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BMI and Risk Factors of Underweight and Obesity in HIV Subjects in Eastern Nigeria

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Abstract

Background and Objectives: Human immunodeficiency virus infection (HIV) is a global healthcare problem. Progression of HIV infection is commonly associated with decreasing weight. In the early phases of HIV infection, factors associated with weight changes are not completely known. This study evaluated the body mass index (BMI) and its potential risk factors in drug-naïve HIV subjects in Owerri, Eastern Nigeria. Methodology: This was a cross-sectional study of HIV subjects. BMI was determined. Relevant investigations were performed. Potential risk factors of BMI were analyzed at different BMI categories. Association of variables with BMI and the strength of variables to predict BMI, underweight and obesity were determined. Results: The mean BMI of the HIV subjects was 26.2 ± 5.4 kg/m^2. Underweight was present in 24 (6.1%), overweight in 150 (38.4%) and obesity in 84 (21.5%) of the HIV subjects. High spot urine creatinine (SUCr), high 24-hour urine osmolality (24HUOsm), high serum cholesterol and high hemoglobin predicted BMI in HIV subjects. Low 24HUOsm predicted under weight, whereas low 24-hour urine protein (24 HUP) and high 24HUOsm predicted obesity in HIV subjects. Conclusion: The prevalence of underweight was low (6.1%), overweight high (38.4%) and obesity high (21.5%) in HIV subjects. High SUCr, high 24HUOsm, high serum cholesterol and high hemoglobin were predictors of BMI in HIV subjects. Low 24HUOsm was a predictor of underweight, while low 24HUP and high 24HUOsm were predictors of obesity in HIV subjects. Abnormalities of serum lipids, renal function, and anemia were common in HIV subjects who were underweight and in those obese. Underweight HIV subjects should be evaluated at the early stages for dyslipidemia, renal damage and anemia.

Keywords

HIV, BMI, Underweight and Obesity, Prevalence, Predictors, Nigeria

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1. Introduction

Human immunodeficiency virus (HIV) infection is a global healthcare problem. About 70% of all people who have HIV infection live in Sub-Saharan Africa [1]. In China, the prevalence of HIV infection is 0.1% [1], while in Kenya and Malawi, both in East Africa, it is 5% [1]. Cameroon, a Central African country, has a similar prevalence 5.0% [1]. In Nigeria, about 3.7% of its population has HIV infection [1].

In populations of subjects with HIV infection, weight has been a burning issue [2] [3]. Seroconversion, changes in metabolism and co-morbidities in the early phases of HIV infection have been shown to influence weight in these subjects [4]-[6]. A study has demonstrated that BMI has biphasic decline: following serocnversion, and just before AIDS development [7]. Variable prevalence of BMI has been observed in HIV subjects, with values ranging from 6.0% to 50.0% [8]-[10].

Studies on BMI in HIV subjects have shown increasing prevalence of overweight and obesity more than underweight [5] [11]. Overweight and obesity prevalence observed in some HIV subjects on antiretroviral therapy (ART) were almost the same as those found in non-HIV populations [10]-[14].

Some studies have identified some associated factors of underweight and overweight/obesity in HIV subjects; they include fever, thrush, and a CD4+ < 100 cells/ml), anemia, dietary patterns and habits [10]-[17]. Although antiretroviral therapy (ART) has influenced the pattern of weight changes in HIV subjects, factors associated with underweight, or overweight/obesity in drug-naïve individuals with HIV infection, are not completely known.

There is a paucity of reports on the prevalence of underweight and overweight/obesity and their associated factors in drug-naïve HIV subjects in Nigeria. This study was undertaken to determine the prevalence of underweight and overweight/obesity and to identify factors associated with weight changes in drug-naïve HIV subjects in Owerri, Eastern Nigeria.

2. Materials and Methods

This was a three-month cross-sectional, analytical study conducted in FMC, Owerri, Nigeria, in 2011. FMC Owerri, a tertiary hospital, with only one other hospital in its category in Imo state, receives referrals from the state and some neighboring states. Imo State has a population of 3,927,563; about 125,337 of these live in Owerri Municipal [18].

