



Gender-Based Comparison of Anthropometric and Hematological Parameters in Asymptomatic HIV Subjects at Nnamdi Azikiwe Teaching Hospital (NAUTH), Nnewi, Anambra State, Nigeria

Ifeoma Priscilla Ezeugwunne

Department of Human Biochemistry,
Nnamdi Azikiwe University, Nnewi, Nigeria

Aikpitanyi-Iduitua Aigbedo Godwin

Medical Laboratory Science Council of Nigeria

Obinna David Ibemere

Padiatrics, Maternal and Children Hospital,
Hafar Al Batin City, Saudi Arabia

Sochima Johnmark Obiekwe

Department of Medical Rehabilitation (Physiotherapy),
College of Health Sciences, Nnamdi Azikiwe University, Nnewi, Nigeria

Ifeanyichukwu Samuel Ike

Western Illinois University,
Department of Public Health, Macomb Illinois, USA

Victor Nwabunwanne Oguaka

Department of Human Biochemistry,
Nnamdi Azikiwe University, Nnewi, Nigeria

Blessing K Myke-Mbata

Department of Chemical Pathology,
Benue State University, Nigeria

Maryrose Onyinyechukwu Ikem

Department of Medical Rehabilitation (Physiotherapy),
College of Health Sciences, Nnamdi Azikiwe University, Nnewi, Nigeria

ABSTRACT

Human Immunodeficiency Virus (HIV) has posed a severe global issue with over thirty years of its epidemic. Nigeria is one of the African countries with higher number of HIV cases with over 1,700,000 cases in 2022. 43 adult female and 57 adult male asymptomatic HIV subjects, aged 18-65 years were randomly recruited at the voluntary counselling and Testing (VCT) Centre Nnamdi Azikiwe University Teaching Hospital (NAUTH) Nnewi. The anthropometric parameters such as Body Mass Index (BMI), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP),

and the hematological parameters such as CD4+ cell count, Packed Cell Volume (PCV), Erythrocyte Sedimentation Rate (ESR), Hemoglobin (Hb), and Absolute Neutrophil (Ab.neu) were analyzed using routine laboratory analyses. The data were analyzed using Statistical Product and Service Solution (SPSS) version 21, independent Students'-test and one way analysis of variance (ANOVA) were used to compare means. The SBP and DBP were significantly elevated in the female asymptomatic HIV subjects than in the male asymptomatic HIV subjects with $p < 0.05$. There was no significant difference in the values of BMI, CD4+, WBC, ESR, Hb, and Ab.neu among the female and male asymptomatic HIV subjects with $p > 0.05$. In conclusion, there are no difference in the hematological parameters.

INTRODUCTION

AIDS can develop from the immunodeficiency virus known as HIV if it is not treated. It has an impact on the immune system, which is crucial for warding off diseases and infections in the body. [1] Despite excellent breakthroughs in scaling up anti-retroviral therapy, this virus has posed a serious global problem that has gone unsolved after more than thirty years of its epidemic [2,3]. Nonetheless, the mortality rate caused by this virus has decreased to a manageable chronic state. Sub-Saharan Africa is expected to have 69% of all HIV-positive people and 70% of all AIDS-related fatalities in 2021 [4]. With more than 1,700,000 HIV cases in Nigeria by 2022, it is one of the African nations with the highest rate of the virus.

To identify polycythemia or anemia, packed cell volume (PCV), which has a normal range of 38.3-48.6% and 35.5-44.9% for males and females, respectively, measures the blood volume occupied by red blood cells. When compared to individuals without HIV, PCV in HIV-positive patients is typically found to be somewhat lower, which may be due to the anti-retroviral medications used to treat HIV's bone marrow-induced anemia or other factors [5, 6].

The CD4 T cell count test determines the quantity of CD4 T lymphocytes, a subset of white blood cells that stimulate the immune system to eliminate infections like bacteria, viruses, and other microbes. These cells are destroyed by HIV, and as a result, HIV progresses to AIDS, which is the fatal stage. [7].

