ORIGINAL ARTICLE OPEN ACCESS

Anthropometric Indices of Human Immunodeficiency Virus-Positive Anti-Retroviral Therapy (ART)-Naïve and ART-Experienced Subjects In Kano, Nigeria

[1,2,3]*Isah S. Y., [2]Ibeh I. N., [2]Emokpae M. A., [3]Anaja P. O., [4]Usman A., [5]Munir J., [1]Labaran H. and [6]Akor S. E.

ABSTRACT

Background: In the management of global pandemic disease like Human immunodeficiency/ Acquired immunodeficiency syndrome (HIV/AIDS), non-evasive methods of evaluation such as the use of anthropometric indices are of great significance because they serve as pointers to the disease severity or otherwise. This study was aimed at assessing the anthropometric indices of HIV virus-positive ART naïve and ART experienced subjects in Kano, Nigeria.

Materials and Methods: A total of 300 subjects were recruited for this study. Two hundred (200) were HIV-infected subjects (155 on ART and 45 naïve) and 100 were healthy controls with an age range of 18-70 years. A questionnaire was administered to study participants for their biodata. Anthropometric indices such as Body Mass Index (BMI), Waist circumference (WC), Hip circumference (HC), Waist-to-hip ratio (WHR) and Waist-to-height ratio (WHtR) were measured on the participants using standard Techniques. SPSS software package version 21.0 was used for data analysis.

Results: The results showed that a higher percentage of 56.5% was observed in HIV patients between the ages range of 18-39 years, while a lower percentage of 5.5% was observed in HIV patients of ages ≥ 60 years. Female patients had a higher percentage of 64%, while males had a lower percentage of 36% with a ratio of 1.78:1. The mean values of WC, HC, WHpR, WHtR, were significantly higher ($p<0.05$) in HIV patients than the controls. BMI and Weight were not statistically significant in HIV patients than the controls. The mean values of BMI, WC, HC, WHpR and WHtR were significantly higher ($p<0.05$) in HIV patients on ART than the naïve. However, no statistical significant in Height of HIV patients on ART compared with the naïve. There were significant ($p<0.05$) positive correlations between BMI with WC, HC, WHpR and WHtR in HIV patients.

Conclusion: HIV infection is more common among females than males, between the age ranges of 18-39 years. Alteration in BMI, WC, HC, WHpR and WHtR are associated with HIV patients with improved well-being when on ART, assessing the Anthropometric indices may help in this group of subject management.

Key words: Anthropometric, Antiretroviral Therapy, Human Immunodeficiency Virus, Kano, Pandemic

INTRODUCTION

Human immunodeficiency virus (HIV) belongs to the genus lentivirus, families of *retroviruses*, and sub-family *Orthoretrovirinae* that causes a disease condition known as acquired immunodeficiency syndrome (AIDS) (1,2). This condition leads to immune system failure, resulting in life-threatening diseases such as opportunist infections, cancers among others in humans (1). This infection could be found in body fluid contacts such as blood, semen, vaginal fluid, pre-ejaculate, and breast milk of the infected persons (3). The main routes of transmission are unprotected sex, infusion of HIV-contaminated blood products, contaminated needles, syringes, and medical equipment, or through ingestion of HIV in expressed breast milk among others. This type of transmission is known as horizontal transmission, and by the transplacental route into the uterus. During pregnancy, during the process of labor and delivery (perinatal transmission), and after birth during breastfeeding, this type of transmission is termed vertical transmission (4). Horizontal transmission accounts for 90% of all HIV infections and is the only mode of infection in adults (5).

Nutritional status is both a determinant and a consequence of HIV infection. HIV itself can worsen malnutrition through higher metabolic demands, malabsorption, and opportunistic infections, while malnutrition can hasten the course of HIV disease by impairing immunological responses. Particularly in environments with limited resources, anthropometric indices may be useful, non-invasive instruments for evaluating people's dietary and health conditions (6). Regular

* Correspondence: isyahaya.mls@buk.edu.ng
[1]Department of Medical Laboratory Science, Bayero University, Kano, Nigeria
Full list of author information is available at the end of the article

evaluation is crucial for tracking changes in musculature and adiposity because body composition (BC) is a crucial aspect of physical health (7). A series of quantitative measurements of the muscle, bone, and adipose tissue are called anthropometric measurements, and they are used to evaluate the body's composition (8). One of the most popular BC techniques, anthropometry is renowned for providing accurate data on the composition of fat and muscle (7). These measurements are critical because they serve as diagnostic criteria for obesity, which considerably raises the risk for illnesses including cardiovascular disease, hypertension, diabetes mellitus, and nutritional status in children and pregnant women, can serve as a benchmark or a measure of development, among other purposes (9). Height, weight, body mass index (BMI), body circumferences (hip, waist, and limbs), and skinfold thickness make up the basic components of anthropometry (10).

Despite the well-established link between diet and immune function, nutritional intake is frequently disregarded as the HIV disease progresses (11). Due to its ease of use, low cost, and ability to approximate body composition and body fat distribution, anthropometry has been widely utilized to evaluate the health and nutritional condition of individuals, groups, and populations (12). HIV patients' deaths were associated with wasting or weight loss of more than 66% of their optimal body weight, especially in the early stages of the epidemic (13). The immune system and the many generalized aspects of host defense are strengthened and protected by optimal nutrition, which includes protein, energy, minerals, and vital micronutrients (14).

HIV care has been transformed by the introduction of ART, which has significantly decreased morbidity and mortality. However, anthropometric profiles may change as a result of metabolic and body composition alterations linked to ART. Assessing patient progress, identifying those at nutritional risk, and directing measures to enhance treatment results all depend on an understanding of these changes (15). This study, therefore, aims to evaluate and compare the anthropometric indices of HIV-positive ART-naïve and ART-experienced individuals in Kano, Nigeria. It seeks to highlight potential differences and inform clinical and nutritional management approaches tailored to the stage of treatment.

