DOI: https://doi.org/10.61841/nn-as-12-1-17 Publication URL: https://jaraps.org/index.php/AS/article/view/17

CD4T-CELL COUNT, BLOOD PRESSURE, SOME SERUM ELECTROLYTE LEVEL IN HUMAN IMMUNODEFICIENCY VIRUS SUBJECTS ON ANTIRETROVIRAL THERAPY IN NNEWI, ANAMBRA STATE, NIGERIA

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To Cite This Article: CD4T-CELL COUNT, BLOOD PRESSURE, SOME SERUM ELECTROLYTE LEVEL IN HUMAN IMMUNODEFICIENCY VIRUS SUBJECTS ON ANTIRETROVIRAL THERAPY IN NNEWI, ANAMBRA STATE, NIGERIA (M.-I. P. Nonyerum, E. I. Pricilia, D. C. Chijioke, C. G. E. Stubbs, & E. N. Ede, Trans.). (2026). Journal of Advance Research in Applied Science (ISSN 2208-2352), 12(1), 8-14. https://doi.org/10.61841/nn-as-12-1-17

ABSTRACT

Background*: Adequate amount of micro minerals are vital for optimal metabolic and immunological functions. Inadequate micronutrients have been associated with poor clinical results and more mortality among Human Immunodeficiency Virus (HIV) victims.* ***Aim:*** *This study evaluated CD4+ T-cell count, serum levels of selected trace elements (selenium, zinc, and copper), and blood pressure among HIV-seropositive subjects on antiretroviral therapy (ART) attending Nnamdi Azikiwe University Teaching Hospital (NAUTH), Nnewi.* ***Methods:*** *A cross-sectional comparative study was conducted among 110 participants aged 21–70 years, comprising 50 HIV-positive individuals on ART, 30 newly diagnosed ART-naïve HIV-positive subjects, and 30 HIV-negative healthy controls. Serum levels of zinc, copper, and selenium were measured using atomic absorption spectrophotometry, while CD4+ T-cell counts was determined using a CyFlow cytometer. Blood pressure and anthropometric parameters were also assessed. Data were analyzed using International Business Machines Statistical Package for the Social Sciences (IBM SPSS) version 27, with statistical significance set at $p < 0.05$.* ***Results:*** *Serum zinc levels were significantly lower in controls compared to both HIV-positive groups ($p = 0.004$; $p = 0.000$). Selenium and copper levels were markedly reduced in HIV-positive subjects not on ART compared with controls ($p = 0.000$). The $CD4^+$ T-cell counts were significantly lower among HIV-infected participants compared with the controls ($p = 0.000$). Significant variations were also observed in systolic and diastolic blood pressures, body mass index (BMI), and sex distribution among the study groups ($p = 0.004$).* ***Conclusion:*** *Zinc levels and $CD4^+$ T-cell counts showed significant differences among study groups, despite ART use. This investigation demonstrates significant associations between trace element concentrations, immune status, and anthropometric indicators among HIV-seropositive individuals, emphasizing the need for regular nutritional observation and fortification as part of comprehensive HIV management.*

KEYWORDS: *Antiretroviral therapy, HIV, trace elements, CD4+ T-cells, nutrition, blood pressure measurement.*

1. INTRODUCTION

BACKGROUND

A good number of the micronutrients are involved in buffering the antioxidant status, especially zinc, copper and selenium. These micronutrients are also involved in immune-modulatory functions [1]. Therefore sub-optimal levels of these antioxidant nutrients during human immunodeficiency virus (HIV) infection can contribute to immune dysregulation and increased HIV replication and progression. The HIV infection can impair nutritional status of the patient, by causing a reduced intake and absorption of the micro-nutrients; it can also cause increased utilization of nutrients leading to nutrient deficient status [1]. Human immunodeficiency virus (HIV) predisposes its victim to various prognostic diseases like malaria, tuberculosis, influenza, etc. Anambra state has about 8.7% prevalence rate which is above the national average of 4.5% [2]. Human immunodeficiency virus (HIV) and Acquired Immune Deficiency Syndrome (AIDS), despite the campaigns, has remained a public health concern in Sub-Saharan Africa, where an estimated 25.8 million adults and children are infected [3]. Human immunodeficiency virus patients have a large variety of physiological alterations at every level of the disease. These complications in synergy with related pathologies give rise to different nutritional problems [4].