A laboratory test for determining the inflammatory or acute response is the Erythrocyte Sedimentation Rate (ESR). It has been discovered to be helpful in monitoring and prognosis of non-inflammatory diseases such as prostate cancer [8]. ESR can be used to track the evolution of HIV/AIDS since the rise of ESR is frequently a significant reflection of the progression of AIDS and other advanced immune deficiency disorders.

Blood pressure, which is the pressure exerted on the walls of the arteries during and in between the contraction of the heart is a measure to diagnose hypertension or hypotension. Hypertension is observed to be prevalent among HIV-infected persons with an increased prevalence amongst those on Anti-retroviral therapy which is usually associated with a low CD4 count and the duration of the virus [9].

Body mass index is the measure of body fat based on height and weight. It is used to screen for weight categories that may lead to medical problems. Just as in non-HIV persons, BMI -defined overweight/obesity is associated with detrimental health conditions in HIV persons.

METHODOLOGY

At the voluntary counseling and Testing (VCT) Centre at Nnamdi Azikiwe University Teaching Hospital (NAUTH) Nnewi, 43 female and 57 male adult participants, aged 18-65 years were randomly recruited. NAUTH is one of the teaching hospitals in Anambra state, South-Eastern part of Nigeria, and one of the biggest facilities in Anambra state where HIV testing and Anti-retroviral services are offered. The consent to participate in the study was obtained from the patients verbally.

The patients were seated in the most comfortable position, and the arterial blood pressure was measured using a mercurial sphygmomanometer and stethoscope. The systolic and diastolic pressure in mmHg was recorded at the point the 1st and last Korotkoff sounds were heard. Afterward, the body mass index was checked using a stadiometer to measure the height in meters and weight in kilograms. The patients were asked to remove every possible external factor that influenced their weight and height such as their footwear and accessories.

The observation of standard aseptic procedures and universal safety precautions in samples collected, stored, and processed was ensured [10]. With a 10milliliters of hypodermic syringe and needle, about 10milliliters of venous blood was collected from each patient. About 5mililiter of the blood was put in a plastic bottle without anti-coagulant, centrifuged at 3000 rpm for 10 minutes, and from which sera which were screened for HIV antibodies were collected. Another 5mililiter of the blood was put inside a dipotassium EDTA (ethylene diamine tetra-acetic acid) anti-coagulated plastic bottle.

The presence of HIV antibodies was screened using an Enzyme-Linked Immunosorbent Assay (ELISA) technique. The first was Genescreen (Sanofi, Pasteur) test kit, and to eliminate some samples that presented false reactions at the initial stage, all initial reactive samples were re-tested using a different ELISA kit (Biorad). Finally, reactive samples after the second test were confirmed using Immunocomb (Organics).

The CD4⁺ count was determined using the flow cytometric technique. 20 microlitre of the blood was put into a 20 microlitre of anti-CD4 monoclonal antibody. In a dark cupboard, these mixtures were incubated for 10 minutes before 800 microlitres of buffer solution were added to the tube. The entire mixture was further transferred to the flow cytometer for the evaluation of CD4⁺ Lymphocytes and was expressed as cells/ μ L of blood.

ESR was calculated using the Westergren graduated tube method. A disposable plastic Westergren-type pipette with an internal diameter of 2.55 millimeters and a length of 200 millimeters was employed for this work. Blood was collected in an EDTA plastic vial using the chosen Westergren method, diluted 4:1. To do this, a tiny container needed to be filled with 0.4 milliliters of sodium citrate anticoagulant and 1.6 milliliters of fully mixed whole blood from an EDTA anticoagulated bottle (4:1 dilution). A Westergren graduated pipette tube was then inserted and positioned vertically inside the ESR stand, where the diluted blood had previously been placed. The blood was drawn to the graduated Westergren pipette tube's zero (0) mark using a secure suction technique to prevent air bubbles. The meniscus on top of the sedimented red cells was observed at one hour (60 minutes), and this value was noted as the ESR.