The subjects consisted of 393 newly-diagnosed, 18 - 65 year-old HIV-seropositive patients, consecutively recruited from an HIV clinic of the hospital.

This study was approved by the Ethical Research Committee of the hospital.

Informed consent was obtained from all the subjects who participated in this study. Demographic and anthropometric data were obtained. Investigations done included HIV screening and confirmatory tests, serum creatinine (SCr), spot urine protein (SUP), spot urine creatinine (SUCr), spot urine osmolality (SUOsm), 24-hour urine protein (24HUP), 24-hour urine creatinine (24HUCr), 24-hour urine osmolality (24HUOsm), CD4 cells count, fasting serum lipid profile (FSLP) (total cholesterol, triglyceride, high density lipoprotein cholesterol (HDL), low density lipoprotein cholesterol (LDL), hemoglobin (Hb). Exclusion criteria were increased abdominal girth from organic causes, pregnancy, and puerperium up to 6 weeks.

Creatinine was determined by modified Jeff's method, osmolality by freezing point depression using Precision System Osmette 5002 osmometer, protein by photometric method. Spot urine creatinine/osmolality ratio (SUCOR), 24-hour urine creatinine/osmolality ratio (24HUCOR) and creatinine clearance (ClCr) were determined.

2.1. Statistical Analysis

The data were analyzed using SPSS version 17.0 (SPSS Int. Chicago, II, USA). Statistical significance of association of variables with BMI was determined at different levels of BMI using chi square. Correlation statistics and multivariate linear regression analysis were used to determine the strength of variables to predict BMI. Further multivariate linear regression of variables with underweight, and another with obesity was done to determine the predictors of underweight and the predictors of obesity. $P \leq 0.05$ was taken as statistically significant.

2.2. Definition of Terms

WHO classification was used to define BMI levels as follows [19]: underweight ≤ 18.5 kg/m^2, normal weight =

18.5 - 24.9 kg/m^2, overweight = 25.0 - 29.9 kg/m^2, obesity class I = 30.0 - 34.9 kg/m^2, obesity class II = 35.0 - 39.9 kg/m^2, obesity class III ≥ 40.0 kg/m^2. However, in this study, obesity was defined as class I, class II and class III obesity added together.

3. Results

Out of the 393 HIV subjects recruited, 1 was excluded from the study on account of errors in sample collection and incomplete data. The mean age of the HIV subjects was 39 ± 11 years. Females were 282 (72.0%) and males 110 (28.0%).

The mean values of variables are shown in **Table 1**. The mean BMI of the HIV subjects was 26.2 ± 5.4 kg/m^2. Out of 392 HIV subjects, 24 (6.1%) have BMI < 18.5 kg/m^2, 133 (34.0% have BMI 18.5 - 24.9 kg/m^2, 151 (38.4%) have BMI 25 - 29.9 kg/m^2 and 84 (21.5%) have BMI > 30 kg/m^2.

Table 2 shows relationship between BMI and selected risk factors. There was significant association between ClCr and different levels of BMI in HIV subjects, p = 0.026. Out of 84 obese (BMI ≥ 30) HIV subjects, 3.8% have ClCr 30 - 59 mls/min while 35.4% have ClCr 60 - 89 mls/min. This showed that the prevalence of obesity declined as ClCr declined. In contrast, out of 24 underweight (BMI < 18.5) subjects, 41.7% have ClCr ≥ 90 mls/min, while 58.3% have ClCr 60 - 89 mls/min, indicating that the prevalence of underweight increased as ClCr declined. Among HIV subjects who have ClCr ≥ 90 mls/min, 10 (5.0%) have BMI < 18.5 kg/m^2, 83 (41.7%) have BMI 25 - 29.9 kg/m^2, and 43 (24.1%) have BMI ≥ 30 kg/m^2.This showed that underweight HIV subjects constituted the smallest proportion of those who have normal ClCr.