Trace elements are required in minute amount by living organisms. They are essential for the host defense against infection and act as activators in controlling biological functions [1, 5]. Changes in the levels of micronutrients and its effects have been described in inflammatory responses, cancer cases, as well as parasitic and viral infections [1, 6]. Human immunodeficiency virus remains a major problem in sub-Saharan Africa. Antiretroviral drugs has greatly improved survival but can cause metabolic, cardiovascular, kidney, and electrolyte issues, so monitoring CD4 count, blood pressure, and electrolytes is essential. Local data from Nnewi are lacking on these, so this study intended to close this gap by providing baseline local data on immune, blood pressure levels, electrolyte balance, and biochemical status, thereby enabling early discovery of ART-related

complications and guide clinical practice.

This study is therefore aimed at evaluating the effect of ART treatment on $CD4^+$ T-cell levels and some nutritional minerals (selenium, zinc and copper) in HIV-positive subjects with reference to their blood pressure of those attending clinic at Nnamdi Azikiwe University Teaching Hospital, Anambra State Nigeria.

2.0 MATERIALS AND METHODS

2.1 MATERIALS

Materials used include, atomic absorption spectrophotometer (Model: ICE 3300, USA), HIV test kits, Partexcyflow cytometer(ParttecCyflow, Germany), rohren tube, sphygmomanometer (BM55, Germany), ultramodern centrifuge machine (Alphine medical laboratory, model 3000, China) and EDTA and plain specimen bottles

2.2. STUDY AREA

This study took place at Nnamdi Azikiwe University Teaching Hospital Nnewi Anambra State Clinic, Nigeria.

2.3. ETHICAL CLEARANCE

Ethical clearance was obtained from ethical committee, Nnamdi -Azikiwe University Teaching Hospital Nnewi-NAUTH/CS/66/VOL.18/VER.3/01/2025/ 32

2.4. SCREENING FOR HUMAN IMMUNODEFICIENCY VIRUS (HIV) AND CLASSIFICATION.

Study Procedures and Variables: A face-to-face interview and a physical examination were done for all participants who consented to take part in the study. A structured questionnaire was used for data collection on participants' demographic and clinical characteristics. Data on HIV infection status and duration of ART, previous and most recent CD4 counts less than 6 months old, were collected from the patients and complemented by recorded parameters from their medical records. The physical exam consisted of measuring patient blood pressures, weight and height.

Subjects for control group were screened for HIV-infection using serial algorithm procedure. This procedure is the WHO standard for HIV testing. It refers to a situation where if the first tested sample indicates non-reactive result, the result is recorded as negative; but if the first tested kit shows reactive, it will be tested with a second test kit, and if the second tested kit shows reactive too, the sample is reported as positive. However, when there is inconsistent result (first test kit reactive, and second test kit non-reactive), a third test kit was used as a tie-breaker to give the final result-retest (i-base, 2023). Unigold and Stat-pak HIV ½ test kits were used for the first, second and tie-breaker respectively. Procedure was carried out according to the manufacturer's description. Classification of HIV stages was done using CD4 counts according to recent WHO HIV staging (i-base, 2023). This was obtained from patients medical records.

2.5. STUDY POPULATION

This research is from about 99,296 people living with HIV in Anambra state (Emeka, Ugwu, and Ezeugwunne 2024) involved 30 healthy subjects (males and females) and 80 (males and females) patients who were diagnosed as primary HIV patients. The mean age was 48.60 ±9.52 years for 50 HIV-infected subjects on antiretroviral therapy (ART)

treatment, while 30 were yet to receive ART (just diagnosed of HIV), 30 apparently healthy as controls. Total study research subject is 110, but one dropped out of 30 not on ART, due to incomplete result.