2 μ L of the participant's EDTA blood was placed into labeled test tubes with the proper labels and 0.38 ml of Turk's Solution (1% ammonium oxalate, 2 ml of glacial acetic acid, 100 ml of distilled water, and 2 drops of aqueous violet). The mixture was put into the charged, new, and enhanced Neubauer chamber through capillary action after the solution had stood for 5 minutes. Under the microscope, an x10 objective lens was used to read the WBC population in the four corner cells. After accounting for the dilution, the amount of WBC was then determined for each participant.

The Absolute Neutrophil Count (ANC) was obtained by multiplying the total number of WBCs by the percentage of the neutrophils (polymorphonuclear (PMN)) and dividing by 100 [11].

$$\text{ANC} = \frac{\text{WBC (cells}/\mu\text{L}) \times \% \text{ (PMNs + bands)}}{100}$$

RESULTS

Anthropometric Parameters:

A total of 57 asymptomatic males and 43 asymptomatic females aged between 18-65 years (32.52 $\pm$ 5.50) participated in the study. The mean ($\pm$ SD) Systolic blood pressure in mmHg (SBP) value in the female participants was 124.56 $\pm$ 13.49, while that of the male participants was 118.28 $\pm$ 10.20. The SBP was significantly higher among the female participants with $p < 0.05$. The mean ($\pm$ SD) Diastolic blood pressure in mmHg (DBP) value in the female participants was 79.07 $\pm$ 9.47, while that of the male participants was 75.07 $\pm$ 7.59. DBP was significantly higher among the female participants than the male participants with $p < 0.05$. The mean ($\pm$ SD) Body Mass Index (BMI) in Kg $\cdot$ m⁻² value among the female participants was 23.71 $\pm$ 3.67, and 22.83 $\pm$ 2.95 among the male asymptomatic HIV-infected subjects. There was no significant difference between the BMI values of the male and female participants.

TABLE 1: Comparison of $\pm$ SD levels of Anthropometric parameters studied in asymptomatic HIV-infected male and female subjects.

SEX	AGE	SDB (mm/Hg)	DBP (mm/Hg)	BMI (Kg $\cdot$ m ⁻²)
FEMALE	30.05 $\pm$ 6.54	124.56 $\pm$ 13.49	79.07 $\pm$ 9.47	23.71 $\pm$ 3.67
MALE	34.98 $\pm$ 4.46	118.28 $\pm$ 10.20	75.07 $\pm$ 7.59	22.83 $\pm$ 2.95
P-value	<0.05	< 0.05	< 0.05	> 0.05
F-value	0.000	0.009	0.022	0.187

Hematological parameters

The mean ($\pm$ SD) CD4 cells/mL values among the female asymptomatic HIV-infected subjects were 455.77 $\pm$ 129.28, while that of the male participants was 423.19 $\pm$ 129.47. There was no significant difference between the CD4 cells of the female and male asymptomatic subjects.

The mean ($\pm$ SD) Packed Cell Volumes (PCV) value among the female asymptomatic HIV subjects was 37.95 $\pm$ 5.65, while in the male participant, the value was 37.00 $\pm$ 5.08. No significant difference was recorded in the PCV values of the female and male asymptomatic HIV-infected subjects ($p > 0.05$).

The mean ($\pm$ SD) Hemoglobin (Hb) in g/dL value of the female asymptomatic HIV-positive participant was 11.94 $\pm$ 1.70, while that of the male subjects was 12.17 $\pm$ 1.51. No significant

difference was seen in the Hb values between the female and male asymptomatic HIV-infected subjects with $p > 0.05$.