There was significant association between CD4 and different levels of BMI in HIV subjects, p = 0.017. Out of 84 obese subjects, 94.0% have CD4 ≥ 200 cells/ml while 6.0% have CD4 < 200 cells/ml. This showed that the prevalence of obesity declined as CD4 cells count declined. On the other hand, out of 24 underweight subjects, 95.8% have CD4 ≥ 200 cells/ml, while 4.2% have CD4 < 200 cells.ml, indicating also that the prevalence of underweight declined as CD4 declined. At CD4 > 200 cells/ml level, underweight were 23 (6.7%), overweight 122 (35.6%) and obese 79 (13.3%). Underweight subjects constituted the smallest proportion of those with CD4 > 200 cells.ml.

There was significant association between 24HUP and different levels of BMI in HIV subjects, p < 0.001. Out of 24 subjects who were underweight, 20.8% have 24HUP 0.150 - 0.300 g, while 54.2% have 24HUP 0.301 - 3.499 g, showing that the prevalence of underweight increased as proteinuria increased. Similarly, out of 84 ob-

Table 1. Characteristics of variables in HIV subjects.

Variables (mean ± SD)	HIV Subjects
Body Mass Index (kg/m^2)	26.2 ± 5.4
Spot Urine Protein(mg/dl)	11.89 ± 19.13
Spot Urine Creatinine (mg/dl)	137.21 ± 98.47
SUOsm (mOsm/kgH_2O)	464 ± 271
24-Hour Urine Protein (g)	0.187 ± 0.290
24-Hour Urine Creatinine (mg)	1507 ± 781
24 HUOsm (mOsm)	564 ± 501
SUCOR (mg/dl/mOsm/kgH_2O)	0.422 ± 0.486
CD4 cells	416 ± 209
Cholesterol (mmol/l)	4.26 ± 0.90
Triglyceride (mmol/l)	1.23 ± 0.37
HDL-C (mmol/l)	1.18 ± 0.39
LDL-C (mmol/l)	2.05 ± 0.58
Creatinine Clearance (mls/min)	91.42 ± 22.98
Hemoglobin (g/dl)	11.2 ± 1.8

SD = standard deviation, SUOsm = spot urine osmolality, 24UOsm = 24-hour urine osmolality, SUCOR = spot urine creatinine/osmolality ratio, HDL-C = high density lipoprotein cholesterol, LDL-C = low density lipoprotein cholesterol.

Table 2. Relationship between BMI and selected risk factors in HIV subjects (n = 375).

Variables	Body Mass Index Levels (no/%)				Λ^2	LHR	P value
	<18.5	18.5 - 24.9	25.0 - 29.9	≥30.0			
ClCr ≥ 90 mls/min	10 (5.0)	58 (29.1)	83 (41.7)	43 (24.1)	16.528	0.011	0.026
60 - 89	14 (9.8)	54 (37.8)	47 (32.9)	28 (19.6)			
30 - 60	0 (0)	16 (48.5)	1442.4)	3 (4.1)			
CD4 cells ≤ 200	1 (2.0)	15 (30.6)	28 (57.1)	5 (10.2)	10,241	0.013	0.017
>200	23 (6.7)	119 (34.7)	122 (35.6)	79 (13.3)			
24 HUP < 0.300 g	13 (3.9)	123 (36.9)	130 (39.0)	67 (20.1)	42,581	<0.001	<0.001
≥0.300 g	13 (24.1)	15 (27.3?)	14 (25.9)	12 (22.2)			
CholIT des (<5.2)	20 (6.0)	119 (34.2)	141 (40.5)	67 (19.3)	15,865	0.012	0.014
bL (5.2 - 6.2)	3 (7.7)	13 (33.3)	9 (23.6)	13 (35.9)			
High (>6.2)	0 (0)	2 (33.3)	0 (0)	4 (66.7)			
LDL-C des (<2.6)	21 (6.5)	110 (34.1)	125 (38.7)	67 (20.7)	932	0.811	0.918
bL (2.6 - 4.1)	3 (4.3)	24 (34.8)	25 (36.2)	17 (24.6)			
HDL-Cdes (<1.0)	9 (6.7)	41 (30.4)	61 (45.2)	24 (17.8)	5006	0.172	0.171
High (>1.0)	15 (5.8)	93 (36.2)	89 (34.5)	61 (23.6)			
TG des (<1.7)	24 (6.8)	118 (33.3)	138 (39.0)	74 (20.9)	9771	0.212	0.369
bL (1.7 - 2.2)	0 (0)	13 (43.3)	10 (33.3)	7 (23.3)			
High (>2.2)	0 (0)	3 (37.5)	1 (12.5)	4 (50.0)			