MATERIALS AND METHODS

Ethical Consideration

Ethical approvals were obtained from Kano State Ministry of Health's Ethical Committee and Aminu Kano Teaching Hospital (AKTH) and it was assigned the reference number MOH/OFT/797/I.I/1858 dated December 30, 2019 and NHREC/28/01/2020/AKTH/EC/2810, dated March 17, 2020 respectively. Before any anthropometric measurements were performed, participants gave their written informed consent and were told of the study's goal and methodology. The study complied with the Helsinki Declaration's requirements.

Study Design and Study Area

The study was a cross-sectional study conducted at the S.S Wali Unit Department of Medicine, Aminu Kano Teaching Hospital (AKTH) Kano, Infectious Disease Hospital (IDH) Kano and Murtala Mohammed Specialist Hospital (MMSH), Kano. The sex, age, tribe, occupation and educational status of the study subjects were obtained using a structured questionnaire.

Inclusion criteria

Patients with HIV infection within the ages of 18 – 70 years who consented to be enrolled in the study or whose consent was obtained from their close relatives. Apparently healthy donors within the ages of 18 – 70 years who consented to be enrolled in the study as controls

Exclusion criteria

Patients with HIV infection who declined to be enrolled in the study. Patients with HIV infection and any underlying viral infectious diseases such as HBV, HCV, TB among others. Patients with HIV infection with pregnancy, on hormonal contraceptive and with behavioral characteristics such as tobacco exposure, alcohol use and intravenous drug users were excluded in the study. Subjects with a history of diabetes mellitus, active opportunistic infections, inflammatory conditions, diarrhoea were excluded.

Determination of Sample Size

The sample size was calculated according to the formula describe by Ezeoma *et al*. (16).

Calculation of sample size, using Fisher's formula: $n=Z^2P(1-P)/W^2$

Where, n= desired sample size
P= known prevalence from other studies =0.6%
Z= standard deviation at 95% confidence interval=1.96
W= degree of accuracy= 0.05
Prevalence of HIV patients in Kano is 8.5% (17).

Therefore, $n= (1.96)^2(0.085)\ 1-0.085/\ (0.05)^2$
n= (3.84 x 0.085) (0.915)/0.0025
n=0.326x 0.915/0.0025
n=0.299/0.0025
n=120

For the purpose of this study, the sample population was increased to two hundred (200) HIV subjects and one hundred (100) apparently healthy volunteers as controls.

Retroviral Screening

The HIV Screening was done for both case and control using diagnostic test kids such as Determine, STAT-PAK and Uni-Gold test kits from Alere Determine™ HIV-1/2, Chembio Diagnostic Systems, Inc and Trinity Biotech respectively using

standard algorism according to the technique described by Delaney *et al*. (18).

Anthropometric Indices Measurements

Height measurement

Height was measured according to the technique described by Ahmad *et al*. (19).

Procedure

The subject's height was measured using a portable stadiometer and measure to the nearest meter. Each individual was standing erect without shoes and with all head covering removed.

Calculation

Result of measurement is expressed in either $(m)^2$ or cm depending on the need.

Weight measurement

Weight was measured according to the technique described by Ahmad *et al*. (19).

Procedure

The weight of the subjects was measured by a portable standard weighing machine and measure to the first decimal function of kilograms. Individual weight was obtained with the usual outdoor clothes which was not heavy but without shoes. All heavy objects (bunch of keys, bangles, wrist watches and mobile phones among others were removed from the subjects.

Calculation

Result of measurement is expressed in kg.

Body Mass Index

Body Mass Index (BMI) was measured according to the technique described by Isah *et al***.** (20),

Procedure

The measurement of the weight (kg) and the height $(m)^2$ were used to measure the BMI.

Calculation

The Body Mass Index was calculated using the formula.

{BMI = weight (Kg)/ height (m^2)}

Waist circumference Measurement

Waist circumference (WC), was measured according to the technique described by Ahmad *et al*. (19).

Procedure

A tape was place around the bare abdomen just above the hip bone at the level of the umbilicus, midpoint between the top of the iliac crest and the lower margin of the last palpable rib in midaxillary line using a non-stretchable flexible tape rule, not squeeze or compress in the skin and was parallel to the floor. The waist was measured in a Relax and exhale manner. Average of two readings was used for analysis

Calculation

Result of measurement was expressed and recorded in centimeters (cm).

Hip circumference Measurement

Hip circumference (HC), was measured according to the technique described by Ahmad *et al*. (19).

Procedure

A tape was place around the buttocks on the hip bone at the midpoint around the superior border of the iliac crest, using a non-stretchable flexible tape rule, not squeeze or compress in the skin and was parallel to the floor. The hip was measured in a Relax and exhale manner. Average of two readings was used for analysis

Calculation

Result of measurement was expressed and recorded in centimeters.

Waist-to-hip ratio Measurement

Waist-to-hip ratio (WHR), was measured according to the technique described by Ahmad *et al*. (19).

Procedure

WHR was calculated by dividing WC (in cm) by hip circumference (cm). Hip circumference was measured at a level parallel to floor, at the largest circumference of the buttocks.

Calculation

The Waist-to-hip ratio was calculated using the formula.

(WHR = Waist / hip)

Waist-to-height ratio Measurement

Waist-to-height ratio (WHtR), was measured according to the technique described by Ahmad *et al*. (19).

Procedure

WHtR was calculated by dividing WC (in cm) by height circumference (cm).

Calculation

The Waist-to-hip ratio was calculated using the formula.

{WHtR = Waist / height}

Data analysis

Data were analyzed using Statistical Package for Social Sciences version 21.0 (SPSS). Normality testing was performed and the data were normally distributed. The Mean and Standard Deviation were computed and results were expressed as mean±SD. Student t-test was used to compare differences between means. Correlation was performed using Pearson's Correlation Coefficient. Statistical significance was set at $p<0.05$.

