

Research Article

Evaluation of Thyroid and Lipid Profile of Hiv Patients Seen in a Faith-Based Health Facility in Anambra State, Nigeria

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Abstract

Background: Human Immunodeficiency Virus (HIV) and thyroid function have been described. Prevalence pattern and atherogenic status significantly differ from HIV-negative control in several studies. Unfortunately, few studies have determined the prevalence of thyroid function and lipids among Nigerians living with HIV.

Objective: This study is to evaluate thyroid hormones and lipid profiles in HIV-positive subjects attending a faith-based health facility in Anambra State Nigeria.

Materials and methods: The serum concentration of Thyroid Stimulating Hormone (TSH), free Triiodothyronine (fT₃), triiodothyronine (T₃), free Thyroxine (fT₄), Thyroxine (T₄), Total Cholesterol [TC], Triglyceride [TG], High-Density Lipoprotein [HDL], Low-Density Lipoprotein [LDL] and Very Low-Density Lipoprotein [VLDL] was determined in 95 HIV positive subjects which include 48 patients who were on HAART-group 1 and 47 not on HAART- group 2; and compared to 30 HIV negative controls – group 3.

Results: The level of TSH and fT₃ was significantly ($p < 0.05$) higher in group 1 participants than in group 2 and the group 3 participants. The level of T₄ was significantly higher in group 2 than in group 1 and group 3 participants. The level of T₃ was significantly lower in Control participants in comparison to both HAART and non-HAART participants. The prevalence of fT₄ dysfunction across the groups was significantly different from each other. The total mean of Cholesterol (163.5 ± 22.7), Triglyceride (163.5 ± 22.7), and Very Low-Density Lipoprotein (14.2 ± 2.4) of the HIV-positive participants were significantly ($p < 0.05$) lower than that of the HIV negative participants.

Conclusion: The results obtained from this study indicate that serum levels of thyroid hormones may be used as baseline periodic markers during antiretroviral therapy and many people living with HIV may benefit from supplementation if appropriate.

Introduction

The incidence of Human Immunodeficiency Virus (HIV) infection has grown to pandemic proportions soon after early cases of Acquired Immunodeficiency Syndrome (AIDS) were reported in 1981 [1]. Globally HIV epidemic has had the greatest impact on Sub-Saharan Africa with a large proportion of 25.6 million of 38.4 million people living with HIV at the end of 2021. About 40 million people have died from AIDS-related illnesses since the start of the epidemic [2].

HIV is mainly characterized by a progressive loss of CD4+

T lymphocytes (CD4+), which cause immunosuppression and involvement by opportunistic diseases. The natural history of AIDS has been altered considerably by high-activity antiretroviral therapy (HAART), which prevents the evolution of the loss of CD4+ to its final stage. Along with prevention campaigns, HAART contributes to the decline of the transmission and stabilization of the epidemic in many countries [3].

With increasing HAART coverage it is imperative to commence the first Line treatment with high-quality drugs that are better tolerated and achieve sustained viral load

More Information

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Keywords: HIV; HAART; Thyroid hormones; Lipid profile; Anambra; Nigeria





suppression. DTG-based regimens have shown better efficacy, durability, and tolerability compared to other regimens in several studies [4].

Hormones play a key role in maintaining homeostasis and regulating many bodily processes, from growth and metabolism to sexual function and reproduction. Over or underproduction of endocrine hormones can contribute to a wide variety of medical conditions [5]. HIV which affects the whole body can interfere with proper endocrine function, and hormones in turn can affect the disease progression [6]. Multiple endocrine mechanisms may interact in complex syndromes, such as wasting, lipodystrophy, and other metabolic abnormalities. Lipodystrophy has become one of the most closely watched manifestations in people with HIV. Cases of lipodystrophy have now been reported among people taking any of the four approved protease inhibitors [PI]. There have been a number of reports of lipodystrophy occurring among HIV-infected patients taking non-protease inhibitor-based HAART combinations [5].

Another complication is Immune Reconstitution Inflammatory Syndrome (IRIS). This condition occurs in some patients receiving HAART who develop clinical deterioration by the re-establishment of immunity despite high CD4+ counts and a low plasma viral load. Immune reconstitution (IR) can be defined as an increased CD4+ count above 200 cells/mm³ in subjects who previously had CD4+ counts lower than 100 – 200 cells/mm³ [7].