2.6. SAMPLING TECHNIQUE

This study will employ systematic random sampling technique in the selection of subjects in accordance with the inclusion criteria.

2.6.1. INCLUSION CRITERIA

a. Adult (21 years and above) HIV-seropositive, male and female patients attending HIV/AIDS clinic in NAUTH, and on antiretroviral therapy (ART) drugs within the past 6 months before the study. The ART regimen was a fixed-dose combination of tenofovir disoproxil fumarate, lamivudine and dolutegravir (TLD).

b. Adult (21 years and above) HIV-positive with patients classified into HIV stage 1 - with CD4 cells less than 200 cells/mm3

c. Adult (21 years and above) HIV-negative, male and female patients attended heart-to-heart center of NAUTH, Nnewi.

d. Adult (20 years and above) immediately screened HIV-postive, male and female patients attending heart-to-heart center of NAUTH, Nnewi.

2.6.2. EXCLUSION CRITERIA

a. People living with HIV on ART and not on ART not within the age of 21-70; either male or female subjects attending the HIV clinic, Nnamdi Azikiwe University Teaching Hospital Nnewi.

b. Those undergoing medical care in the wards

2.6.3. SAMPLE SIZE DETERMINATION

Cocran Method-**R**emesh Incoporated Headquarters6815 Euclid Avenue Cleveland, Ohio @AI Right Reserved 2024

$n = (Z\alpha/2 + Z\beta)^2 (\bar{o}_1^2 + \bar{o}_2^2) \div (\mu_1 - \mu_2)$

n – required sample size, Zα/2 – z score for the sample size significance level (1.96 for 95%)

Zß – z score for desired power,(0.84 for 80%, 1.28 for 90%)

$\bar{o}_1^2$ -variable in group 1, $\bar{o}_2^2$ -variable in group 2, $\mu_1 - \mu_2$ - minimium detectable difference the two means (effective size)

Calculations;

$n = (1.96 + 0.84)^2 * (16^2 + 10^2) \div 5^2 = 7.84 * 356 / 25 = 111.426$ scaled down to 110

(Uakarn, Chaokromthong and Sintao, 2021).

2.8. STUDY DESIGN AND SUBJECTS

A total of 110 subjects was enrolled and grouped as follows: Group1:Fifty (50) HIV subjects with infected with malaria on anti-retroviral therapy (ART), Group2: 30 HIV subjects not on ART subjects attending the HIV clinic, at Nnamdi Azikiwe University Teaching Hospital Nnew. Group 3(Control): Thirty apparently healthy HIV sero-negative individuals were recruited as controls. All subjects residents in Nnewi and its surroundings, Anambra State, Southern Nigeria. All subjects were between the ages of 21–70 years. The University's Teaching Hospital Medical Ethics Committee gave the approval. Informed consent was obtained by discussion from the subjects prior to the study.

2.9. METHODS

2.9.1 SPECIMEN COLLECTION

Blood specimens were taken from apparently healthy subjects and people living with HIV/AIDS. Blood (10 ml) was collected from each person (5ml in EDTA and 5 ml in plain bottles). The samples were labeled appropriately with codes. Venous blood samples (1ml) collected in EDTA tubes were subjected to malaria diagnosis by rapid tests (Standard Diagnostics Boline), and the results were confirmed by microscopy. The blood count was undertaken on hematology analyzer (Mindray Company, Shenzhen, China). The blood samples in plain container were centrifuged at 3500 × *g* for 10 minutes (at 3,000 rpm) to obtain serum. The serum was stored at -40 ºC for micronutrient assay.

2.9.2 SCREENING FOR HUMAN IMMUNODEFICIENCY VIRUS (HIV)

Test for HIV was carried out according to the method of [7], using HIV test kit (Unigold and Stat-pak HIV).

