Relationship between BMI and CD4 cell counts among people living with HIV on ART attending Infectious Disease Hospital, Kano State

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Research Article

Keywords: CD4 cell count, Human immune deficient virus, Body mass index, HAART

Posted Date: July 24th, 2023

DOI: https://doi.org/10.21203/rs.3.rs-3184852/v1

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Abstract

Background

There are currently an estimated 38 million people living with HIV (PLWHIV) in the globe. The aim of the present study was to examine the relationship between Body mass index (BMI) and CD4 cell counts among people living with HIV attending Infectious Disease Hospital, Kano State.

Method

Two hundred HIV-positive and non-HIV positive above 18 years of age were recruited for the study. Blood samples were collected from both categories for the determination of CD4 count. The relationship between the height, weight, BMI, and CD4 cell counts was examined using Pearson correlation, and a p-value less than 0.05 was considered statistically significant.

Result

Mean heights of among male HIV subject (1.66 ± 0.07) was significantly higher (p < 0.001) compared to female HIV subjects (1.54 ± 0.09). BMI was significantly higher (p < 0.001) in female HIV subjects (24.74 ± 4.95) when compared to male HIV subjects (21.78 ± 2.73). There was a moderate positive correlation (r = 0.280, p = 0.006) between CD4 cell count and height in non-HIV males; however, there was no significant correlation between CD4 count and BMI in HIV and non-HIV individuals.

Conclusion

The study concludes that there exists sexual dimorphism in HIV subjects among people living with HIV. There was no significant relationship between CD4 cell count and BMI in HIV and non-HIV individuals.

INTRODUCTION

There are currently an estimated 38 million people living with HIV (PLWHIV) in the globe, and this figure is expected to rise as time goes on [1], [2]. Among this number, Africa has about 25.7 million PLWHIV [3]. The fourth-largest HIV epidemic in the world and one of the highest rates of new infections in sub-Saharan Africa are both found in Nigeria, the most populous nation in Africa. As a result of the surge in HIV treatment in Nigeria, there were approximately 903,000 people living with HIV in 18 Nigerian States as of the year 2021[4]. Life-sustaining highly active antiretroviral treatment (HAART) is administered to more than 1,679,600 individuals in this nation who are over the age of 15 [4]. Human immunodeficiency virus type 1 (HIV-1) is managed and treated with the use of the pharmaceutical regimen known as HAART. It contains a number of pharmaceuticals from the antiretroviral families [5], [6]. For several HAART drugs used to treat HIV, there are indications, mechanisms of action, and contraindications. However, long-term
co-morbidities such metabolic alterations have emerged as a result of antiretroviral treatment usage [7], [8].

Numerous studies in the last five years have shown an increase in the prevalence of obesity and overweight among HIV-positive people, particularly in Africa, with a clear correlation to HAART adherence [9]–[15]. Prior research has mostly focused on evaluating how weight affects immune cells in HIV-uninfected people, with mixed results. Some findings imply that being overweight or obese is linked to greater immune cell numbers [16]–[19] while others reported that obesity results in decreased immune counts and function [20]–[23]. Since the advent of antiretroviral treatment (ART), the proportion of overweight and obese PLWHIV has grown along with the burden of metabolic disorders, particularly type 2 diabetes mellitus (T2DM), through a variety of reasons [24]–[28].

Body mass index (BMI) is calculated by dividing a person's height in meters squared by their weight in kilograms. Underweight, healthy weight, overweight, and obesity are the four weight categories that may be easily and cheaply screened using BMI. Centres for Disease Control and Prevention [29] reported the following classification by BMI values: underweight ($< 18.5\text{kg/m}^2$); healthy weight ($18.5-24.9\text{kg/m}^2$); overweight ($25-29.9\text{kg/m}^2$) and obesity ($30-39.9\text{kg/m}^2$). These cut-off values are based on statistical analysis, and it has been shown that living at the extremes of appropriate nutrition, thinness, and overweight/obesity increases the likelihood of acquiring chronic illnesses with serious negative effects on the general public health [30]–[33]. Given that obesity is linked to greater rates of infectious complications, more severe viral infections, and increased death rates owing to subpar vaccination responses, it may have a negative impact on immunological responses [34]–[39].

