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EVALUATION OF PLASMA TRACE ELEMENTS LEVELS IN HUMAN IMMUNODEFICIENCY VIRUS (HIV) PATIENTS ON HIGHLY ACTIVE ANTIRETROVIRAL THERAPY (HAART) ATTENDING FEDERAL MEDICAL CENTER OWERRI, IMO STATE

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ABSTRACT

Trace elements play significant biological roles that drive life and can be affected by the deleterious effects of the Human Immunodeficiency Virus (HIV). Highly active antiretroviral therapy (HAART) is a combination of several antiretroviral therapies that have the potential to improve the quality of life of individuals with HIV infection. The aim of this study was to evaluate the plasma trace elements of HIV-positive individuals on HAART. A total of 196 participants were recruited for the study, including 126 HIV patients on HAART, 35 HIV non-HAART patients, and 35 HIV-negative subjects. HIV status and plasma trace element levels of the participants were determined using standard procedures. The results of the study showed that zinc, selenium, and iron levels in HAART patients were significantly higher ($p<0.05$) than those in non-HAART patients (control group 1) but lower than those in the control group 2. Additionally, these elements were significantly higher ($p<0.05$) in male patients on HAART compared to their female counterparts. In conclusion, this study suggests that HAART has a positive influence on blood serum trace element metabolism in HIV-positive patients.

Keywords: Patients, Selenium, Serum, Virus, Zinc

INTRODUCTION

A mineral element is classified as a trace element if its concentration in the body is minimal and is not needed in excess of 100 mg/day. The human body contains at least 70 trace elements, which make up an estimated 0.005-0.01% of total body weight (Singer *et al*., 2018). Each trace element has specific biological roles, and a deficiency in any of them can lead to the manifestation of clinical signs and symptoms, hindering growth and development (Torti *et al*., 2018; Cannas, 2020). Certain micronutrients, such as zinc, copper, and selenium, are known for their ability to maintain the antioxidant status of a system and play immuno-modulatory roles (Cunningham *et al*., 2005).

Acquired Immune Deficiency Syndrome (AIDS) leads to the development of opportunistic infections due to the weakening of the body's natural immune defenses following infection with the Human Immunodeficiency Virus (HIV) (Ryu and Ryu, 2017). AIDS is associated with a variety of complications, such as an increased resting metabolic rate, gastrointestinal issues, oxidative stress, malabsorption, altered metabolism, gut infections, and changes in gut barrier function, all of which have a significant impact on the metabolism and absorption of trace elements (Hummelen *et al*., 2010).

During the infection, the body requires a higher intake of trace elements to effectively mount an immune response against pathogens, as evidenced by the proliferation of lymphocytes and the activation of neutrophils and macrophages. However, as the viral infection progresses, there is a modulation of trace elements such as iron, zinc, chromium, magnesium, copper, calcium, and manganese, leading to immunosuppression and increased oxidative stress and its associated effects (Rodrigues *et al*., 2025). This phenomenon explains the various abnormalities in blood trace elements, including zinc and selenium, observed in HIV/AIDS patients, which can compromise immune functions (Fabris *et al*., 1988).

A combination of several antiretroviral medications forms highly active antiretroviral therapy (HAART), which is used to slow down the replication of HIV in a host (UNAIDS/WHO, 2013). HAART is expected to alleviate critical metabolic functions and developmental processes affected by HIV infection, highlighting the importance of evaluating trace element levels in HIV patients on HAART. Therefore, the aim of this study was to evaluate trace element in HIV patients on highly active antiretroviral therapy (HAART).

MATERIALS AND METHODS

Study Location

The study was conducted at the Heart-to-Heart Center of the Federal Medical Centre (FMC) Owerri, located at (5.5096° N, 7.0391° E) in Imo State, South-East Nigeria. The study received approval from the Hospital authority, and patients' consent to participate was obtained.

Sample Size

From a population size of 396, a total of 196 individuals were recruited for the study. Among them, 126 were confirmed HIV positive and were receiving highly active antiretroviral therapy (HAART), 35 had HIV but were not on HAART, and the remaining 35 were HIV negative. The sample size was determined using a sample size calculator, considering a confidence level of 95%, a margin of error of 0.05%, and a population proportion of 50%.

Collection and Preparation of Test Samples

Approximately 5 mL of blood was collected from the antecubital vein of the subjects using a sterile syringe and placed into a dry plain plastic tube to clot. The clotted blood sample was then centrifuged at 1500 rpm for 5 minutes, and the resulting serum was separated into another container, labeled, and stored at -20°C until further use.