PROCEDURE

Subjects for control group were screened for HIV-infection using serial algorithm procedure. This procedure is the WHO standard for HIV testing. It refers to a situation where if the first tested sample indicates non-reactive result, the result is recorded as negative; but if the first tested kit shows reactive, it will be tested with a second test kit, and if the second tested kit shows reactive too, the sample is reported as positive. However, when there is inconsistent result (first

test kit reactive, and second test kit non-reactive), a third test kit was used as a tie-breaker to give the final result-retest. Unigold and Stat-pak HIV ½ test kits were used for the first, second and tie-breaker respectively. Procedure was carried out according to the manufacturer's description. Classification of HIV stages was done using CD4 counts according to recent WHO HIV staging[33].

2.9.3 CD4+ T-CELL (CLUSTERS OF DIFFERENCIATION T-CELLS) ASSAY

This was done according to the method of [8].

PROCEDURE

CD4+ T-cells count were analyzed using Partexcyflow cytometer by PartecCyflow, Germany. After booting the machine, 20 ml of CD4+ T-cell count PEmAb reagent was added to a Rohren tube followed by 20 l of well-mixed EDTA blood sample. Both will be mixed and incubated in the dark for 15 min at room temperature. This was followed by addition of 800 l of the CD4+ T-cell count buffer. The mixtures was mixed and read on the cyflow by plugging the sample tube to the sample port of the cyflow.

2.9.4 MEASUREMENT OF BLOOD PRESSURE

This was done according to the method of [9].

PRINCIPLES

Blood pressure measurement is a fundamental clinical procedure used to assess cardiovascular health. It involves determining the force exerted by circulating blood on the walls of blood vessels, primarily arteries. Accurate measurement is crucial for diagnosing hypertension and monitoring treatment efficacy, it comprises two phases: systolic pressure, the pressure during heart contraction, when blood is ejected into the arteries and diastolic pressure: the pressure during relaxation, when the heart fills with blood, the lower value, indicating the pressure in the arteries when the heart is at rest between beats. An example of normal measure value for a resting healthy adult human is 120mmHg for systolic and 80mmHg for diastolic (120/80mmHg). The difference between the systolic and diastolic pressures is referred to as pulse pressure. For each heartbeat, blood pressure varies between systolic and diastolic pressure. Systolic pressure is peak pressure in the arteries which occur near the end of the cardiac cycle when the ventricles are contracting. Diastolic pressure is minimum pressure in the arteries, which occurs near the beginning of the cardiac cycle when the ventricles are filled with blood.

PROCEDURE

Participants were instructed to avoid caffeine, smoking, and strenuous activity for at least 30 minutes before the measurement. Each participant was seated comfortably and allowed to rest quietly for five minutes, with the back supported, legs uncrossed, feet flat on the floor, and the arm supported at heart level. An appropriate cuff size was chosen using mid-upper arm circumference. The cuff was positioned 2–3 cm above the antecubital fossa with the bladder centred over the brachial artery.

The radial pulse was palpated while inflating the cuff until the pulse disappeared to estimate the systolic level.The stethoscope diaphragm was placed over the brachial artery. The cuff was inflated to 20–30 mmHg above the estimated systolic pressure and deflated slowly at 2–3 mmHg per second.The first Korotkoff sound (Phase I) was recorded as systolic blood pressure.The disappearance of the Korotkoff sounds (Phase V) was recorded as diastolic blood pressure.

2.9.5 DETERMINATION OF SERUM, SELENIUM AND COPPER LEVELS IN HUMAN IMMUNODEFICIENCY VIRUS SUBJECTS ON ANTIRETROVIRAL THERAPY

The above mentioned trace elements were analyzed using the method described by Raghad [10]. Atomic Absorption Spectrophotometer's principle (AAS) is based on the sample being aspirated into the flame and atomized when the FAAS light beam is directed through the flame into the monochromator and onto the detector that measures the amount of light absorbed by the atomized element in the flame. Since metals have their own characteristic absorption wavelength, a source lamp composed of that element is used, making the method relatively free from spectral or radiational interferences. The amount of energy of the characteristic wavelength absorbed in the flame is proportional to the concentration of the element in the sample procedure.