RESULTS

The results obtained from the present study are presented in Tables 1-4 respectively. Table 1 shows the socio-demographic distribution of the study participants. The mean age of the patients in the study was 37.12 ± 12.44 and that of the controls was 32.88 ± 11.14. The higher frequency of 113 (56.5%) patients was between the age ranges of 18-39 years, while the lower frequency of 11 (5.5%) patients was in age ≥ 60. Females had a higher frequency of 128 (64.0%) than the males with 72 (36%) for the patients with a female to male ratio of 1.78:1. The higher frequency of Ethnic group was observed in Hausa/Fulani patients to be 149 with a percentage frequency of 74.5% and the lower frequency of Ethnic group in patients was 51 with a percentage frequency of 25.5% in other tribes. The higher frequency of marital status was observed in married patients to be 111 with a percentage frequency of 55.5% and the lower frequency of marital status was in single patients with a frequency of 89 and a percentage of 44.5%. The higher frequency of patients based on educational status was observed in patients who attained secondary education to be 78 with a percentage frequency of 39% and the lower frequency was in Religious knowledge with a frequency of 2 with a percentage frequency of 1 %. The higher frequency of Occupation was revealed to be traders with 79 and a percentage frequency of 39.5, while the lower frequency of occupation in patients was 1 with a percentage frequency of 0.5% in public servants. Table 2 shows the status of patients according to the regimen. A total of 45 ART Naïve patients participated in the study, female patients had a higher frequency of 26 while male patients had a lower frequency of 19. A total sum of 155 patients on ART participate in the study, was female patients on ART had a higher frequency of 98, while males had a lower frequency of 57. Patients on the first-line regimen had a higher frequency of 114 while patients on the second-line regimen had a lower frequency of 41. The first and second-line regimens had a higher frequency of 72 and 26 respectively in female patients, and the lower frequency of 42 and 15 respectively in male patients. The Anthropometric Indices (Mean ±SD) in HIV patients and controls are shown in tables 3. The mean± SD of height, waist circumference, hip circumference, waist-to-hip ratio, and waist-to-height ratio of patients were significantly ($p <0.05$) higher when compared with corresponding values of controls respectively. However, there was no statistically significant ($p >0.05$) in BMI and weight of patients when compared with the controls. Table 4 Indicate the Anthropometric Indices (Mean ±SD) in HIV patients on ART and Naïve. The mean± SD of weight , BMI , waist circumference, hip circumference, waist-to-hip ratio and waist-to-height ratio of patients ART were significantly ($p <0.05$) higher when compared with corresponding values of Naïve patients with weight, BMI, waist circumference, hip circumference, waist-to-hip ratio and waist-to-height ratio respectively. However, there is no statistically significant ($p =0. 223$) in height of patients on ART when compared with the naïve patients. The correlation of BMI with WC, HC, WHR, and WHtR in the study participant was shown iin table 5. There was a statistically ($p=0.00$) positive correlation between BMI & HC, BMI & WC, BMI & WHR, and BMI & WHtR in both patients and control. There was no correlation between BMI & WHR in the control group.

Table 1: Sociodemographic distribution of the study participants

Factors	Patients (Total n=200)	Control (Total n=100)
Age group (yrs)		
18 - 39	113 (56.5)	76 (76.0)
40 – 59	76(38.0)	20 (20.0)
≥ 60	11 (5.5)	4 (4.0)
mean ± SD	37.12 ± 12.44	32.88 ± 11.14
Gender		
Males	72 (36.0)	33 (33.0)
Females	128 (64.0)	67 (67.0)
Females or Male	1.78:1	2.03:1
Ethnic group		
Hausa/fulani	149 (74.5)	69 (69.0)
Others	51 (25.5)	31 (31.0)
Marital status		
Single	89 (44.5)	58 (58.0)
Married	111 (55.5)	42 (42.0)
Educational Level		
None	33 (16.50)	3 (3.00)
Primary	49 (24.50)	6 (6.00)
Secondary	78 (39.00)	14 (14.00)
Tertiary	38 (19.00)	77 (77.00)
Religious knowledge	2 (1.00)	0 (0)
Occupation		
Civil servant	42 (21.0)	38 (38.0)
Trader	79 (39.5)	3 (3.0)
Student	4 (2.0)	34 (34.0)
Unemployed	55 (27.5)	22 (22.0)
Artisan	19 (0.5)	3 (3.0)
Public servant	1 (0.5)	0 (0)

f= frequency; %=percentage; yrs=years.

Table 2: Status of patients according to regimen

ART Category	Male	Female	Total (n=200)
ART Naive	19	26	45
First-line regimen	42	72	114
Second-line regimen	15	26	41
	57	98	

n=Number of Subject; *ART= Antiretroviral Therapy*

Table 3: Anthropometric Indices (Mean ±SD) in HIV patients and controls

Parameters	Patients (n=200)	Controls (n=100)	*t-value*	*p-value*
Height (m)	1.65 ± 0.08	1.52 ± 0.09	2.064	0.040*
Weight (Kg)	64.56 ± 11.75	65.24 ± 12.36	-0.461	0.645
BMI(Kg/m^2)	23.83 ± 4.56	24.67 ± 4.14	-1.552	0.122
WC (cm)	76.85 ± 16.24	67.69 ± 9.07	5.242	0.001*
HC (cm)	88.05 ± 17.76	80.36 ± 9.94	4.023	0.001*
WHpR	0.87 ± 0.07	0.84 ± 0.05	3.889	0.001*
WHtR	0.47 ± 0.12	0.42 ± 0.05	3.987	0.001*

*p≤ 0.05 (significant of Independent t-test) for patient Vs Control for Analysis *; n=Number of Subject; BMI= Body Mass Index; WC=Waist circumference; HC=Hip circumference; WHpR=Waist-to hip ratio; WHtR=Waist-to-height ratio; HIV= Human Immunodeficiency Virus; SD= Standard deviation.*