Human Immunovirus (HIV) Testing

A serial testing algorithm was used to determine the HIV status of the subjects. Serum samples were first tested for HIV using a rapid test kit (Alere Determine HIV – 1/2 Ag/Ab Combo). Positive results were confirmed using a different HIV rapid test kit (Uni-Gold Recombigen HIV kit). In cases where conflicting results were obtained, a tie-breaker test (HIV 1/2 Stat-Pak Assay Kit) was used to determine the HIV status.

Determination of Trace Elements

Serum iron, zinc, and selenium levels were determined using a Coupled Plasma Mass Spectrometer (Thermo Scientific, designed in the UK and manufactured in China).

Data Analysis

The results were analyzed using the SPSS software package version 20. Results were presented as mean ± standard deviation. Student's t-test was used to assess the association between variables, with a significance level set at $P < 0.05$.

The plasma levels of trace elements in HAART subjects are presented in Table 1, showing higher levels of zinc, selenium, and iron compared to non-HAART subjects. The plasma zinc, selenium, and iron levels in HAART subjects were significantly ($p<0.05$) higher than those in non-HAART individuals (control 2) but significantly ($p<0.05$) lower than those in HIV-positive individuals (control 1).

Table 1: Trace Elements levels in HIV infected HAART Subjects

Minerals	HAART Subjects	NON-HAART Subjects CTRL 1	HIV -ve Subjects CTRL 2	P-value
Zinc (µg/dl)	87.66 ± 20.05	65.37 ± 16.53	107.46 ± 19.0	0.04
Selenium (µg/l)	82.54 ± 16.60	75.54 ± 16.89	99.16 ± 12.32	0.01
Iron (µg/dl)	64.52 ± 26.97	49.11 ± 15.55	90.73 ± 25.86	0.02

Values are expressed as mean ± standard deviation $p<0.05$ is significant

Trace element levels in male and female subjects are presented in Table 2, showing that plasma zinc levels in male HAART subjects were significantly higher ($p<0.05$) compared to the levels in female HAART subjects. However, plasma zinc and selenium levels in male HAART subjects were not significantly different ($p>0.05$) from those in female HAART subjects.

Table 2: Trace Elements in Male and Female HAART subjects

Parameters	Males n = 63	Females n = 63	P – value
Zinc (µg/dl)	89.07 ± 20.43	85.84 ± 17.61	0.37
Selenium (µg/l)	78.76 ± 16.71	74.32 ± 16.32	0.88
Iron (µg/dl)	69.24 ± 30.37	59.80 ± 20.04	0.03

Results are expressed as mean ± standard deviation. *P<0.05*

Discussion

Highly active antiretroviral therapy (HAART) is a combination of several antiretroviral medicines designed to slow the rate of viral replication in the host's body (UNAIDS/WHO, 2013). It has proven to be very effective in improving the quality of life of individuals with HIV infection and has been linked to reduced mortality and morbidity rates (Ballocca *et al*., 2016). It is expected that blood trace element levels could be adversely affected by HIV infection due to factors such as micronutrient malabsorption, altered metabolism, and gut infections, among others (Singhal and Austin, 2002).

The increased levels of zinc, selenium, and iron in HAART subjects may be attributed to the fact that HAART helps reduce the viral load in individuals and improves overall body functionality. Our study's findings are consistent with the work of Ademuyiwa *et al*. (2022), which demonstrated that HIV-positive patients not receiving HAART are at a higher risk of opportunistic infections, further compromising their immunity and chances of survival. The decreased trace element levels observed in non-HAART 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 Rayman *et al*. (2012), which indicated that HIV infection exacerbates micronutrient deficiencies.

Cunningham *et al*. (2005) have established the impact of suboptimal levels of certain antioxidant trace elements such as selenium, zinc, and copper on immune degradation in HIV patients. This study also revealed that the reported trace elements (selenium, zinc, and iron) were higher in male HAART patients than in their female counterparts, possibly due to women experiencing menstruation and potentially losing these trace elements through monthly discharge.

CONCLUSION

This study evaluated the levels of trace elements in HIV patients receiving HAART. The results showed that trace element levels increased in Human Immunodeficiency Virus patients on HAART, which is contrary to the observation in non-HAART HIV patients. Additionally, the study found that trace element levels were higher in males compared to females.

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