The mean ($\pm$ SD) Erythrocyte Sedimentation Rate ESR (mm/hr) values of the female asymptomatic HIV-infected subjects was 22.77 ± 19.33 , while the value of the male subjects was 17.86 ± 12.88 . No significant difference exists between the ESR values of the female and male subjects where $p > 0.05$.

The mean ($\pm$ SD) White Blood Cells (WBC) value of the female asymptomatic HIV-infected subjects was 4.18 ± 0.89 , while the value for the male subjects was 4.36 ± 0.80 . There was no significant difference between the WBC value of the female subjects and the male subjects ($p > 0.05$).

The mean ($\pm$ SD) of Absolute Neutrophil (Ab.neu) value of the female asymptomatic HIV-infected subjects was 2.48 ± 0.72 , and that of the male asymptomatic HIV-infected subjects was 2.60 ± 0.77 . No significant difference was observed in the values between the female and male asymptomatic HIV-infected subjects with $p > 0.05$.

TABLE 2: Comparison of $\pm$ SD levels of Haematological parameters studied in the asymptomatic HIV-infected Female and male subjects.

SEX	CD4/mL	PCV (L/L)	Hb (g/dL)	ESR (mm/hr)	WBC $\times 10^9$	Ab.neu $\times 10^9$
FEMALE	455.77 $\pm$ 129.28	37.95 $\pm$ 5.65	11.94 $\pm$ 1.70	22.77 $\pm$ 19.33	4.18 $\pm$ 0.89	2.48 $\pm$ 0.72
MALE	423.19 $\pm$ 129.47	37.00 $\pm$ 5.08	12.17 $\pm$ 1.51	17.86 $\pm$ 12.88	4.36 $\pm$ 0.80	2.60 $\pm$ 0.77
P-value	> 0.05	> 0.05	> 0.05	> 0.05	> 0.05	> 0.05
F-value	0.216	0.378	0.484	0.131	0.287	0.409

DISCUSSION

In this study, we observed a significant elevation in the systolic and diastolic blood pressure among the female asymptomatic HIV subjects. Although the SBP and DBP values of our subjects were relatively comparable to the male subjects studied in Ezeugwunne et al, 2019, these present findings contradicted the findings of a similar study.^[24] Despite these alterations in blood pressure among the studied subjects, the subjects were still within the normotensive region (systolic blood pressure ≤ 140 mmHg and/or diastolic blood pressure ≤ 90 mmHg). According to World Health Organization (WHO), hypertension is diagnosed if, when it is measured on two different days, the systolic blood pressure readings on both days are ≥ 140 mmHg and/or the diastolic blood pressure readings on both days is ≥ 90 mmHg.^[25]

In this study, there was no significant elevation in the BMI of the female asymptomatic HIV subjects. This finding agrees with that of Almeida et al, and Oliveira et al, but is contrary to Jaime et al where BMI was significantly lower in men. ^[26, 27, 28] According to the WHO classification of BMI levels, underweight ≤ 18.5 kg/m², normal weight 18.5-24.9kg/m², overweight= 25.0-29.9kg/m², obesity class 1= 30.0-34.9kg/m², obesity class 11= 35.0-39.9kg/m² and obesity class 111= ≥ 40.0 kg/m² ^[12]. our subjects were still within the normal range of 18.5-24.9kg/m². Positivity to HIV leads to a decrease in CD4 cells count. This study observed no significant elevation in the CD4 count of the female asymptomatic HIV subjects when compared to the male

subjects. This finding is contrary to some studies which found CD4 cells significantly higher in female HIV-positive subjects than the male subjects. [13, 14, 15] This finding, however, is in line with the findings of Chukwuemeka *et al*, [22] where no significant gender-based difference was observed between symptomatic subjects on ART.