Table 4: Anthropometric Indices (Mean ±SD) in HIV patients on ART and Naïve

Parameters	ART (n=155)	Naive (n=45)	*t-value*	*p-value*
Height (m)	1.64 ± 0.07	1.66 ± 0.09	-1.222	0.223
Weight (Kg)	65.89 ± 11.61	59.96 ± 11.19	3.047	0.003*
BMI(Kg/m^2)	24.50 ± 4.32	21.62 ± 4.71	3.830	0.001*
WC (cm)	81.76 ± 12.51	59.93 ± 16.36	9.572	0.001*
HC (cm)	92.39 ± 16.21	73.09 ± 14.55	7.189	0.001*
WHpR	0.89 ± 0.05	0.81 ± 0.09	7.481	0.001*
WHtR	0.50 ± 0.10	0.37 ± 0.12	6.775	0.001*

*p≤ 0.05 (significant of Independent t-test) for patient Vs Control for Analysis *; n=Number of Subject; BMI= Body Mass Index; WC=Waist circumference; HC=Hip circumference; WHpR=Waist-to hip ratio; WHtR=Waist-to-height ratio; HIV= Human Immunodeficiency Virus; SD= Standard deviation; ART= Antiretroviral Therapy.*

Table 5 Correlation of BMI with WC, HC, WHpR and WHtR in the study participant

	Patients (n=200)		Controls (n=100)	
Parameters	**r(Pearson)**	***p-value*#**	**r(Pearson)**	***p-value*#**
BMI & HC	0.775	0.001*	0.447	0.001*
BMI & WC	0.740	0.001*	0.462	0.001*
BMI & WHpR	0.417	0.001*	0.108	0.284
BMI & WHtR	0.677	0.001*	0.492	0.001*

*#=determined by pearsons correlation; *p= Correlation is significant at ≤ 0.05 levels (2- tailed); Cl=95% Confidence Interval; r = strength of correlation; (-) inversely correlation; (+) proportional correlation; n=Number of Subject; BMI= Body Mass Index; WC=Waist circumference; HC=Hip circumference; WHpR=Waist-to hip ratio; WHtR=Waist-to-height ratio; HIV= Human Immunodeficiency Virus*.

DISCUSSION

Anthropometric measurements are reliable, non-invasive and strong indicators for different diseases, HIV progression or decline as a result of viral toxicity, ART or loss of appetite in HIV- Infected people remain a significant predictor of survival of the patient (21). The improvement in anthropometric indices may be interpreted as a surrogate measure of immunologic healing because it might be linked to factors such as increased intake, appetite, decreased metabolic demand among others (22).

The current study shows that the mean age of HIV patients was 37 years, with the highest frequency between the age ranges of 18-39 years. Our finding is in accordance with the report of Abubakar *et al*., (23). Our finding is slightly in variance with the report of Pangmekeh *et al.* (24). The youth population are the worst hit or more vulnerable to HIV due to inadequate access to sex education as a results of our norms and value about sex and parental consent required before sex education (25). High societal factors risk behaviours that may reduce their ability to avoid copulation, maintenance of multiple sex partners, intravenous drug use, and other high-risk behaviors also make them vulnerable (26). Physical, emotional, financial, social, and economic attributes of adolescence and psychological factors in young people might also be implicated (27). Previous reports have shown that adolescents who begin sexual activity early are likely to have sex with more partners, and with partners who have been at risk of HIV exposure (28).

Women continue to bear the brunt of this global epidemic since its inception, particularly in sub-Sahara Africa (29). In the present study, it was observed that females had a higher frequency of HIV infection than males with female-to-male ratio of 1.78:1. This finding agrees with the studies of Ramjee and Daniels, (29); Abubakar *et al*., (23). The finding is at variance with the report of Soares *et al*. (12). A multitude of factors might lead to the increased vulnerability of HIV

infection in females. These include biological, behavioral, socioeconomic, cultural, and structural risks among others (30). Kebede *et al*. (30), also reported that women received counseling services on *HIV/AIDS* more than their male counterparts, and to this note, most newly HIV-infected patients were discovered.

Our study reveals that a higher frequency of ethnic group of patients with HIV was observed in Hausa/Fulani. Isah and Abdulazeez. (31), reported that the predominant population of the ancient commercial city of Kano which is located in North-Western Nigeria is predominantly Hausa with numerous inter-marriages with Fulani, they are mostly addressed as Hause/Fulani. This might explain the reason for our finding. However, the patients in this study were of the same racial background, therefore, no racial comparison was made.

In our finding, the higher frequency of marital status of patients with HIV was perceived in married patients. This finding is in conformity with the findings of previous studies of Pangmekeh *et al.* (24) and Nabukenya *et al*. (32), but inconsistent with the findings of previous study of Fagbamigbe *et al*. (33). Marriage rates among black African women are aged range between 15-59 years (34), and Knowledge of HIV status is crucial for HIV prevention and management in marital relationships (35). The finding might be connected with married couples having more liberty of assessing treatment and counseling when compared with others who didn't care to have either routing HIV testing or counseling because of their status of being un-married (36), with the moral standard of Kano, North-western Nigeria (37). Widows are not properly catered for in Africa (38). Single, separated, and divorced women who contracted HIV are often treated with disdain and stigmatization (39), and this reduces their willingness to go for screening in other to commence HIV treatment if infected. Matrimony plays a huge role in identifying patients with HIV, particularly during antenatal care among others. This subsequently leads to a decline in the spread of HIV when compared with the single marital status (40). Another key factor associated with HIV infection among couples may include residing in a high HIV prevalence study region, and the increasing number of the previous couple unions an individual who have sexual involvement with among others (32).

The finding in our study shows that the burden of HIV Infection is more predominant in patients who attained secondary education. This is in agreement with the work of Muyunda *et al*. (41) and contrast with the reports of Fagbamigbe *et al*. (33), Pangmekeh *et al.* (24). The high level of illiteracy in northern Nigeria is driven by various factors, including economic barriers and sociocultural norms and practices which discourage the attendance of higher education, especially for girls who in the North *e.g.* early marriage is the order of the day most women are in secondary schools before they get married. This may explain the current finding (42).