Materials and methods

Study location/site

The study was carried out at the USAID/FHI Clinic of Immaculate Heart Mission Hospital, Umunze, in Orumba South Local Government Area of Anambra State, Nigeria.

Study population

The study population included known HIV-positive individuals who visited USAID/FHI Clinic in Immaculate Heart Mission Hospital Umunze, Anambra State, Nigeria. The controls are apparently healthy HIV-negative individuals who were age and gender-matched to the subjects attending Immaculate Heart Hospital Umunze GOPD for medical checkups and medication.

Method for sample collection

About 8 ml of venous blood was collected by venepuncture from the cubital fossa into plain specimen tubes. It was allowed to clot, centrifuged and the resultant serum stored at -20°C until analyses were carried out for T₃, T₄, TSH, fT₃, fT₄, TC, TG, HDL, LDL, and VLDL.

Ethical approval

This study was proposed and approved as an M.Sc thesis at the Department of Chemical Pathology, Nnamdi Azikiwe

University Nnewi campus while the research and ethics committee of Immaculate Heart Hospital Umunze reviewed and approved the study with approval number – IHH/REC/M4/53/19. Moreover, written and verbal consent was obtained from study participants upon the acquisition of their data. The questionnaire contained a code for patient identification which was also used to label the blood sample to match the questionnaires. Written consent was also obtained while collecting blood samples for chemical analysis. Participants were also informed about their right to leave the study at any time with no resultant consequence and standard care and respect were accorded to the targeted respondents whether they have consented or declined to participate in the study.

Sample size

For calculating the sample size, the formula proposed by Naing, et al. [8] was adopted. It states:

$$N = Z^2PQ / D^2$$

Where N = minimum sample size

Z = standard normal deviate at 95% confidence interval which is 1.96

P = least estimate of population prevalence from the literature review

D = test difference between two sub-samples regarding a proportion, assuming an equal number of cases (D = 0.10).

$$Q = 1 - P$$

$$N = \frac{1.96^2 \times 0.5 (1 - 0.5)}{0.10^2}$$

$$N = 96.04$$

Research design

This is a cross-sectional study conducted over a span of 6 months in USAID/FHI Clinic of Immaculate Heart Hospital Umunze, Nigeria, to check thyroid abnormalities as well as dyslipidemia among HIV-positive participants compared with HIV-negative controls.

Laboratory analysis

All reagent used was of analytical grade [AR]. Measurement of serum Thyroid Stimulating Hormone [TSH], Thyroxine [T₄], Triiodothyronine [T₃], free Thyroxine [fT₄], and free Triiodothyronine [fT₃] were determined using the Electrochemiluminescence assay procedure. While enzymatic methods were used in the analysis of lipid profiles.

Estimation of TSH: The determination of serum TSH was based on the method of Hopton and Harrop [9], an immunoenzymometric assay. Upon mixing the monoclonal biotinylated antibody, the enzyme-labeled antibody and



serum containing the native antigen reaction results between the native antigen and the antibodies, without competition or steric hindrance, to form a soluble sandwich complex. After equilibrium is attained the antibody bound fraction is separated from the unbound antigen by decantation. The enzyme activity in the antibody-antigen bound fraction is directly proportional to the native antigen concentration.

Estimation of thyroxine: Serum thyroxine was determined using isotopic and non-isotopic (competitive) Immunoassay method [10] which measures both free and protein-bound T_4 .

Principle: Heterogenous assays require physical separation of free and bound T_4 and a variety of solid-phase supports are used. An assortment of photometric, fluorescent, and luminescent substrates are available for monitoring the enzyme activity of the antibody-bound fraction. In contrast, homogenous enzyme immunoassays do not require physical separation of free and bound T_4 . These procedures are rapid and simple to use and also have been applied to several major automated instruments.

Estimation of triiodothyronine: Isotopic and nonisotopic immunoassays are the methods of choice used to measure total T_3 concentrations by Chopra, et al. 1971 [10].

Principle: Procedures are similar to those described for T_4 , except that a ^{125}I - T_3 tracer and T_3 - specific antibody are used. Solid-phase systems are preferred to liquid-phase separation systems. As with the T_4 methods, most T_3 methods use ANS to release T_3 from serum-binding proteins without disturbing the binding of T_3 to antibodies. A typical calibration curve ranges from 25 to 800 ng/dl.