The dried samples to be constituted were first digested by heating 2 g of both samples in a furnace for 2 hours at 550 OC. This shall be followed by diluting the samples with 20 ml of H2SO4 and filtered with filter paper (Whatman 110mm). The digested samples were fed into an air-acetylene flame and the metal's concentration is read from the equipment.

3.0. PRESENTATION OF RESULTS

The values for serum trace elements, CD4 T cell counts and anthropometric parameters are hereby presented on table 1. From the results, it was observed that Zn levels in all the treatment groups (groups 1 and 2) were significantly higher at $p = 0.004$ when compared with the control. CD4-T cell counts in all the groups were significantly lower at $p < 0.000$ when compared with the control and with one another. Tested anthropometric parameters were all significance. This indicates that age of individuals affects the ART actions on HIV positive subjects. Systolic and diastolic blood pressures were also insignificant despite being on ART, compared to that of control with degree of freedom at $p < 0.05$. When HIV

positive on ART is compared to HIV positive not on ART, except age all other tested parameters were significance at p = 0.000, and all were significant when compared with the control at p< 0.000. Systemic blood pressure for HIV+ subjects on ART was significantly higher when compared with HIV+ subjects not on ART and control (p< 0.000). Human immunodeficiency virus (HIV)+ subjects not on ART have significantly higher systolic and diastolic blood pressures when compared with the control (p< 0.000) (table1)

Tables 2 and 3 showed levels of association among all the studied parameters at p< 0.05. It was observed from the results that there were levels of association among all the studied parameters

Table 1: SERUM TRACE ELEMENT LEVELS AND CD4-T WITH ANTHROPOMETRIC PARAMETERS OF HUMAN IMMUNODEFICIENCY VIRUS SUBJECTS ON ANTIRETROVIRAL THERAPY IN NNEWI, ANAMBRA STATE, NIGERIA

Groups	Zinc(ppm)	Copper(ppm)	Selenium (ppm)	CD4-T cells	Age(yrs)	Weight(kg)	Height(m)	BMI(kkg /m^2	SBP(mmHg	DBP(mm Hg)
1 .HIV+ve on ART(n=50)	11.55 ±6.55*	22.98 ±6.43	9.97 ±5.92	602.90 ±26.16*	48.60 ±9.52	72.64 ±14.53	1.62±0.06	27.72±5.24	122.80±19.62	82.24 ±12.49
2.HIV+ve not on ART(n=29)	13.14 ±5.37*	20.64±4.33	9.15 ±3.43	139.55± 18.60*	47.23 ±5.76	50.86 ±6.02	1.49±0.50	22.76±2.03	151.38±19.62	102.76±4.55
3.Control (n=30)	8.41 ±2.88	21.17 ±5.52	9.68 ±4.28	1221.0 ±16.64	48.87 ±7.85	83.20 ±6.92	1.57±0.06	33.87±2.42	128 .33±74.66	87.33 ±8.41
F-value	5.862	1.661	0.255	221.979	0.330	67.314	46.406	59.566	37.034	40.534
p-value	0.004	0.195	0.775	0.0000	0.720	0.000	0.000	0.000	0.000	0.000
1 v 2	0.088 0.270	6.180 0.081	8.699 0.496	33.627 0.000	2.146 0.444	36.430 0.000	0.322 0.000	29.343 0.000	6.007 0.000	21.267 0.000
1 v 3	8.263 0.004	0.588 0.201	1.714 0.815	3.633 0.000	0.009 0.898	26.405 0.000	0.195 0.000	23.811 0.000	6.111 0.078	4.270 0.033
2 v 3	12.637 0.000	3.816 0.000	7.857 0.600		3.405 0,600	3.382 0.000	0.855 0.000	0.523 0.000		

