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ASSESSMENT OF ANTHROPOMETRIC INDICES, MICROELEMENTS AND CD4-COUNT IN ADULT-HUMAN IMMUNIDEFICIENCY VIRUS SUBJECTS AT NNAMDI AZIKIWE UNIVERSITY TEACHING HOSPITAL, NNEWI AT ADVANCED STAGE

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ABSTRACT

Human immunodeficiency virus (HIV) infection continues to pose a substantial health burden, especially in sub-Saharan Africa, where nutritional factors and micronutrient status play critical roles in immune function and disease trajectory. This case–control investigation evaluated anthropometric parameters, blood pressure indices, CD4 cell count, and selected trace elements among 70 HIV-positive adult males aged 18–60 years attending Nnamdi Azikiwe University Teaching Hospital, Nnewi, Nigeria. Participants were stratified based on duration of infection. Standardized procedures were employed to determine height, weight, body mass index (BMI), systolic and diastolic blood pressure, and serum concentrations of zinc, copper, and selenium. Statistical analyses were conducted using SPSS version 16.0, with statistical significance defined at $p<0.05$. Findings revealed a progressive and statistically significant rise in CD4 count with increasing duration of infection and exposure to antiretroviral therapy. Both systolic and diastolic blood pressures demonstrated significant variations across duration categories, characterized by higher initial values and subsequent stabilization over time. Selenium levels differed markedly between groups, while zinc showed moderate statistical variation; copper levels did not demonstrate significant differences. Although BMI did not vary significantly across infection durations, the overall mean BMI suggested a predominance of overweight status. These results indicate that sustained antiretroviral therapy is associated with immune recovery and relative cardiovascular adjustment, whereas alterations in micronutrient status persist. Continuous assessment of nutritional and biochemical indicators may therefore enhance comprehensive care and long-term prognosis in adults living with HIV.

Keywords: *Human Immunodeficiency virus infection, Antiretroviral therapy, CD4 T-lymphocyte count, Trace elements, Anthropometric indices*

1. INTRODUCTION

HIV and AIDS still provide a major global challenge and continue to be a major cause of morbidity and mortality in children and adults alike. The joint United Nations Programme on HIV/AIDS (UNAIDS) estimated about 33 million people worldwide living with HIV or AIDS at the end of 2025 [1]. In 2024 statistics, HIV prevalence in Nigeria was an estimated 0.3%. In the same year, an estimated 130,000 people died from AIDS-related illnesses [2]. According to UNAIDS GAP Report 2023, in 2025 there were about 2.1 million HIV positive in India, making the prevalence of approximately 0.26%. Of these 86,000 were new HIV infections. There were almost 44% adults on Anti-retroviral treatment and 68,000 AIDS related deaths occurred in 2025 [2]. Nigeria has the third largest HIV epidemic in the world. Overall, Nigeria's HIV epidemic is slowing down, with a 32% decline in new HIV infections (130,000 in 2013 and 86000 in 2023), and a 54% decline in AIDS-related deaths between 2021 and 2024. Despite this, 51% of deaths from HIV/AIDS in Africa are in Nigeria [2].

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 [3].

The height (to the nearest cm) and weight (to the nearest Kg) were measured with a SECA body meter and a weighing balance (Hospibrand ZT-120, England). The height was taken without the patient wearing footwear and the weight measured wearing light clothing. The Body Mass Index (BMI) was then calculated by dividing weight (Kg) by height squared (m2) and categorized according to WHO criteria into normal weight (BMI 18.5–24.9), underweight (<18.5), overweight (25.0–29.9), obese (>30.0). Waist and hip circumference was measured to the nearest 0.1 (cm) using non-stretchable tape body. Participants asked to stand still with heels together and their waist circumference (WC) was obtained by measuring the distance around the smallest area below the rib cage and above umbilicus (belly button){3]. Hip circumference measurements were taken at the point yielding the maximum circumference over the buttocks with the tape in a horizontal plane, touching but not compressing the skin. Waist-hip ratio was determined by dividing waist circumference (cm) to hip circumference (cm). Abnormal waist circumference (abdominal obesity) was defined as WC ≥ 102 (cm) for males and WC ≥ 88 (cm) for females. Abnormal waist-hip ratio (WHR) was defined as WHR ≥ 0.9 for males and WHR ≥ 0.85 for females.

Human Immuno Deficiency Virus infection and Acquired Immune Deficiency Syndrome (HIV/AIDS) is a spectrum of conditions caused by infection with the human immunodeficiency virus. [1] 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, preejaculate, 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.