The contribution of population mobility to the HIV epidemic in sub-Saharan Africa particularly commercial activity has greatly enhanced the spread of HIV and other communicable diseases (43). Our study shows that the higher frequency of HIV patients observed based on occupation were traders. Our finding is in line with the studies conducted by Camlin *et al*. (43), but disagreed with the work of Conyers *et al*. (44). The predominant occupation in Kano is trading, this is because Kano is one of the largest commercial cities in sub-Saharan Africa (45), and this may justify this finding.

In the current investigation, HIV patients on the first-line regimen had a higher frequency than patients on the second-line regimen. Alene *et al*. (46), agreed with this finding. It is agreed that the first-line regimen is safe, available, affordable, and convenient to use, while the second-line regimen does not have fixed-dose combinations, the drugs are mostly monopoly products and their prices are much higher than first-line fixed-dose combinations (47). Additionally, second-line ART is mainly used in *patients* who develop treatment failure for *first-line* drug regimens (48). In a nutshell, HIV-infected individuals can now live close to normal lifespans because of efficient antiretroviral therapy (ART), but they nevertheless have high rates of metabolic disease due to both conventional lifespans such as Western diet, sedentary lifestyle among other, and HIV-/ART-related factors such as chronic inflammation and immune activation, gut microbiome disturbances, drug toxicities (49).

The current study shows the mean value of BMI was not statistically significant in HIV patients when compared with the controls. This is similar to the reports of Naidoo *et al*. (50). Our finding disagreed with the report of Anyabolu. (51). However, Hattingh *et al*. (52), reported contrary. Our finding may be attributed to the larger number of HIV patients on ART in the current study. Antiretroviral therapy as a treatment for HIV/AIDS has decreased overall the morbidity and mortality associated with the disease and also improves well-being by restoration of weight loss (53). Furthermore, the universal test and treatment strategy guideline enables ART access irrespective of $CD4^+$ count, which may reduce the number of patients that are presented with advanced HIV disease, including a low BMI. Naidoo *et al*. (50), this might also be the reason for this finding.

The adipose tissue which is a possible mechanism underlying the effect of BMI is an active endocrine and paracrine organ that regulates energy storage, immunity, and inflammation (54). Our study reveals that the mean values of BMI were statistically significantly higher in ART patients than the Naive patients with the higher frequency of bodyweight BMI observed in Normal weight. This is in conformity with the report of Kwiatkowska *et al*. (55). This finding is contrary to the study of Jiang *et al*. (56). The rationale for this finding may be due to HIV infection profoundly affects nutritional status because the disease is associated with poor appetite, impaired

nutrient absorption, increased basal metabolic rate, severe malnutrition, and opportunistic infections (50), subsequently resulting to more body wasted or decrease in BMI because malnutrition and infection are closely related (57). Modern ART initiation is often associated with weight gain (58).

The measurement of Anthropometric parameters is a simple non-invasive and inexpensive parameter measured in HIV/AIDS patients (59). Our current data also showed that the mean values of Waist circumference, Hip circumference, Waist-to-hip ratio, and Waist-to-height ratio were statistically significantly higher in HIV patients than in the controls. Our report is consistent with the finding of Erlandson *et al*. (60). Our finding is not in line with the studies conducted by Kwiatkowska *et al*. (55). Our findings may suggest a higher risk for heart disease or diabetes in HIV patients due to an increase in total abdominal adipose tissue and abdominal subcutaneous adipose tissue, probably due to the effect of the ART regime in this group of patients in the study population (60, 61).

Anthropometric parameters classifying cardio-metabolic risk and subsequent increase in morbidity and mortality in HIV/AIDS patients (53). The findings in this study suggest that the mean values of weight, waist circumference, hip circumference, waist-to-hip ratio, and waist-to-height ratio were statistically significantly higher in HIV patients on ART than the Naïve. Our result aligns with the work of Soares *et al*. (12), Lake. (49). These findings are not consistent with the study of Esposito *et al*. (62). Long-term use of ART has been associated with numerous metabolic complications such as dysglycaemia, insulin resistance, dyslipidaemia, lipodystrophy inflammatory sequelae (49).

Anthropometric measurement is a critical marker for the measurement of adiposity and body mass among others in HIV patients, where both underweight and overweight are of great importance. These measurements are predictor markers of visceral adiposity and cardiovascular disease (9). In our findings, a significant positive correlation was observed between BMI with HC, WC, WHR, and WHtR in HIV patients. This aligns with the finding of Dimala *et al*. (59). This indicates that when there is a proportional increase in BMI, there is a probable increase in HC, WC, WHR, and WHtR due to excess fat carried around those regions of the body, and with a decrease, BMI decrease in the anthropometric indices occurs (63).

Conclusion: Based on the findings of this study, it can be concluded that, HIV infection is more common among females than males, and the prevalence of the disease is higher in patients between the age ranges of 18-39 years. HIV infection is associated with decreased BMI and an increase in WC, HC, WHpR and WHtR in HIV naïve patients with improved well-being or condition when on ART.

Funding: The authors did not receive any outside funding for this study.

Conflict of Interests: The authors declare that there is no conflict of interest related to the publishing of this work.

Author's contributions: Each author bears responsibility for the accuracy and integrity of this work, having contributed to its completion and approval.

Acknowledgement: We would like to express our gratitude to the Department of Medical Laboratory Science Bayero University, Kano, Muhammad Abdullahi Wase Specialist Hospital and Aminu Kano Teaching Hospital staff for their support during the research period.