Nonisotopic assays similar to those described for serum T_4 have been applied to the measurement of T_3 . Most commercial methods use peroxidase or alkaline phosphatase to label T_3 antigens or T_3 antibodies; enzyme activity is determined commonly by the use of a variety of sensitive photometric, fluorescent, or chemiluminescent substrates.

Estimation of free thyroxine fT_4 :

Principle

- Sample, T_4 derivant coated microwells and enzyme-labeled Anti- T_4 were combined.
- During the incubation, the T_4 derivant coated on microwells and fT_4 present in the sample compete for binding to the enzyme-labeled antibodies.
- After washing, a complex was generated between the solid phase and enzyme-linked antibodies by immunological reactions.
- The substrate solution was then added and catalyzed by this complex, resulting in a chromogenic reaction.

The resulting chromogenic reaction was measured as absorbance.

- The colour intensity was proportional to the amount of fT_4 in the sample.

Estimation of free triiodothyronine fT_3 :

Principle: Competition enzyme immunoassay. Upon immobilized antibody, enzyme- T_3 conjugate, and a serum containing the native free T_3 antigen, a competition reaction results between the native free T_3 and the enzyme- T_3 conjugate for a limited number of insolubilized binding sites. The interaction is illustrated by the following reaction:



AbC.W. = Monospecific Immobilized Antibody (Constant Quantity)

Ag = Native Antigen (Variable Quantity)

EnzAg = Enzyme-Antigen Conjugate (Constant Quantity)

AgAbC.W. = Enzyme-antigen Conjugate-Antibody Complex

K_a = Rate Constant of Association

k_a = Rate Constant of Disassociation

$k = k_a / k_a = \text{Equilibrium Constant}$

After equilibrium is attained, the antibody-bound fraction is separated from the unbound antigen by decantation or aspiration. The enzyme activity in the antibody-bound fraction is inversely proportional to the native free antigen concentration. By utilizing several different serum references of known antigen concentration, a dose-response curve can be generated from which the antigen concentration of an unknown can be ascertained.

Estimation of total cholesterol: The enzymatic method of Allain, et al. [11] was used for the determination of serum total cholesterol. This is based on the determination of Δ^4 -cholestenone after enzymatic cleavage of the cholesterol ester by cholesterol esterase, conversion of cholesterol by cholesterol oxidase, and subsequent measurement by the Trinder reaction of the hydrogen peroxide formed [12].

Estimation of triglycerides [13]: The serum triacyl glycerol was determined using Lipoprotein Lipase (LPL) from microorganisms for the rapid and complete hydrolysis of TGs to glycerol followed by oxidation to Dihydroxyacetone (DHAP) and hydrogen peroxide under the catalysis of Glycerol Kinase (GK) and Glycerol Phosphate Oxidase (GPO) and also subsequent measurement by the Trinder reaction of the hydrogen peroxide formed [13].

Estimation of high-density lipoprotein cholesterol [14]:



The HDL-Cholesterol was assayed using the Friedewald equation by subtracting the amount of cholesterol associated with LDL and VLDL assuming a prolonged fasting state (12 h - 14 h). The LDL-Cholesterol was computed by subtracting Total HDL-Cholesterol from Total Cholesterol and expressed as mmol/L [14].

Estimation of low-density lipoprotein cholesterol [14]:

Principle: Indirect methods to measure LDL cholesterol assume that total cholesterol is composed primarily of cholesterol in VLDL, LDL, and HDL. In practice, Ldl can be measured indirectly by the use of either the Friedewald equation or by β -quantification.

Friedewald equation

In the most widely used indirect method, cholesterol, triglyceride, and HDL cholesterol are measured and HDL cholesterol is calculated from the primary measurements by use of the empirical equation of Friedewald, et al. 1972 [14].

$$(\text{LDL cholesterol}) = (\text{Total cholesterol}) - (\text{HDL cholesterol}) - (\text{Triglyceride})$$

Where all concentrations are given in milligrams per deciliter.