Values above are the means of triplicate results ± STD. Values in the same column having the same symbols are statistically different (P< 0.05, < 0.004, = 0.000,). * = significance. BMI= body mass index, SBP= systolic blood pressure DBP= diastolic blood pressure

Table 2: GROUPS 1-2; LEVELS OF ASSOCIATION STUDIED BETWEEN PARAMETERS IN THE HUMAN IMMUNODEFICIENCY VIRUS +VE SUBJECTS

Parameter–Gp1(HIV+ on ART)	Pearson r	p-value
Zn v Cu	-0.650	0.000
Zn v Se	-0.633	0.000
Cu v Se	-0.497	0.000
Age v WT	0.298	0.036
Age v BMI	0.352	0.012
Age v DBp	0.347	0.013
WT v HT	0.319	0.024
WT v BMI	0.918	0.000
BMI v DBp	0.282	0.048
CD4 v DBp	-0.299	0.035
SBP v DBp	0.463	0.001
Parameter–Gp2(HIV+not ART)		
Cu v Se	-0.402	0.031
Cu v WT	0.681	0’000
Cu v BMI	0.548	0.000
Cu v CD4	0.868.	0.000
Se v Age	-0.478	0.009
Se v sex	-0.476	0.009
Se v SBp	0.550	0.002
Age v HT	-0.781	0.000
Sex v BMI	-0.437	0.018
Age v SBP	-0.529	0.003

HT= Hight, WT= Weight. BMI= body mass index, SBP= systolic blood pressure DBP= diastolic blood pressure.

Table 3: LEVELS OF ASSOCIATION STUDIED BETWEEN PARAMETERS IN THE HUMAN IMMUNODEFICIENCY VIRUS (HIV) –VE SUBJECTS (CONTROL GROUP)

Parameter	Pearson r	p-value	P< 0.05
Zn v sex***	-0.913	0.000	P< 0.05
Zn v CD4	-0.468	0.009	P< 0.05
Zn v HT	0.518	0.002	P< 0.05
Zn v SBp	0.522	0.003	P< 0.05
Zn v DBp	0.734	0.000	P< 0.05
Cu v Se	0.695	0.000	P< 0.05
Cu v HT	0.591	0.001	P< 0.05
Cu v BMI	0.707	0.000	P< 0.05
Cu v CD4	0.374	0.042	P< 0.05
Se v HT	0.589	0.001	P< 0.05
Se v BMI	-0.649	0.000	P< 0.05
Se v SBp	0.384	0.036	P< 0.05
Age v WT	0.923	0.000	P< 0.05
Age v HT	0.568	0.001	P< 0.05
Age v BMI	0.439	0.015	P< 0.05
Age v CD4	0.484	0.007	P< 0.05
Age v SBp	-0.363	0.049	P< 0.05
Sex v CD4 ***	0.457	0.011	P< 0.05
WT v HT	0.583	0.001	P< 0.05
WT v BMI	0.505	0.004	P< 0.05
HT v BMI	--9.390	0.033	P< 0.05

BMI= body mass index, SBP= systolic blood pressure DBP= diastolic blood pressure

4. DISCUSSIONS AND CONCLUSION

DISCUSSION

This study has so far investigated CD4T-cell count, blood pressure, some serum electrolyte levels in human immunodeficiency virus subjects on antiretroviral therapy in Nnewi, Anambra State, Nigeria. It also investigated the level of association of these parameters with one another and anthropometric parameters.