Λ^2 = chi square, LHR = likelihood ratio, ClCr = creatinine clearance, 24HUP = 24-hor urine protein, CholT = serum total cholesterol, LDL-C = serum low density lipoprotein cholesterol, HDL-C = serum high density lipoprotein cholesterol, TG = serum triglyceride, des = desirable level, bL = borderline.

ese subjects, 10.1% have 24HUP 0.150 - 0.300 g, while 15.2% have 24HUP 0.301 - 3.499 g, indicating also that the prevalence of obesity increased as proteinuria increased.

There was significant association between cholesterol and different levels of BMI in HIV subjects, p = 0.014. Out of 24 underweight subjects, 16.7% have cholesterol ≥ 5.2 mmol/l while 83.3% have cholesterol < 5.2 mmol/l, demonstrating that the prevalence of underweight declined as cholesterol increased. Similarly, out of 84 obese subjects, 21.4% have cholesterol ≥ 5.2 mmol/l, while 78.6% have cholesterol < 5.2 mmol/l, demonstrating that the prevalence of obesity declined as cholesterol increased. Among those who have cholesterol desirable level < 5.2 mmol/l, underweight was 20 (6.0%), overweight was 14 (40.5%) and obese was 67 (19.35). This showed that underweight subjects constituted the least proportion of those with desirable serum cholesterol.

There was no significant association between different levels of BMI and LDL, p = 0.918, HDL, p = 0.171, and triglyceride, p = 0.369, in HIV subjects.

Table 3 shows that BMI has significant correlation with SUP (r = −0.138, p = 0.006), SUCr (r = 0.131, p = 0.009), 24HUP (r = −0.171, p = 0.001), 24HUOsm (r = 0.183, p < 0.011), CD4 (r = 0.137, p = 0.006), serum cholesterol (r = 0.211, p < 0.001), hemoglobin (r = 0.344, p < 0.001), in HIV subjects.

There was no significant correlation between BMI and SUCr, p = 0.220, 24HUCr p = 0.125, SUCOR, p = 0.603, triglyceride, p = 0.641, HDL, p = 0.391, LDL, p = 0.053, and ClCr, p = 0.475.

Table 4 shows a multivariate linear regression analysis of the potential risk factors with BMI in HIV subjects. High SUCr, high 24HUOsm, high serum cholesterol and high hemoglobin predicted BMI in HIV subjects. Further multivariate linear regression analysis of underweight, obesity with potential risk factors is shown in **Table 5**. Low 24HUOsm predicted underweight, whereas low 24HUP and high 24HUOsm predicted obesity in HIV subjects.

4. Discussion

In this study, the prevalence of underweight was 6.1%, overweight 38.4% and obesity 21.5% in newly-diagnosed HIV subjects. BMI changes have significant association with ClCr (p = 0.026), CD4 (p = 0.017), 24HUP (p <

Table 3. Correlation of BMI with selected variables in HIV subjects.