A decreased PCV means red blood cell loss due to any of the following reasons such as cell destruction, blood loss, and failure of bone marrow production. An increased PCV can be due to dehydration or an abnormal increase in red blood cell production. [16] In this study, we observed no significant difference in the packed cell volume of the male and female asymptomatic HIV subjects. This finding is contrary to that of Martina and Chinecherem, 2022 who found the PCV value of the female asymptomatic HIV subjects significantly lower than that of the male subjects.[17]

In this study, we observed no significant elevation in the mean WBC and Neutrophil value of the female asymptomatic HIV subjects compared to the male subjects. These findings align with the findings of Babatope *et al*, where no gender-based difference was seen in the mean WBC and neutrophil of asymptomatic HIV subjects in Irrua, Edo state Nigeria. [18]

This present study showed no significant difference between the mean ESR values of the female and male asymptomatic HIV subjects, a finding conversely to that of Ndakotsu *et al*, where ESR values were typically higher in the female asymptomatic subjects than the male.[19]

Also, the present study observed no significant elevation in the mean Hemoglobin level in the male asymptomatic HIV subjects when compared to the female subjects. This finding is harmonious with the findings of Bong *et al*, who reported Anemia to be more common in females (84.2%) than males (34.6%), as well as the findings of Shen *et al* who recorded lower HB levels among the female subjects than the male subjects Adults with Newly Diagnosed HIV/AIDS in China. [20, 21]

CONCLUSION

In conclusion there is only a significant elevation of SBP and DBP in the female asymptomatic HIV subjects than in the male subjects. Also, there is no significant gender-based differences in the CD4+ counts, WBC, ESR, Hemoglobin, and Absolute neutrophil in asymptomatic HIV subjects studied.

Reference

1. WHO. World Health Organization. HIV/AIDS factsheet. WHO. 2019.
2. Danel C., Moh R., Gabillard D., Badje A., Le Carrou J., Ouassa T., Ouattara E., Anzian A., Ntakpé J.B., Minga A., Kouame G.M *et al* (2015). TEMPRANO ANRS 12136 Study Group A trial of early antiretrovirals and isoniazid preventive therapy in Africa. *N. Engl. J. Med.* ;373(9):808–822. doi:10.1056/NEJMoa1507198
3. Piot P., Abdool Karim S.S., Hecht R., Legido-Quigley H., Buse K., Stover J., Resch S., Ryckman T., Møgedal S *et al* (2015). UNAIDS–Lancet Commission Defeating AIDS-advancing global health. *Lancet* .386(9989):171–218. doi: 10.1016/S0140-6736(15)60658-4. [PubMed] [CrossRef] [Google Scholar]
4. Piot P., Abdool Karim S.S., Hecht R., Legido-Quigley H., Buse K., Stover J., Resch S., Ryckman T., Møgedal S *et al* (2015). UNAIDS–Lancet Commission Defeating AIDS-advancing global health. *Lancet*.386(9989):171–218. doi: 10.1016/S0140-6736(15)60658-4. [PubMed] [CrossRef] [Google Scholar]