Infection with the virus results in progressive deterioration of the immune system, leading to immune deficiency. According to estimates by WHO and UNAIDS, 36.7 million people were living with HIV globally at the end of 2015. Sub-Saharan Africa is the most affected region, with 25.6 million which accounts for two-thirds of the global total of new HIV infections. 1.1 million persons living with HIV died of HIV-related causes globally. [2] The National HIV/AIDS estimates in 2014 showed Ghana had 250,232 persons living with HIV with 59% being females and 41% males. 229,009 accounting for 92% were adults and 21,223 (8%) were children. There has been several reports on HIV Treatment and management using various therapies but literature is still scanty on the effects of anthropometric indices, trace elements and CD4 Count on adult HIV subjects attending Nnamdi Azikiwe University Teaching Hospital (NAUTH), Nnewi, Anambra State, Nigeria. This work sought to close this gap by assessing anthropometric indices, microelements and CD4 count on adult HIV subjects at Nnamdi Azikiwe University Teaching Hospital, Nnewi, Nigeria with a view.

2. MATERIALS AND METHODS

2.1 MATERIALS USED

The materials used for the study includes, HIV diagnostic test kits, sphygmomanometer, and Leicester stadiometer.

Study design: This is a case-controlled study

2.1.2 ETHICS APPROVAL:

The subjects were given informed consent, while the study design was approved by the ethical committee of the Nnamdi Azikiwe University Teaching Hospotal, Nnewi, Anambra State.

2.1.3 STUDY SETTING AND DESIGN

This study was carried out at the Nnamdi Azikiwe University Teaching Hospital (NAUTH), Nnewi, Anambra State, Nigeria. It was a case-controlled study designed to evaluate anthropometric indices, trace elements, and immunological parameters among adult

HIV subjects.

2.1.4 SAMPLE SIZE:
A total of 70 adult male participants were involved in the study

2.1.5 INCLUSION CRITERIA:
Age between 18 and 60 (42 ±13) years were randomly recruited at the Voluntary Counseling and Testing (VCT) Centre in Nnamdi Azikiwe University Teaching Hospital (NAUTH), Nnewi, Nigeria.

2.1.6 GROUPING:
Based on World Health Organization (WHO) criteria for staging HIV, the participants were grouped as follows:

200 mg twice daily: this was administered to the symptomatic HIV stage 11 subjects on ART. Symptomatic HIV subjects

2.2 METHODS
2.2.1 SAMPLE COLLECTION
Five mill of blood sample were collected from each of the participant in the groups. The serum samples were stored at -20°C until analyzed. The participants were screened for HIV infection using Immunoassay and Immunochromatographic method according to the method described by [2].

2.2.2 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 DetermineTM HIV-1/2, Chembio Diagnostic Systems, Inc and Trinity Biotech respectively using Standard algorism according to the technique described by [4].

2.2.3 MEASUREMENT OF BLOOD PRESSURE
Blood pressure was measured according to the recommendations of the American Heart Association [5] using a mercury sphygmomanometer (Accoson Dekamet, England) and a stethoscope.

PRINCIPLE
Blood pressure measurement assesses the force of circulating blood on arterial walls and is a key indicator of cardiovascular health.

PROCEDURES
Each subject was seated comfortably, arm supported at heart level, after resting for 15 minutes. A suitable cuff was wrapped 2–3 cm above the elbow crease. The cuff was inflated until the radial pulse disappeared, then 20–30 mmHg above that level. The stethoscope was placed over the brachial artery as the cuff was deflated gradually. The first Korotkoff sound indicated the systolic pressure, and the disappearance of the sound indicated the diastolic pressure. Two readings were taken and averaged

Blood pressure categories were defined as:

- Optimal (SBP < 120 mmHg, DBP < 80 mmHg)
- Normal (SBP 120–129, DBP 80–84)
- High-normal (SBP 130–139 or DBP 85–89)
- Stage 1 hypertension (SBP 140–159 or DBP 90–99)
- Stage 2 hypertension (SBP ≥ 160 or DBP ≥ 100)

Pulse pressure = SBP – DBP.

2.2.4 MEASUREMENT OF BODY MASS INDEX (BMI)
This was calculated by using the method as described by [6],

2.2.5 ANTHROPOMETRIC MEASUREMENTS
Anthropometric measurements included weight and height. These measurements were performed after the participants had removed their shoes and with minimal clothing. Weight was measured to the nearest 0.1 kg using weighing scale, TANITA® UM 075, which was periodically checked for accuracy and calibrated as necessary. Height was measured to the nearest 1 mm with a portable Leicester® stadiometer. BMI (kg/m2) was computed using weight (in kilogram) divided by height (in meters squared). The height, weight and BMI were than compared with the growth chart for Indian children as authenticated by the Indian Association of Pediatrics.

$$BMI = \frac{Weight\ (kg)}{Height^2\ (m^2)}$$

HEIGHT MEASUREMENT
Height was measured according to the technique described by [7].