Author Details: [1]Department of Medical Laboratory Science, Bayero University, Kano, Nigeria; [2]Department of Medical Laboratory Science, University of Benin, Benin City, Edo State; [3]Department of Chemical Pathology, Ahmadu Bello University Teaching hospital, Shika, Kaduna, Nigeria; [4]Department of Pharmacology and Therapeutics, Faculty of Pharmaceutical Sciences, Ahmadu Bello University, Zaria, Nigeria; [5]University Health Services Unit, Federal University of Technology, Babura, Jigawa state, Nigeria; [6]Department of Medical Laboratory Science, Prince Abubakar Audu University, Anyigba

REFERENCES

1. Barasa, S.S. True story about HIV: theory of viral sequestration and reserve infection. HIV AIDS (Auckl). 2011; 3:125-33.
2. German Advisory Committee Blood (Arbeitskreis Blut), Subgroup 'Assessment of Pathogens Transmissible by Blood'. Human Immunodeficiency Virus (HIV). Transfusion medicine and hemotherapy. 2016; 43(3):203-22.
3. Al-Jabri, A.A. Mechanisms of Host Resistance Against HIV Infection and Progression to AIDS. Sultan Qaboos University medical journal. 2007; 7(2):82-96.
4. Nkwo, P. Prevention of mother to child transmission of human immunodeficiency virus: the Nigerian perspective. Annals of Medical and Health Sciences Research. 2012; 2(1):56-65.
5. Rupali, P., Condon, R., Roberts, S., Wilkinson, L., Voss, L. & Thomas, M.G. Prevention of mother to child transmission of HIV infection in Pacific countries. Internal Medicine Journal. 2007; 37(4):216-23.
6. De, Pee, S. & Semba, R. D. Role of nutrition in HIV infection: review of evidence for more effective programming in resource-limited settings. Food and Nutrition Bulletin. 2010; 31(4):S313-S344.
7. Martin, C.J., Muller, E., Labadarios, D., Veldman, F.J. & Kassier, S.M. Body composition of HIV-positive

candidates for and recipients of a kidney transplant: comparative analysis between DEXA and anthropometric indices. South African Journal of Clinical Nutrition. 2020; 34 (3):110-115.

8. Kyle C, John K. Anthropometric Measurement https://www.ncbi.nlm.nih.gov/books/NBK537315/#article-17666.s6. Last Update: April 28, 2020.

9. Kidy, F. F., Dhalwani, N., Harrington, D. M., Gray, L. J., Bodicoat, D. H., Webb, D., Davies, M. J. & Khunti, K. Associations Between Anthropometric Measurements and Cardiometabolic Risk Factors in White European and South Asian Adults in the United Kingdom. Mayo Clinic Proceedings. 2017; 92(6):925-933.

10. Sebo, P., Herrmann, F. R. & Haller, D. M. Accuracy of anthropometric measurements by general practitioners in overweight and obese patients. BMC obesity. 2017; 4:23.

11. Kim, J. H., Spiegelman, D., Rimm, E. & Gorbach, S. L.. The correlates of dietary intake among HIV-positive adults. The American Journal of Clinical Nutrition. 2001; 74(6):852-61.

12. Soares, L. R., da Silva, D. C., Gonsalez, C. R., Batista, F. G., Fonseca, L. A., Duarte, A. J. & Casseb, J. Discordance between body mass index and anthropometric measurements among HIV-1-infected patients on antiretroviral therapy and with lipoatrophy/lipohypertrophy syndrome. Revista do Instituto de Medicina Tropical de Sao Paulo. 2015; 57(2):105-510.

13. Sharma, A., Hoover, D. R., Shi, Q., Gustafson, D., Plankey, M. W., Hershow, R. C., Tien, P. C., Golub, E. T. & Anastos, K. Relationship between Body Mass Index and Mortality in HIV-Infected HAART Users in the Women's Interagency HIV Study. PloS One. 2015; 10(12):e0143740.

14. Onyango, A.C., Walingo, M.K., Mbagaya, G. & Kakai, R. Anthropometric and dietary profile of HIV sero-positive patients in Chulaimbo sub-district hospital, Kenya. Journal of Pharmaceutical and Biomedical Science. 2011. 1(3) 34- 44.

15. Regina, Saka., Emmanuel, A.D., Frank, E. A. H., Matilda, A., Albert, G. B., Amoah, G. A. A. & Edwin, K. W. Nutritional status and effect of highly active anti-retroviral therapy (HAART) on selected trace elements in people living with HIV in Ghana. Scientific African.2023.19, e01586.

16. Ezeome, E. R., & Marshall, P. A. "Informed consent practices in Nigeria." Developing world bioethics. 9, 3 (2009): 138-148.

17. Emmanuel, G.O., Umoh, P., Amechi, P., Sanni, O.F., Abang, R., Boniface, O.B., Yahaya, I.M. & Auwal, A.M. Prevalence of HIV and willingness to uptake preventive services among female sex workers in Kano State, Nigeria. PLoS One. 2025; 20(4):e0319942.

18. Delaney, K. P., Branson, B. M., Uniyal, A., Phillips, S., Candal, D., Owen, S. M. & Kerndt, P. R. Evaluation of the performance characteristics of 6 rapid HIV antibody tests. Clinical infectious diseases. 2011; 52(2):257-63.

19. Ahmad, N., Adam, S. I., Nawi, A. M., Hassan, M. R. & Ghazi, H. F. Abdominal Obesity Indicators: Waist Circumference or Waist-to-hip Ratio in Malaysian Adults Population. International Journal of Preventive Medicine. 2016; 7:82.

20. Isah, S.Y., Okafor, P.A., Anaja, P.O., Yeldu, M.H., Hamid, K.M., Gwaram, B.A., Shehu A., Abdullahi, M., Zakariyya, A.A., Kabir, N., Jelani, I., Chidi, U. & Yahaya, H.M. (2018). Anthropemetric Indices of Patients with Hyperthyroidism Attending Aminu Kano Teaching Hospital, Kano North Western Nigeria. Bayero Journal of Medical Laboratory Science. 2018; 3(2): 309 – 314.

21. Bailin, S. S., Gabriel, C. L., Wanjalla, C. N. & Koethe, J. R. Obesity and Weight Gain in Persons with HIV. Current HIV/AIDS reports. 2020; 17(2):138-150.

22. Martin-Hadmaș, R. M., Martin, Ș. A., Romonți, A. & Mărginean, C. O. The Effect of Dietary Intake and Nutritional Status on Anthropometric Development and Systemic Inflammation: An Observational Study. International Journal of Environmental Research and Public Health. 2021; 18(11):5635.