Variables	Correlation coefficient(r)	P value
Spot urine protein	−0.138	0.006
Spot urine creatinine	0.131	0.009
Spot urine osmolality	0.082	0.220
24-hour urine protein	−0.171	0.001
24-hour urine creatinine	0.079	0.125
24-hour urine osmolality	0.183	<0.001
SUCOR	0.126	0.603
CD4	0.137	0.006
Serum cholesterol (total)	0.211	<0.001
Serum triglyceride	0.023	0.641
Serum HDL-C	0.043	0.391
Serum LDL-C	0.198	0.053
Creatinine clearance	0.037	0.475
Hemoglobin	0.344	<0.001

BMI = body mass index, SUCOR = spot urine creatinine osmolality ratio, HDL-C = high density lipoprotein cholesterol, LDL-C = low density lipoprotein cholesterol.

Table 4. Multivariate linear regression of variables with BMI in HIV subjects.

Variables	Beta	T	P value
Spot urine protein	−0.138	−0.441	0.150
Spot urine creatinine	0.131	2.198	0.029
24-hour urine protein	−0.171	−0.655	0.513
24-hour urine osmolality	0.183	2.456	0.001
CD4 cells	0.137	0.247	0.805
Serum cholesterol (total)	0.211	4.606	<0.001
Hemoglobin	0.344	8.785	<0.001

BMI = body mass index.

Table 5. Multivariate linear regression of variables with underweight and Obesity in HIV subjects.

Variables	Underweight (BMI < 18.5)			Obesity (BMI ≥ 30)		
	Beta	t	P value	Beta	T	P value
SUP	−0.107	−0.421	0.674	−0.087	−0.677	0.500
SUCr	0.357	1.384	0.185	0.049	0.384	0.702
24HUP	−0.176	−0.798	0.436	−0.216	−2.012	0.048
24HUOsm	−0.830	−5.770	<0.001	0.430	3.364	0.001
CD4 cells	0.196	1.079	0.296	−0.131	−1.099	0.275
Cholesterol	0.352	1.203	0.246	0.103	0.875	0.384
Hemoglobin	0.112	0.456	0.655	0.118	1.102	0.274

BMI = body mass index, SUP = spot urine protein, SUCr = spot urine creatinine, 24HUP = 24-hour urine protein, 24HUOsm = 24-hour urine osmolality.

0.001), cholesterol (0.014). High SUCr ($p = 0.029$), high 24HUOsm ($p = 0.001$), high serum cholesterol ($p < 0.001$) and high hemoglobin ($p < 0.001$) were predictors of BMI in HIV subjects. Low 24HUOsm ($p < 0.001$) was a predictor of underweight, whereas low 24HUP ($p = 0.001$) and high 24HUOsm ($p = 0.001$) were predictors of obesity in HIV subjects.

The prevalence of underweight 6.1% in HIV subjects observed in this study is slightly lower than the 8.8% reported by Carolline de Araújo MarizI *et al.* in Brazil [10]. This observed slight difference in prevalence might be explained by the difference in the size of the study population. Their study involved 2018 subjects, whereas ours was 393. However, a report by Kwiatkowska *et al*. [20] showed a prevalence of 6.8% in a study involving 72 subjects in Poland [20], a prevalence similar to our finding. In a related study in HAART-treated subjects [21], the prevalence of underweight 2.0% was lower than that obtained in our study. This showed that HIV subjects on HAART have less underweight than those who were not on HAART [21].

On the contrary, the prevalence of overweight 38.4% and obesity 21.5% noted in this study are similar to those reported in two studies, one in Brazil [10], the other in USA [22]. These, including our findings, are similar to the BMI reported in a general population in Eastern Nigeria [23]. The high prevalence of obesity observed in our study in subjects who were not on HAART, might be explained by a background high prevalence of obesity in the general population [23].

In this study, low SUP was associated with BMI, ($r = -0.138$, $p = 0.006$), but did not predict BMI, $p = 0.150$. From literature search we could not find any previous study that evaluated SUP in BMI in HIV subjects.

This study demonstrated that SUCr was a predictor of BMI in HIV subjects. This indicated that low SUCr was related to declining BMI including underweight, while high SUCr was related to increasing BMI including obesity. However, the study further demonstrated that SUCr was not a predictor of isolated underweight, nor was it a predictor of isolated obesity. Although SUCr varies over 24 hours, low SUCr reflects low excretion of creatinine in urine, and this may quantitatively indicate kidney damage [24]. Therefore, SUCr as a predictor of BMI in HIV subjects in this study implied that underweight HIV subjects were more likely to have kidney damage.