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 was expressed in either $(m)^2$.

2.2.6 WEIGHT MEASUREMENT
Weight was measured according to the technique described by [8].

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.

2.2.7 BODY MASS INDEX
Body Mass Index (BMI) was measured according to the technique described by [2]

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)

2.2.8 STATISTICAL ANALYSIS:
The data obtained was statistically analyzed using Statistical Package for Service solution (SPSS) version 21. One of way analysis of variance (ANOVA) and students't-test were used to compare means. The results were expressed as mean ±SD and confidence limits was chosen at 95% ($P < 0.05$). $P < 0.05$ was considered statistically significant while $P > 0.05$ was insignificant.

4. PRESENTATION OF RESULTS
The results obtained from the assessment of anthropometric indices, microelements and CD4-Count in adult-Human Immunideficiency virus subjects at Nnamdi Azikiwe University Teaching Hospital, Nnewi, Anambra State, Nigeria at advanced stage are hereby presented in tables 1 and 2. Table 1 shows a significant increase in CD4 count ($p<0.05$) in duration 2 and 4 (640.27 ± 28.25) (732.71 ± 33.95) when compared to duration 1 and 3 (492.89 ± 20.25) (591.44 ± 23.00), while duration 1 was the least1 V 2 **(**0.027 ± 0.157)**, 2 V 3 (**0.000 ± 0.595) shows significant difference when compared 1 V 3, 1 V 4 **(**0.084 ± 0.267) (6.555 ± 0.131) receptively.In table 2, systolic blood pressure (SBP) shows an increase ($p<0.05$) in column 1, 3, 4 (135.56 ± 15.09) (120.83 ± 15.55) (120.00 ± 57.73) and 1 as the highest when compared to 2 as the lest (119.67 ± 27.80) **, 1 V 3 (**0.004 ± 0.028) shows significant difference when compared to **1 V 2, 2 V 3, 3 V 4 (**0.784 ± 0.084) (1.456 ± 0.886) (2.506 ± 0.847) and (3.121 ± 0.016) **1 V 4 (**3.121 ± 0.016) as the height. Distolic blood pressure (DBP) shows a significant decrease ($p<0.05$) in duration 3 (77.22 ± 14.37) when compared to 2, 4 and 1 the height (83.73 ± 9.99) (81.43 ± 6.90) and (91.78 ± 11.11) respectively.

Table 1: Level CD4 Count, Systolic Blood Pressure and Diastolic Blood Pressure of Human Immunodeficiency Virus Subjects in Nnewi, Nigeria

DURATION	**CD4**	**SBP** (mmHg)	**DBP** (mmHg)
1	492.89 ± 20.25	135.56 ± 15.09	91.78 ± 11.11
2	640.27 ± 28.25	119.67 ± 27.80	83.73 ± 9.99
3	591.44 ± 23.00	120.83 ± 15.55	77.22 ± 14.37
4	732.71 ± 33.95	120.00 ± 57.73	81.43 ± 6.90
F-VALUE	0.574	8.089	11.096
P-VALUE	0.682	0.000	0.000
1 V 2	0.027 ± 0.157	0.784 ± 0.084	0.027 ± 0.094
1 V 3	0.084 ± 0.267	0.004 ± 0.028	0.174 ± 0.009
1 V 4	6.555 ± 0.131	3.121 ± 0.016	2.795 ± 0.039
2 V 3	0.000 ± 0.595	1.456 ± 0.886	0.441 ± 0.137
3 V 4	4.096 ± 0.339	2.506 ± 0.847	2.286 ± 0.144

Table 2: Microlements, Weight and Height of Human Immunodeficiency Virus Subjects in Nnewi, Nigeria