It was observed that zinc levels increased both in HIV+ subjects on ART(group 1) and HIV+ subjects not on ART(group 2) (table 1). This may be an indication of electrolyte imbalance. This agrees with the similar reports of [11-14]. Electrolyte supplements being taken by Human Immunodeficiency Virus Patients have been reported to cause electrolyte imbalance including increased zinc levels [11-14]. A lot of patients used a lot of herbal formulations and supplements at the same time with their antiretroviral drugs and sometimes without clinical supervisions [11-14]. Some of these products may interact with ART therapy, alter metabolism in the liver and may affect trace element regulation in the blood [11-12], thereby altering kidney functions. Current meta-analysis highlighted the importance of zinc supplementation in HIV-infected patients. An experiment showed that selenium was important in the regulation of NFkB, which is important in mitigating the effect of HIV pathogenesis through its effects in up-regulating glutathione peroxidase [15]. All other values for tested anthropometric parameters were significant except age, which can be a pointer to other physiological factors associated with ageing. Zinc plays an important role in antioxidant defense actions in persons affected by HIV. It functions as an important structural constituent of an enzyme called superoxide dismutase (SOD). Superoxide dismutase is an important antioxidant enzyme which transforms toxic superoxide radicals into hydrogen peroxide. This helps to reduce damage by oxidation and thereby reduce oxidative stress [16]. Zinc also helps in maintaining integrity of membrane.

The CD4T-Cell is among the immunological indices used to access the immune status and stages of disease in HIV patients [17]. From the results analyzed so far for CD4T-cell counts, The HIV + subjects on ART and that not on ART had declined CD4T-cell counts. This may be suggesting that the decline may be due to HIV effects on the subjects. This accretion is again in line with the report of [18]. Human immunodeficiency virus had been known to cause destruction of immune cells, thereby reducing the CD4T-cells in the body [18]. The observed higher CD4T-cell counts in HIV subjects on ART than those nor on ART may be due to the therapeutic effects of the ART. Antiretroviral therapy has been known to reduce viral load in HIV patients, increase the CD4T-cell count, thereby reducing the effects of the disease, improving the immunity and reducing complications [18-19].

Systolic and diastolic blood pressures showed also insignificant changes at the set degree of freedom ($p<0.05$). This agrees with the report of [20]. Human immune deficiency virus or the medications that treat it could cause changes in

the gut bacteria that lead to inflammation in the blood vessels. Human immune deficiency virus thus raises the risk for kidney problems linked to high blood pressure [20]. A similar study found no linear association between log CD4 count and both systolic and diastolic blood pressures, no independent relationship between CD4 count and hypertension after controlling for age, sex, family, and history of hypertension, BMI-defined overweight, HAART use, and duration of HIV infection [20]. Zinc supplementation in HIV-infected patients enhances immunological response, characterized by an increase in $CD4^+$ T-cells counts [10]. In addition, it increases zinc serum levels in HIV-infected patients, indicating the importance of zinc supplementation in this group of patients [10]. This study showed there are levels of association among all the studied parameters at $p< 0.05$.

However, it was also observed that trace elements (Zn, Se, and Cupper), and CD4T-cell count had correlation with anthropometric parameters measures (weight, height, body mass index), suggesting that the disease and treatment may be dependent on these anthropometric parameters [21]. Anthropometric parameters like weight and body mass index have been reported to have correlation with CD4T-cell recovery in HIV patients. Higher BMI before commencement of ART is linked with higher increases in CD4 count, which is suggesting better nutritional status [21].

5. CONCLUSION

The findings of this study highlight significant associations between CD4 T-cell counts, serum levels of selenium (Se), zinc (Zn), copper (Cu), blood pressure, weight, height, and BMI among HIV-positive individuals on TDL ART. These results suggest that adequate levels of key trace elements may support the recovery and function of immune helper cells, potentially enhancing the effectiveness of ART. Importantly, the study provides a rationale for exploring the adjunctive use of antioxidant supplements (Se, Zn, Cu) alongside ART as a strategy to optimize immune restoration in people living with HIV. Future controlled clinical trials are recommended to evaluate the efficacy, safety, and optimal dosing of such supplementation in improving immunologic and clinical outcomes.

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