5. Osime, E. O., Oresanja, O. O., & Okwara, B. U (2015). Packed cell volume Platelet count, PT, PTTK and Fibrinogen concentration of HIV positive patients on antiretroviral drugs. *Pakistan journal of medical sciences*, 31(6), 1533–1536. <https://doi.org/10.12669/pjms.316.7943>
6. Ukibe NR, Onyenekwe C, Ahaneku J, Meludu S, Ukibe S, Ilika A, Ifeanyi M, Igwegbe A, Ezeani M, Onochie A, and Ofiaeli N. (2010). Packed cell volume and serum iron in subjects with HIV-malaria co-infection in Nnewi, South-Eastern Nigeria. *Int. J. Biol. Chem. Sci.* 4(2): 471-478, ISSN 1991-8631. DOI: <https://doi.org/10.4314/ijbcs.v4i2.58155>
7. Tagoe D. N. A., & BoachieJ. (2012). Assessment of the impact of malaria on CD4+ T Cells and haemoglobin levels of HIV-malaria co-infected patients. *The Journal of Infection in Developing Countries*, 6(09), 660-663. <https://doi.org/10.3855/jidc.2124>
8. Lewis SM, Bawn BJ, Bates I. *Practical Haematology* 9th Ed. Churchill Livingstone Edinburgh. p 633
9. Dimala CA, Atashili J, Mbuagbaw JC, Wilfred A, Monekosso GL (2016) Prevalence of Hypertension in HIV/AIDS Patients on Highly Active Antiretroviral Therapy (HAART) Compared with HAART-Naïve Patients at the Limbe Regional Hospital, Cameroon. *PLoS ONE* 11(2): e0148100. doi: 10.1371/journal.pone.0148100
10. WHO/UNAIDS (1998) Importance of simple/rapid assays of HIV testing. *Wkly Epidemiol Rec* 72: 321-328.
11. Coates, T.D. (2020, April 15). Laboratory evaluation of neutrophil disorders. UpToDate. <https://www.uptodate.com/contents/laboratory-evaluation-of-neutrophil-disorders>
12. WHO. *Physical Status: The Use and Interpretation of Anthropometry*. Technical Report Series. World Health Organization, Geneva.1995;854, 1-1-9950
13. Babatope, I. O., Esumeh, F. I., Orhue, P. I., & Iyevhobu, K. O. (2022). CD3, CD4, AND CD8 Counts of Asymptomatic and Symptomatic HIV-1 Subjects in Irrua, Edo State, Nigeria. *European Journal of Applied Sciences*, 10(3). 744-764.
14. Gize, A., Mathewos, B., Moges, B., Workineh, M., Gedafaw, L. (2014). Establishment of normal reference intervals for CD3+, CD4+, CD8+, and CD4+/CD8+ ratio of T lymphocytes in HIV-negative adults from University of Gondar Hospital, North West Ethiopia. *AIDS Research & Treatment*, 10, 1155-1161. Malaza, Abraham & Mossong, Joël & Bärnighausen, Till & Viljoen, Johannes & Newell, Marie-Louise. (2013). Population-Based CD4 Counts in a Rural Area in South Africa with High HIV Prevalence and High Antiretroviral Treatment Coverage. *PloS one*. 8. e70126. 10.1371/journal.pone.0070126.
15. Adoga, M.P., Pennap, G.R., John, P.A., Shawulu, P.T., Kaba, S.V., Forbi, J.C., Agwale, S.M. (2012). CD4 – and CD3-T lymphocyte reference values of immunocompetent urban and rural subjects in an African Nation. *Scandinavian Journal of Immunology*, 76, 33-38.
16. Schumacher, YO.; Grathwohl D, Barturen, J M, Mollenweber, M, Heinrich, L, Schmid, A, Huber, G, Keul, J "Haemoglobin, Haematocrit and Red Blood Cell Indices in Elite Cyclists. Are the Control Values for Blood Testing Valid?". *International Journal of Sports Medicine*. 2000; 21 (5): 380–385.
17. Ngwu Amauche Martina and Eneh Joy Chinemerem. (2022). Hematological Changes in HIV Subjects Receiving Antiretroviral Treatment in Enugu State University of Science and Technology Teaching Hospital, Enugu, Nigeria. *African Journal of Health Sciences Volume 35, Issue No.4, July-August 2022*
18. Babatope, I.O., Esumeh, F.I., Orhue, P.I., Amaechi, R.A (2022). Leucocyte Profiles of Asymptomatic and Symptomatic HIV-1 Subjects in Irrua, EDO State, Nigeria. *Journal of Current Medical Research and Opinion*. CMRO 05 (05), 1203–1215. DOI: <https://doi.org/10.52845/CMRO/2022/5-5-1>

