)	2020 n = 270 (%)	2021 n = 286 (%)	2022 n = 346 (%)
Underweight (16.99 - 18.49)	90 (38.9)	166 (29.4)	100 (26.0)	79 (26.1)	93 (20.0)

Normal (18.5-24.99)	93 (40.9)	115 (35.4)	55 (30.0)	89 (28.1)	68 (25.2)
Overweight (25-30)	23 (9.9)	152 (19.7)	94 (21.4)	50 (22.7)	113 (26.3)
Obesity (>30)	24 (10.3)	220 (15.5)	321 (22.6)	353 (23.1)	392 (28.5)

**Table 4** Risk factors for obesity (BMI >30) among study participants

Characteristic	OR [95% CI] (Unadjusted)	P - value (Unadjusted)	OR [95% CI] (Adjusted*)	P - value (Adjusted)
Age (years)				
18 - 30	1.0		1.0	
31 - 50	1.33 (1.13 - 1.56)	0.001	1.01 (0.76 - 2.01)	0.06
Gender				
Female	2.09 (1.75 - 2.50)	0.01	2.2 (1.81 - 2.67)	0.007
Male	1.0			
Marital status				
Single	0.76 (0.65 - 0.90)	0.08	0.54 (0.43 - 1.23)	0.09
Divorced/Separated	1.0			
Widowed	1.0			
Level of education				
Less than secondary (<12 years)	1.31 (1.07 - 1.60)	0.01	1.5 (0.84 - 2.56)	0.21
Secondary and above (≥12years)	1.0		1.0	
Identifiable risk for HIV transmission				
Heterosexual	1.0			
Intravenous drug use	1.21 (1.08 - 1.50)	0.07	1.42 (0.82 - 2.46)	0.23
Men having sex with men				
Mother to child	1.0			
Blood transfusion	1.0			
Unknown	1.31 (1.04 - 1.47)	0.09	1.56 (0.98 - 2.76)	0.21
Social Class				
Low	2.11 (0.13 - 8.32)	0.03	1.9 (0.87 - 6.73)	0.34
Middle	1.0		1.0	
Upper	1.0		1.0	
Opportunistic Infections				
Yes	0.72 (0.49 - 1.07)	0.09	0.51 (0.72 - 2.32)	0.15
No	1.0		1.0	
BMI				
< 16.99	1.0		1.0	
16.99 - 18.49	2.4 (1.5 - 2.9)	0.01	1.9 (1.3-2.2)	0.02
18.5 - 24.99	1.0		1.0	

25 – 30	1.0		1.0	
>30	1.0		1.0	
CD4 count				
<200 cells/mm <sup>3</sup>	1.44 (1.18 - 1.76)	0.0002	2.51 (2.13 - 3.09)	0.001
200 - 499	1.0			1.0
≥500 cells/mm <sup>3</sup>	1.0			1.0

↖Adjusted for age, gender, marital status, level of education, identifiable risk for HIV transmission, social class, opportunistic infection, BMI, CD4 count

#### 4. Discussion

This study found a high prevalence of obesity among patients newly diagnosed of HIV on ART. There is a progressive increase in the prevalence of obesity following commencement of ART. Obese individuals grew from 10.3% in the year 2018 to 28.5% in the year 2022. Although the prevalence of obesity has increased in the general population in Nigeria [22-25, 29]. The reported increase in the prevalence of obesity in this study is not likely to be an accurate representation of the rising obesity epidemic in the country, which is estimated to be between 3.5-8.5% [28, 29]. ART were reported to be associated with obesity in a few identified studies [28]. However, findings from two studies in Nigeria that revealed a high prevalence of obesity (21-26%) correlate with findings in this study [7, 9, 11]. Although, a small sample size from most city inhabitants were used in the two identified studies. Moreover, it is reasonable to believe that the rise in obesity was more likely to be a result of ART than a shift in societal patterns. Additionally, the non-significant variations in the proportion of patients who were obese at baseline across the years reinforce the finding that ART was to blame for the gradual gain in weight.

In this study, it was discovered that low baseline BMI was associated with obesity. Although, it is believed patients who were underweight and wasted at the time of enrollment had more severe disease. It is possible that they eventually recovered and put on weight as a result of the clearance of opportunistic infections and reduction of viral loads. Patients in this group also frequently adhere better to their medication schedules, and this may result into a quicker recovery. It is also likely that the stigma attached to wasting in HIV/AIDS patients encourages eating to gain weight in an effort to hide the disease's diagnosis. This may however explain the link between low baseline BMI and obesity that has been reported. In another study that comprised the general population and HIV-infected populations, there is a connection between obesity and female gender [20, 26, 29]. This also correlates with findings in this study. Findings in this study are also in keeping with previous studies that identified a link between immunological reconstitution and weight gain [16, 17, 32]. The observed relationship between low baseline CD<sub>4</sub> count less than 200cells/mm<sup>3</sup> and obesity is in support of findings from this study. Patients with low CD<sub>4</sub> count appear sicker and more likely to stick to their treatment regimens; this may speed up their recovery.

This study has limitations since we excluded patients who were not regular on their ART. On the other hand, this study was limited to only one center out of the accredited centers for management of HIV/AIDS in Delta State Nigeria. Hence, findings may not be generalise-able to the entire HIV community. In comparison to other studies that were multi-centered, they have a higher likelihood of generalizing their findings to the entire HIV community. Another limitation to this study is the absence of HIV-negative control group for comparison. This study however has strengths since it adopted a retrospective study design with appropriate sample size which makes generalization of results possible.

#### 5. Conclusion

This study has shown that HIV-infected individuals receiving ART frequently have obesity. The development of obesity following ART is linked to female gender, low baseline BMI, and CD<sub>4</sub> counts less than 200cells/mm<sup>3</sup>. Hence, programs aimed at preventing obesity and its effects in HIV-infected patients receiving medication should be incorporated into the national guideline, with more focus on women and patients with advanced stage of the disease.

#### Compliance with ethical standards

##### *Disclosure of conflict of interest*

No conflict of interest to be disclosed.

*Statement of informed consent*

Informed consent was obtained from all individual participants included in the study.

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