23. Abubakar, M.G., Abduljalil, M.M. & Nasiru, Y, I. Changes in Liver Function Enzymes of HIV/AIDS Patients Treated with Antiretroviral Drugs (ARVS) in Specialist Hospital, Sokoto, Nigeria. Nigerian Journal of Basic and Applied Science.2014; 22(3&4): 85-89.

24. Pangmekeh, P. J., Awolu, M. M., Gustave, S., Gladys, T. & Cumber, S. N. Association between highly active antiretroviral therapy (HAART) and hypertension in persons living with HIV/AIDS at the Bamenda regional hospital, Cameroon. The Pan African Medical Journal. 2019; 33:87-91.

25. Leung, H., Shek, D. T. L., Leung, E. & Shek, E. Y. W. Development of Contextually-relevant Sexuality Education: Lessons from a Comprehensive Review of Adolescent Sexuality Education Across Cultures. International Journal of Environmental Research and Public Health. 2019; 16(4):621-632.

26. Yao, Y., Wang, N., Chu, J., Ding, G., Jin, X., Sun, Y., Wang, G., Xu, J. & Smith, K. Sexual behavior and risks for HIV infection and transmission among male injecting drug users in Yunnan, China. International Journal of Infectious Diseases. 2009; 13(2):154-161.

27. Gerbi, G.B., Habtemariam, T., Robnett, V., Nganwa, D. & Tameru, B. Psychosocial factors as predictors of HIV/AIDS risky behaviors among people living with HIV/AIDS. Journal of AIDS and HIV Research. 2012; 4 (1):8-16.

28. Gerbi, G. B., Habtemariam, T., Robnett, V., Nganwa, D., & Tameru, B. Early sexual debut: prevalence and risk factors among secondary school students in Ido-ekiti, Ekiti state, South-West Nigeria. Journal of AIDS and HIV research. 2012; 4(1), 8–16.

29. Ramjee, G., & Daniels, B. Women and HIV in Sub-Saharan Africa. AIDS Research and Therapy. 2013; 10(1):30-43.

30. Kebede, T., Dayu, M. & Girma, A. The Burden of HIV Infection among Pregnant Women Attending Antenatal Care in Jimma University Specialized Hospital in Ethiopia: A Retrospective Observational Study. Interdisciplinary Perspectives on Infectious Diseases. 2022; 2022:3483767.

31. Isah, S.Y., & Anas, S.A. Evaluation of C-Reactive Protein and Interleukin-6 among Nephrotic Syndrome Patients in Kano Metropolis. Journal of Medical Laboratory Science. 2021; 31(2):1-11.

32. Nabukenya, A. M., Nambuusi, A. & Matovu, J. K. B. Risk factors for HIV infection among married couples in Rakai, Uganda: a cross-sectional study. BMC infectious diseases. 2020; 20(1):198.

33. Fagbamigbe, A.F., Adebayo, S.B. & Idemudia, E. Marital status and HIV prevalence among women in Nigeria: Ingredients for evidence-based programming. International Journal and Infectious Disease. 2016; 48:57-63.

34. Shisana, O., Risher, K., Celentano, D. D., Zungu, N., Rehle, T., Ngcaweni, B. & Evans, M. G. Does marital status matter in an HIV hyperendemic country? Findings from the 2012 South African National HIV Prevalence, Incidence and Behaviour Survey. AIDS care. 2016; 28(2):234-241.

35. Musheke, M., Merten, S., & Bond, V. Why do marital partners of people living with HIV not test for HIV? A qualitative study in Lusaka, Zambia. BMC Public Health. 2016; 16(1):882.

36. Matovu, J. K., Denison, J., Wanyenze, R. K., Ssekasanvu, J., Makumbi, F., Ovuga, E., McGrath, N. & Serwadda, D. Trends in HIV counseling and testing uptake among married individuals in Rakai, Uganda. BMC Public Health. 2013; 13:618.

37. Adamu, F. Gender, Hisba and the Enforcement of Morality in Norther Nigeria. Africa. 2008; 78(1): 136-152.

38. Adebowale, S.A., Atte, O. & Ayeni, O. Elderly well-being in a rural community in North Central Nigeria Sub-Saharan Africa. Public Health Research.2012; 2:92–101.

39. Waite, L.J & Gallagher, M. What are the possible consequences of divorce for adults? Utah Divorce Orientation. Available at:www.divorce.usu.edu/files/uploads/lesson6.pdf (accessed. 2014.

40. Semrau, K., Kuhn, L., Vwalika, C., Kasonde, P., Sinkala, M., Kankasa, C., Shutes, E., Aldrovandi, G. & Thea, D. M. Women in couples antenatal HIV counseling and testing are not more likely to report adverse social events. AIDS (London, England). 2005; 19(6):603-609.

41. Muyunda, B., Musonda, P., Mee, P., Todd, J. & Michelo, C. Educational Attainment as a Predictor of HIV Testing Uptake Among Women of Child-Bearing Age: Analysis of 2014 Demographic and Health Survey in Zambia. Frontiers in Public Health; 2018. 6: 192.

42. Kazeem, A., Jensen, L. & Stokes, C. S. School Attendance in Nigeria: Understanding the Impact and Intersection of Gender, Urban-Rural Residence and Socioeconomic Status. Comparative education review. 2010; 54(2):295-319.

43. Camlin, C. S., El Ayadi, A. M., Kwena, Z. A., McFarland, W., Johnson, M. O., Neilands, T. B., Bukusi, E. A. & Cohen, C. R. High Mobility and HIV Prevalence Among Female Market Traders in East Africa in 2014. Journal of Acquired Immune Deficiency Syndromes. 2017; 74(5):e121-e128.

44. Conyers, L., Chiu, J.Y., Rueda, S., Misrok, M., Lynn, V. & McKinney-Prupis, E. Employment as a Social Determinant of HIV Care and Prevention Outcomes. In (Ed.), AIDS Updates - Recent Advances and New Perspectives. IntechOpen.2021; https://doi.org/10.5772/intechopen.98418.

45. Anaja, P.O. & Isah, S. Y. Lipid Profile Pattern in Patients with Different Disease Conditions in Kano, Northwest, Sokoto Journal of Medical Laboratory Science.2017; 2(4): 70 – 75.