S/N	**DURATION**	**Zn**	**Cu**	**Se**	**Ase**	**WT**	**HT**	BMI (Kg/m2
1)	**<6 MONTHS N=9**	9.526 ± 0.98	25.87 ± 6.55	5.01 ± 3.14	47.44 ± 12.86	72.33 ± 18.83	1.60 ± 0.07	28.12 ± 6.59
2)	**>6-12MONTHS N=15**	10.02 ± 4.27	22.60 ± 6.11	7.01 ± 2.82	51.73 ± 3.81	75.07 ± 14.30	1.64 ± 0.07	28.04 ± 4.65
3)	**> 1YRS-5YRS N=18**	11.66 ± 4.42	23.37 ± 6.90	11.60 ± 3.29	47.22 ± 10.29	70.72 ± 13.31	1.62 ± 0.05	27.08 ± 5.00
4)	**> 5YRS N=7**	17.30 ± 8.61	19.30 ± 5.37	19.16 ± 7.42	50.71 ± 5.56	74.86 ± 14.32	1.61 ± 0.06	28.93 ± 6.02
	F-VALUE	2.576	2.181	16.648	0.958	0.892	13.585	0.246
	P-VALUE	0.042	0.076	0.000	0.434	0.471	0.000	0.911
	1 V 2	1.362 ± 0.888	0.000 ± 0.243	0.163 ± 0.122	12.962 ± 0.355	0.383 ± 0.691	0.099 ± 0.242	0.754 ± 0.972
	1 V 3	1.151 ± 0.547	0.308 ± 0.371	0.730 ± 0.000	0.954 ± 0.965	1.155 ± 0.822	0.336 ± 0.627	0.478 ± 0.684
	1 V 4	0.081 ± 0.114	0.017 ± 0.045	2.174 ± 0.000	4.518 ± 0.507	0.376 ± 0.762	0.017 ± 0.762	0.176 ± 0.803
	2 V 3	0.220 ± 0.290	0.461 ± 0.737	0.385 ± 0.000	4.866 ± 0.099	0.528 ± 0.377	0.012 ± 0.307	0.059 ± 0.574
	3 V 4	4.506 ± 0.141	0.537 ± 0.140	2.389 ± 0.002	1.547 ± 0.289	0.076 ± 0.523	0.173 ± 0.946	0.000 ± 0.441

5. DISCUSSION AND CONCLUSION

5.1 DISCUSSION

Anthropometric measurements are reliable, non-invasive and strong indicators for different diseases, HIV progression or decline as a result of viral toxicity, 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 [8]. 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. The study show the increase in CD4, according [9] in his research that percentage (around 30%) of HIV-infected patients who fail to have complete CD4+ recovery (≥500 CD4+ T-cell count/µl) after long periods of ART Those patients who maintain low CD4+ counts remain at risk of acquired immunodeficiency syndrome (AIDS) progression, developing non-AIDS-related morbidity, and dying, from the result the duration 2,3 and 4

there was significant increase $p<0.005$ from the base line which agrees with the results though the mechanism was not known.

Systolic blood pressure is an indices used to monitor patient cardiovascular health and treatment effect, according to low SBP indicate severs weakness of the immune system but high SBP will indicate an improvement in the immune system or improved ART related metabolic changes [9]. From the results, SBP within the duration 1,2,3 and 4 show a significant increase ($p<0.05$) in duration 1 which may be associated by the entry of early stage of ART, HIV disease at entry into HIV care and might have had comorbid opportunistic infections that could lower their BP levels directly or through weight loss. Conversely, other studies have found that HIV infection with ART is associated with higher BP levels compared with HIV-uninfected persons with a similar sex and age distribution which might be the reason for the initial increase but with administration of ART it tends to normalize [10]. This agrees with the works of [11]. High blood pressure is associated with the elevation of diastolic blood pressure , research has it that persistent elevation is said to have entered stage 1 hypertension within the range of 130 to 139mmhg and diastolic pressure at 80 to 90.stage 2 ranges from 140 higher and diastolic 90 and above, from the result it indicate that duration 2,3 and 4 shows a decline which might be as the result of the infection and tends to normalize as the ART administration progress that agree with the work of [11]. However, all these factors do not fully explain the great variability of immune reconstitution in ART-treated patients, but also might be a sign of recovery.

The results obtained in this study show a significant depression of blood selenium, iron, zinc and copper during HIV infection (Table 2). Selenium, Iron, Zinc and Copper are cationic micronutrients that have been well documented as playing very significant roles in sustaining mammalian immunity. It does appear that a cascade reaction involving quite a large number of macro and micro-molecules lead to the eventual destruction of the immunity of an HIV infected person. [11].

Copper is an essential micronutrient crucial for fetal growth and development, playing a pivotal role in energy supply, myelination, neurotransmitter metabolism, and connective tissue development [11]. Its concentration reduces to 19.30 ± 5.37 as to be compared with early onset (6month) of HIV. Zinc acts as an antioxidant by scavenging superoxide anions, although high supplementation levels can induce mitochondrial oxygen specie [12). It is integral to gene transcription, protein synthesis, and numerous cellular processes, exhibiting both antioxidant and pro-oxidant actions [12].