19. Ndakotsu M A, Salawu L, and Durosinmi M A (2009). Relation between Erythrocyte Sedimentation Rate, Clinical and Immune Status in HIV-infected Patients. *Nigerian Journal of Medicine*, Vol.18, No. 2 April - June 2009, ISSN 1115 2613
20. Elvis Mbu Bisong, Henry Ohem Okpa, Udoezuo Kingsley Ogbonna, Ofem Egbe Enangand Emmanuel Monjok. (2017). The Prevalence and Risk Factors Associated Withanaemia Among HIV Patients Attending Clinic at the University of Calabar Teaching Hospital, Calabar, Nigeria. *Global Journal of Pure and Applied Sciences* Vol. 23, 187-192. DOI: <https://dx.doi.org/10.4314/gjpas.v23i1.19>
21. Shen Y, Wang Z, Lu H, Wang J, Chen J, Liu L, et al. (2013) Prevalence of Anemia among Adults with Newly Diagnosed HIV/AIDS in China. *PLoS ONE* 8(9): e73807. <https://doi.org/10.1371/journal.pone.0073807>
22. Chukwuemeka, O., Priscilla, E. I., Onyinyechukwu, E. O., Adamma, A. R., Alozie, O. O., Joy, O., Chidiebere, O. E., Chinonso, N. J., Nwando, O.-E. C., & Onyenekwe, C. C. (2021). Gender Comparison of Alpha-Fetoprotein, CD4, Albumin and Some Liver Enzymes in Symptomatic HIV Subjects on Antiretroviral Therapy. *Journal of Progressive Research in Biology*, 5(1), 17-25. Retrieved from <http://www.scitecresearch.com/journals/index.php/jprb/article/view/2062>.
23. Ezeugwunne IP, Ogbodo EC, Analike RA, Onuora IJ, Obi-Ezeani CN, Ugwu MC, Amah UK, Okezie AO, Onyenkwe CC, Ahaneku JE. (2019). Body Mass Index, Blood Pressure and Serum Cortisol Level as Stress Index kn Symptomatic HIV/AIDS Male Subjects on Antiretroviral Therapy Negative to Malaria Parasite in Nnewi, Anambra State, Nigeria. *International Journal of Clinical and Biomedical Research*, Sumathi Publications. ;5(2):19-23. DOI: 10.31878/ijcbr.2019.52.04
24. Ifeoma Priscilla Ezeugwunne, Amaifeobu Clement, Samuel Chukwuemeka Meludu, Rosemary Adamma Analike, Johnjude Chinonso Nnamdi, Victor Nwabunwanne Oguaka, Emeka Callistus Onyeka Izuchukwu, D Eberechi Nwanguma, Nonso Samuel Nduka, GA Aikpitanyi-Iduitua. (2021). Evaluation of microalbumin, cystatin c, creatinine, and uric acid levels in HIV patients in Nnamdi Azikiwe University Teaching Hospital, Nnewi. *The Journal of Community Health Management* 2021;8(3):132–142. <https://doi.org/10.18231/j.jchm.2021.030>
25. WHO (2021). Obesity and overweight: WHO fact sheet. Retrieved from: <https://www.who.int/news-room/fact-sheets/detail/obesity-andoverweight>
26. Almeida L, Jaime P. Aspectos atuais sobre nutrição e Aids na era da terapia antiretroviral de alta atividade (2006). *J Bras Aids*; 7(1): 4-8.
27. Oliveira OMV, Medeiros RS, Nascimento MAB do, De Boni MS. Perfil nutricional e fatores de risco para obesidade central de pessoas que vivem com HIV/AIDS. *Comun Ciênc Saúde* (2008); 19(4): 305-14.
28. Jaime PC, Florindo AA, Latorre M do RD de O, Brasil BG, Santos ECM dos, Segurado AAC (2004). Prevalência de sobrepeso e obesidade abdominal em indivíduos portadores de HIV/ AIDS, em uso de terapia anti-retroviral de alta potência. *Rev Bras Epidemiol*; 7(1): 65-72.