In the age of HAART, nothing is known about how weight affects immune cell counts in people with HIV. According to a short research, obese HIV patients had similar CD4 cell counts to normal-weight people but greater CD3, CD8, and total lymphocyte counts [40], [41], hence the need to evaluate the relationship between BMI and CD4 cell counts among people living with HIV attending Infectious Disease Hospital, Kano State. The aim of the present study was to examine the relationship between BMI and CD4 cell counts among people living with HIV attending Infectious Disease Hospital, Kano State.

**MATERIALS AND METHODS**

**Study Area**

This research was conducted at Infectious Disease Hospital (IDH), Kano, a 250-bed capacity hospital in Sabon Gari Kano in the northwest region of Nigeria. IDH, Kano is a comprehensive antiretroviral treatment (ART) site since 2005 [42]. Presently about 18000 patients are enrolled in IDH Kano for ART.

**Study Population**

Consist of clients who are non-HIV and PLWH who had been diagnosed positive by the hospital laboratory (using rapid antibody test), presently on ART, and satisfy the following criteria:
Participant Selection

**Inclusion criteria**

HIV-positive and non-HIV infected patients accessing outpatient care in IDH, patients between 18 to 60 years of age, and consented to participate in the study were included

**Exclusion criteria**

Patients less than 18 years of age, pregnant mothers above 5mths and lactating mothers, and those not willing to participate in the study were excluded

Sample Size Determination

Obtained by using the formula;

\[ N = Z^2 pq/d^2 \]

Where \( Z \) = std normal deviation = 1.96 at 95% confidence interval; and \( d \) = degree of accuracy or precision = 5%

\[ N = 1.96^2(0.85\times0.15)/(0.05)^2 \]

\[ N = 196.04 \text{ approximately 200} \]

Minimum sample size = 200 patients

Study Design

The research was a descriptive cross-sectional observational study and deployed a simple random technique was employed in selecting the subject for the study.

Ethical Consideration

Ethical clearance was sought from the Kano State Ministry of Health. An introductory letter was sought from the Department of Anatomy, Faculty of Basic Medical Science, Bayero University, Kano, and presented to the management of Infectious Disease Hospital, Kano for permission to conduct the study. Informed consent was obtained from the study participants. Each patient was examined separately while ensuring adequate confidentiality and privacy using a mobile hospital screen

BMI Determination

The BMI was determined as outlined in a previous study by Mustapha et al., (2011). Height (in meters), were measured with the patient standing barefoot against a non-extending vertical shaft, with the head, buttocks and heels touching the shaft. The weight (kg), were measured while the subject was standing, wearing light clothing with no shoes on a weighing scale. Weight and height were measured to the
nearest 0.1 kg and 0.1 cm. Two measurements were taken per subject in each group, and when there was a more than 2 cm difference between the two, a third measurement was taken. The mean of the closest two measurements was used to calculate BMI. Body mass index (BMI) [calculated by the quetelet index, that is, weight (kg)/height squared m$^2$].

**Blood Sample Collection and Analysis**

Ten (10) milliliters of whole venous blood samples were collected by clean venipuncture using a 10ml hypodermic syringe and needle from each patient. About 2 ml of blood was transferred to dipotassium EDTA (ethylene diamine tetraacetic acid or sequestrene) anti-coagulated plastic bottles for the CD4 test.

The CD4 count was done in BD FACS Calibar flow cytometer, an automated multicolor system that performs both analysis and sorting using dual lasers 488nm air-cooled argon-ion laser and 635nm red diode laser. Cells are treated with monoclonal antibodies CD3, CD4, and CD45 conjugated to different fluorochromes. As a cell passes through the flow chamber, it is intersected by a laser beam. Forward light scatter is proportional to the cell size and right-angle scatter is related to cell granularity which allows the separation of WBCs based on size and granularity (Parinitha 2012).