46. Alene, M., Awoke, T., Yenit, M.K., Muluneh, A., Tadesse, A., Melaku, K. Y. & Adino, T, T. . "Incidence and predictors of second-line antiretroviral treatment failure among adults living with HIV in Amhara region: a multi-centered retrospective follow-up study." BMC infectious diseases.2019; 19:599-618.

47. Nunn, A. S., Fonseca, E. M., Bastos, F. I., Gruskin, S. & Salomon, J. A. Evolution of antiretroviral drug costs in Brazil in the context of free and universal access to AIDS treatment. PLoS Medicine; 2007; 4(11): e305.

48. Baraki, A. G., Gezie, L. D., Zeleke, E. G., Awoke, T. & Tsegaye, A. T. (2019). Body mass index variation over time and associated factors among HIV-positive adults on second-line ART in north-west Ethiopia: a retrospective follow-up study.2019; BMJ Open; 9(9): e033393.

49. Lake, J. E. The Fat of the Matter: Obesity and Visceral Adiposity in Treated HIV Infection. Current HIV/AIDS reports. 2017; 14(6):211-219.

50. Naidoo, K., Yende-Zuma, N. & Augustine, S. (2018). A retrospective cohort study of body mass index and survival in HIV infected patients with and without TB co-infection. Infectious Diseases of Poverty. 2018; 35:43-55.

51. Anyabolu, E.N. BMI and Risk Factors of Underweight and Obesity in HIV Subjects in Eastern Nigeria. World Journal of AIDS. 2016; 6: 8-15.

52. Hattingh, Z., Walsh, C. & Bester., C.J. Anthropometric profile of HIV-uninfected and HIV-infected women aged 25–44 years in mangaung, Free State. South African Family Practice.2011; 53(5):474-480.

53. Eggleton, J.S. & Nagalli, S. Highly Active Antiretroviral Therapy (HAART). In StatPearls.StatPearls Publishing. 2022 Janh ttps://www.ncbi.nlm.nih.gov/books/NBK554533/. Last Update: July 8, 2022.

54. Zaldivar, F., McMurray, R. G., Nemet, D., Galassetti, P., Mills, P. J. & Cooper, D. M. Body fat and circulating leukocytes in children. International journal of obesity. 2006; 30(6):906-911.

55. Kwiatkowska, W., Knysz, B., Drelichowska-Durawa, J., Czarnecki, M., Gasiorowski, J., Biłyk, E., Karczewski, M. & Witkiewicz, W. HIV [Overweight, obesity and underweight in HIV infected patients]. Przeglad lekarski. 2013; 70(3):113-117.

56. Jiang, J., Qin, X., Liu, H., Meng, S., Abdullah, A. S., Huang, J., Qin, C., Liu, Y., Huang, Y., Qin, F., Huang, J., Zang, N., Liang, B., Ning, C., Liao, Y., Liang, H., Wu, F., & Ye, L. An optimal BMI range associated with a lower risk of mortality among HIV-infected adults initiating antiretroviral therapy in Guangxi, China. Scientific Reports. 2019; 9(1):7816.

57. Tekleab, A.M., Tadesse, B.T., Giref, A.Z., Shimelis, D. & Gebre, M. Anthropometric Improvement among HIV Infected Pre-School Children Following Initiation of First Line Anti-Retroviral Therapy: Implications for Follow Up. PLoS One. 2016; 11(12):e0167565.

58. Erlandson, K,M,, Taejaroenkul, S., Smeaton, L., Gupta, A., Singini, I.L., Lama, J.R., Mngqibisa, R., Firnhaber, C., Cardoso, S.W., Kanyama, C., Machado, da Silva A.L., Hakim, J.G., Kumarasamy, N., Campbell, T.B. & Hughes, M.D. A Randomized Comparison of Anthropomorphic Changes with Preferred and Alternative Efavirenz-Based Antiretroviral Regimens in Diverse Multinational Settings. Open Forum Infectious Disease. 2015; 2(3):ofv095.

59. Dimala, C.A., Ngu, R.C., Kadia, B.M., Tianyi, F.L. & Choukem, S.P. Markers of adiposity in HIV/AIDS patients: Agreement between waist circumference, waist-to-hip ratio, waist-to-height ratio and body mass index. PLoS One. 2018; 13(3):e0194653.

60. Erlandson, K.M., Zhang, L., Lake, J.E., Schrack, J., Althoff, K., Sharma, A., Tien, P.C., Margolick, J.B., Jacobson, L.P. & Brown, T.T. Changes in weight and weight distribution across the lifespan among HIV-infected and -uninfected men and women. Medicine (Baltimore). 2016; 95(46):e5399.

61. Esposito, F.M., Coutsoudis, A., Visser, J. & Kindra., G. Changes in body composition and other anthropometric measures of female subjects on highly active antiretroviral therapy (haart): a pilot study in kwazulu-natal, South Africa Clinical. Southern African Journal of HIV Medicine.2008; 36-42.

62. Mohammed, I.Y. & Yahaya, I.A. Therapy-related lipid profile changes among patients' on highly active antiretroviral treatment in Kano, North-Western Nigeria. Nigerian Journal of Basic and Clinical Science.2015; 12: 111-115.

63. Haregu, T. N., Oti, S., Egondi, T. & Kyobutungi, C. Measurement of overweight and obesity an urban slum setting in sub-Saharan Africa: a comparison of four anthropometric indices. BMC obesity. 2016; 3:46.

How to cite this article: Isah S. Y., Ibeh I. N., Emokpae M. A., Ocheni A. P., Usman A., Jabir M., Labaran H. and Akor S. E. Anthropometric Indices of Human Immunodeficiency Virus-Positive Anti-Retroviral Therapy (ART)-Naïve and ART-Experienced Subjects In Kano, Nigeria. *Journal of Basic and Applied Medical Sciences.* 2025; 5(1), 26-35. https://dx.doi.org/10.4314/jbams.v5i1.4