ClCr was significantly associated with BMI changes, $p = 0.026$, but was not a predictor of BMI in HIV subjects in this study. This study also showed that underweight HIV subjects constituted the smallest proportion of those who have normal ClCr. We did not find, from literature search, any study on BMI in HIV subjects that assessed SUCr or ClCr.

We found that 24HUP was associated with BMI changes ($p < 0.001$) but did not predict BMI ($p = 0.513$) in this study. However, the study demonstrated that low 24HUP was a predictor of isolated obesity, $p = 0.048$.This showed that obese HIV subjects were less likely to have significant proteinuria. However, literature search did not reveal any study that evaluated the association of proteinuria with BMI in HIV subjects.

Our study showed that 24HUOsm was a predictor of BMI in HIV subjects. However, low 24HUOsm was a predictor of underweight, while high 24HUOsm was a predictor of obesity. Low 24HUOsm may indicate inability of the kidney to concentrate urine, which may be observed in kidney damage that involves the interstitial compartment and the distal tubules. We could not find any study on 24HUOsm in BMI in HIV, from literature search. However, a study demonstrated that high 24HUOsm was associated with HIV infection [25], in contrast to another study that reported low 24HUOsm in HIV infection [26].

CD4 cells count was associated with BMI changes, $p = 0.017$, but did not predict BMI, $p = 0.805$, in HIV subjects in this study. We also observed that underweight subjects constituted the smallest proportion of those with CD4 $\geq$ 200 cells/ml. This finding is in agreement with those reported in some studies in which CD4 < 200 cells/ml was associated with underweight in an HIV population [10] [27].

We showed that serum total cholesterol was a predictor of BMI in HIV subjects in this study. However, serum cholesterol did not predict isolated underweight, $p = 0.246$, and did not predict isolated obesity, $p = 0.384$, either. We also noted that underweight subjects constituted the least proportion of those with desirable serum cholesterol. Literature search did not reveal any lipid studies in BMI in the early phases of HIV infection. However, abnormalities of serum cholesterol were shown in HIV subjects, especially those on HAART [26] [28].

In this study, hemoglobin was a predictor of BMI in HIV subjects. However, hemoglobin was not a predictor of isolated underweight, $p = 0.655$ as well as isolated obesity, $p = 0.214$.This observation is similar to a report that also documented anemia associated with weight changes in HIV subjects [10].

The study showed that there was no association between BMI and SUOsm, 24HUCr, SUCOR, HDL, LDL, triglyceride, in HIV subjects.

5. Conclusion

The prevalence of underweight was low (6.1%), overweight high (38.4%) and obesity high (21.5%) in HIV subjects. High SUCr, high 24HUOsm, high serum cholesterol and high hemoglobin were predictors of BMI in the

HIV subjects. Low 24HUOsm was a predictor of underweight, while low 24HUP and high 24HUOsm were predictors of obesity in HIV subjects. Abnormalities of serum lipids, renal function, and anemia were common in HIV subjects who were underweight and those obese. Underweight HIV subjects should be evaluated at the early stages for dyslipidemia, renal damage and anemia.

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Abbreviations

BMI: body mass index
ClCr: creatinine clearance
FMC: Federal Medical Centre
FSLP: fasting serum lipid profile
Hb: hemoglobin
HDL: high density lipoprotein cholesterol
HIV: human immunodeficiency virus
LDL: low density lipoprotein cholesterol
SCr: serum creatinine
SUCOR: spot urine creatinine/osmolality ratio
SUOsm: spot urine osmolality
SUP: spot urine protein
24HUCOR: 24-hour urine creatinine/osmolality ratio
24HUCr: 24-hour urine creatinine
24HUOsm: 24-hour urine osmolality
24HUP: 24-hour urine protein