**Safety Measures**

Standard precautions were observed by the researcher and research assistant to prevent the spread of infection through the use of PPE, alcohol-based hand sanitizer, and washing of hands with antiseptic washing soap. Where the measuring instrument accidentally comes in contact with body secretions such as saliva and sweat it was disinfected with methylated spirit. Lastly, the researcher and research assistant wore protective ward coats.

**Data Management and Analysis**

The data for the study was exported to Microsoft Excel® for cleaning the data and plotting of graphs. The relationship between the height, weight, BMI, and CD4 cell counts was examined using Pearson correlation, and a p-value less than 0.05 was considered statistically significant.

**RESULT**

**The Height, Weight and BMI of HIV and Non-HIV Subjects**

Table 1 shows descriptive statistics of the height, weight, and BMI of HIV and Non-HIV patients accessing outpatient care in IDH. The mean heights and weights of HIV patients were 1.59 ± 0.10 and 59.23 ± 11.21, while in non-HIV patients the mean heights and weights were 1.61 ± 0.10 and 60.16 ± 12.93 respectively. The body mass indexes are 23.35 ± 4.32 and 23.27 ± 4.59 in HIV and non-HIV patients.
Table 1
Descriptive Statistics of Height, Weight, and BMI of HIV and Non-HIV Subjects accessing outpatient care in IDH

<table>
<thead>
<tr>
<th>Status</th>
<th>Variables</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIV</td>
<td>Height (m)</td>
<td>188</td>
<td>1.30</td>
<td>1.85</td>
<td>1.59 ± 0.10</td>
</tr>
<tr>
<td></td>
<td>Weight (kg)</td>
<td>188</td>
<td>25.00</td>
<td>110.00</td>
<td>59.23 ± 11.21</td>
</tr>
<tr>
<td></td>
<td>BMI (kg/m²)</td>
<td>188</td>
<td>14.79</td>
<td>45.79</td>
<td>23.35 ± 4.32</td>
</tr>
<tr>
<td>Non-HIV</td>
<td>Height (m)</td>
<td>197</td>
<td>1.40</td>
<td>1.89</td>
<td>1.61 ± 0.10</td>
</tr>
<tr>
<td></td>
<td>Weight (kg)</td>
<td>197</td>
<td>39.00</td>
<td>107.00</td>
<td>60.18 ± 12.93</td>
</tr>
<tr>
<td></td>
<td>BMI (kg/m²)</td>
<td>197</td>
<td>14.85</td>
<td>41.84</td>
<td>23.27 ± 4.59</td>
</tr>
</tbody>
</table>

Sexual Dimorphism in BMI among PLWHIV and Non-HIV Infected Patients

Table 2 shows the sexual dimorphism of height, weight, BMI, and CD4 counts in HIV and Non-HIV patients accessing outpatient care in IDH. In HIV patients, there is a significant difference in height, BMI, and CD4 counts \( (p < 0.05) \). While, in Non–HIV patients there is a significant difference in height, weight, and CD4 count \( (p < 0.05) \).

Table 2
Sexual dimorphism of Height, Weight, BMI, and CD4 Counts in HIV and non-HIV patients accessing outpatient care in IDH

<table>
<thead>
<tr>
<th>CD4 cell count</th>
</tr>
</thead>
<tbody>
<tr>
<td>STATUS</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>HIV</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Non-HIV</td>
</tr>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Results were presented as Mean ± SD, HIV: Human immunodeficient virus, and BMI: Body mass index. The difference was considered significant at \( p < 0.05 \)

Relationship Between BMI and CD4 Count in HIV and Non-HIV Patient
DISCUSSION

Mean height among males living with HIV on ART was significantly higher when compared to their female counterparts. Traisathit et al. [43] noted that an early ART approach throughout the formative years of life can boost height and development. However, most previous studies have reported lowered in growth rate and height in male children [44]–[47]. Diet, way of life, and socioeconomic background significantly influence variations in body composition, including height, among PLWHIV [48]–[51].