This study's findings were consistent with the work of [9], which demonstrated that HIV-positive patients are at a higher risk of opportunistic infections, further compromising their immunity and chances of survival. The decreased trace element levels observed in HIV-positive individuals could be due to decreased absorption and altered metabolism of trace elements caused by the infection. This aligns with the findings of [9, 10], which indicated that HIV infection exacerbates micronutrient deficiencies.

Infection with HIV may impair the utilization of zinc by disturbing protein synthesis and its stability, prevention of intestinal absorption and imposition of low activation of zinc for metabolism. This may account for the lower cationic trace elements observed in the blood of HIV infected individuals screened in this study. It may also imply that the rate of consumption of zinc, copper, and selenium were higher in HIV infection than in normal individuals. The observed decreases in trace elements may be related to massive cells destruction associated with the infection, since some of these trace elements form parts of the enzyme system occurring in some of these cells that may be so destroyed; or as a result of other metabolic errors. Zinc supplementation should be considered in HIV patients that are zinc deficient and on poor diet [12]. Selenium is an essential trace element involved in various physiological processes, particularly as a key component of GPx, an enzyme that protects cell membranes from LPO. Functional measures of selenium status, such as GPx and selenoprotein P, are crucial for antioxidant defense, thyroid hormone formation, and DNA synthesis, all affecting fertility [33]. There was a high significant difference in the selenium concentration within the group of a given duration. Duration of 5yrs recorded a selenium concentration of 19.16 ± 7.42 in comparison with the early onset (6month). This indicates the malabsorption of selenium in expending other trace minerals to scavenge for free radicals causing oxidative stress trigger by different inflammatory activities.

A look into the BMI of this studied population, there was no significant difference across all the duration of all the HIV patients. BMI is meant to be used as a simple means of classifying sedentary (physically inactive) individuals with an average body composition. For these individuals, the current value settings are as follows: a BMI of 18.5 to 25 kg/m^2 may indicate optimal weight; a BMI lower than 18.5 kg/m^2 suggests the person is underweight while a number above 25 kg/m^2 may indicate the person is overweight; a BMI below 15 may indicate the person has an eating disorder; a number above 30 suggests the person is obese (over 40, morbidly obese). The results obtained from this research work showed that, the individuals are obsessed with an average BMI of 28 Kg/m^2.

Even though there is no statistically significant difference in the average BMI change between the duration of assessment, the interaction effect with time suggests that, as follow-up times increase, there may be a higher BMI increment among individuals as they undertake various therapeutic approaches. The increase in BMI level over time in patients, could be due to the reduction in the metabolic demand of body cells, the reversal of HIV-associated catabolism, the return of

gastrointestinal function, the decreased incidence of opportunistic infections, and the redistribution of fat as a component of Lipodystrophy [34]. This implies that the longer HIV-positive adults are better nutritional status and survival of patients which in turn decreases the energy expenditure to fight infections.

The BMI increment status of HIV-positive adults with advanced HIV stages is same to be compared to patients with WHO stages I or II clinical illnesses. The finding is antagonist with prior studies conducted in Ethiopia and other countries [5-8].

The observed decline in BMI status in 5years duration assessment might be due to the presence of high nutritional requirements or calorie expenditures and the poor appetite and absorption of nutrients in individuals with advanced-stage clinical disease. Indeed, advanced opportunistic infections such as chronic diarrhea, fever, oral, and esophageal candidiasis are common features of WHO III/IV clinical disease, which all lead to decreased BMI levels, poor nutrition, and finally death [12].

5.2 CONCLUSION

The anthropometric parameters such as body mass index (BMI) in this work therefore decreased as the stages of HIV progresses in HIV victims not on ART in Nnewi Anambra State, Nigeria. Also trace element such as zinc, copper and selenium levels decreased as duration in the HIV victims increased. The reverse was the case for those on ART treatment. The trace elements might have been malabsorped. The HIV victims might have emaciated as a results of nutrient malabsorption. This study calls for further studies on the comparative evaluation of the effects of chronic administration of ART on the Tp53, BAX and BCl genes of adult male and female HIV subjects.

High priority should be placed on nutritional counseling and management in order to improve the nutritional status of HIV patients as this will go a long way in improving the immunity of the HIV victims. Micronutrient supplementation with selenium and zinc may therefore support improved nutritional and immune status in adults living with HIV. Micronutrient supplementation with selenium and zinc may therefore support improved nutritional and immune status in adults living with HIV.

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