Females living with HIV had significantly higher BMI compared to their male counterparts. This observation is in consonance with findings by [52]–[56] who reported high BMI in females living with HIV when compared to males. High BMI has been linked to high consumption of calories [57]. Other factors include; lack of physical activities, drugs, genetics, unhealthy lifestyle, metabolic syndrome, poor eating habits, less sleep and high amount of stress [58]. Adults that are shorter tend to have higher BMIs, especially females [59]. This affirms the findings in this present study with regards to increase in height in HIV males when compared to HIV females. Women are believed to have higher BMIs than men for a variety of reasons, including more fat deposition and less muscle mass in women than in men [60], [61], hence the possible reason for the observed higher BMI among HIV females in this study.

Although, there was a moderate positive correlation between CD4 cell count and height in non-HIV males which is in consonance with findings by Ogeh et al. [44], there was no significant correlation between CD4 cell counts and BMI in both HIV and non-HIV males and females in this present study. Mishra and Soren [62] found that a favorable link between height and CD4 cell count can be a sign of effective treatment and management of PLWHIV's health. Following the use of ART at an early stage of diagnosis, growth can significantly improve [63], [64]. This suggests that using HAART effectively is a dependable strategy to gradually raise CD4 cell count in PLWHIV. No matter how long a person has had the virus, it is still advised that they receive this medication since it keeps the viral load low and the CD4 count high [65]. A reduced HIV reservoir has also been linked to extraordinary CD4 cell count recovery on ART in conjunction with better nutrition, which is closely matched to levels in non-HIV persons [66]. The result of this present study therefore suggests that the HAART compliance level in PLWHIV in Kano should be encouraged because comparison of CD4 cell counts in PLWHIV and non-HIV in relation to positive outcomes in BMI can be an indication of enhanced HIV care, hence the need for sustainability of HIV health care in accessible health facilities.

CONCLUSION
The study concludes that there exists sexual dimorphism in HIV subjects among people living with HIV. There was no significant relationship between CD4 cell count and BMI in HIV and non-HIV individuals.

Declarations

Ethics approval and consent to participate

This study was approved by the Kano State Ministry of Health. Informed consent was obtained from all the patients and all methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication

Not applicable

Availability of data and materials

Data for the present study will be made available by the corresponding authors following a reasonable request

Competing interests

The authors declare no conflict of interest.

Funding

The study did not receive funding

Authors’ contributions

OOD, MUI, conceptualized the study; OOD, MUI, EME, and IMU designed the study; OOD, MUI, EME, and IMU collected the data; OOD, EME, and IMU conducted the statistical analysis, OOD, MUI, EME, and IMU conducted data interpretation. OOD, MUI, EME, and IMU drafted the initial manuscript while OOD, MUI, EME, and IMU reviewed it for intellectual content. All authors approved the final version for publication and remain in agreement to ensure that questions related to the integrity of any part of the work are resolved.

Acknowledgments

The authors convey appreciation to the participants and research assistants for availing the data.

References


Figures
Figure 1

Correlation between Weight and CD4 count in PLWH and non-HIV patient Male Patients Accessing Outpatient Care in IDH

Figure 2

Correlation between Weight and CD4 count in PLWH and non-HIV patient Female Patients Accessing Outpatient Care in IDH
Figure 3
Correlation between Height and CD4 count in PLWH and non-HIV patient Male Patients Accessing Outpatient Care in IDH

Figure 4
Correlation between Height and CD4 count in HIV and non-HIV patient Female Patients Accessing Outpatient Care in IDH
Figure 5

Correlation between BMI and CD4 count in HIV and non-HIV patient Male Patients Accessing Outpatient Care in IDH.

Figure 6

Correlation between BMI and CD4 count in PLWH and non-HIV patients Female Patients Accessing Outpatient Care in IDH