Statistical analysis: (using IBM SPSS version 20)

Data were analyzed. Distributions of variables were reported in frequency and percentages. Comparison of the proportion of distribution of the dependent variable across the independent variables was analyzed using chi-square and Fisher's exact. Post hoc analysis involved pairwise comparisons using the z-test of two proportions was done after statistically significant chi-square of Fisher exact analysis. Analysis of the mean difference between groups was done using a *t* - test for two groups and a One-way analysis of variance (ANOVA) for groups more than two. Statistical significant differences were considered at a *p* - value less than 0.05. Post-hoc analysis for statistically significant comparison was done in ANOVA, the result of post-hocs were expressed in superscript within the tables. Values with the same superscript are not significantly different at a *p* - value of 0.05. Thyroid hormone was classified as both normal and abnormal (dysfunction) based on the value within the reference range. The categorical outcome was used as cross-tabulation against the serostatus category to study the prevalence of hormonal dysfunction across the group of serostatus.

Results

The results obtained in this study are presented in Tables 1 to 6.

Demographic characteristics and the sero status category of the study population

The characteristics of the study population such as gender, age group, HIV Status, HAART Status, and HAART Duration are

shown in Table 1. The number of subjects for the total study is 125, with 95 (76%) being seropositive which including 48 (38.4%) patients who were on HAART and 47 (37.6%) not on HAART; and 30 (24%) were seronegative individuals that served as control. 84(67.2%) were female and 41 (32.8%) were male Table 1.

Comparison of the average level of the thyroid hormone between seropositive and seronegative patient

Table 2 showed the level of various thyroid hormones between the HIV-positive and HIV-negative participants. The mean levels of TSH, T_4 , T_3 , and fT_3 were higher in HIV-positive patients than the HIV-negative participants, while the level of fT_4 (25.1 \pm 7.5) in HIV positive patients was lower compared to HIV-negative participants (42.5 \pm 8.4). The comparison of the mean using an independent sample *t* - test showed that there was a significant (*p* < 0.05) difference between the serostatus in the various thyroid hormone level except for fT_3 where the difference between the mean was statistically not significant (*p* > 0.05) Table 2.

Thyroid hormone levels across the groups

Table 3 shows the average thyroid hormone level across three groups based on HAART administration (those on HAART, Those not on HAART, and the control participants). The analysis of the mean difference was done with one-way ANOVA. The result showed that the level of TSH and fT_3 was significantly (*p* < 0.05) higher in patients on HAART than in

Table 1: Demographic Characteristics and the sero status category of the study population.

| Variables | Group | Frequency | Percentage | Mean \pm SD |
|--------------|--------------|-----------|------------|----------------|
| Gender | Female | 84 | 67.2 | |
| | Male | 41 | 32.8 | |
| | | 125 | 100 | |
| Age group | 30 below | 32 | 25.6 | 27.0 \pm 3.7 |
| | 31 - 40 | 64 | 51.2 | 36.1 \pm 2.7 |
| | 41 - 50 | 18 | 14.4 | 45.9 \pm 3.2 |
| | 51 - 60 | 11 | 8.8 | 57.0 \pm 1.9 |
| HIV Status | Positive | 95 | 76 | |
| | Negative | 30 | 24 | |
| HAART Status | On HAART | 48 | 38.4 | |
| | Not On HAART | 47 | 37.6 | |
| | Control | 30 | 24 | |
| | Total | 125 | 100 | |
| Duration | 1-2yrs | 14 | 29.8 | |
| | 3-4yrs | 23 | 48.9 | |
| | 5-6yrs | 10 | 21.3 | |
| | Total | 47 | 100 | |

Table 2: Level of the Thyroid hormone in Seropositive and seronegative persons.

| Variables | Serostatus | | t - value | p - value |
|-----------|-------------------|-------------------|-----------|-----------|
| | Positive (n = 95) | Negative (n = 30) | | |
| TSH | 3.3 \pm 2.7 | 2 \pm 1.2 | 3.63 | <0.001 |
| T_4 | 10.2 \pm 2.1 | 8.6 \pm 1.5 | 3.68 | <0.001 |
| T_3 | 2.3 \pm 0.8 | 1.4 \pm 0.5 | 5.72 | <0.001 |
| fT_4 | 25.1 \pm 7.5 | 42.5 \pm 8.4 | 10.83 | <0.001 |
| fT_3 | 3 \pm 1 | 2.7 \pm 0.9 | 1.46 | 0.14 |



Table 3: Thyroid Hormone level across the groups.

| Variables | On HAART | Not On HAART | Control | F-value | p - value |
|-----------------|------------------------|-------------------------|-------------------------|---------|-----------|
| TSH | 4 ± 3.1 ^a | 2.5 ± 2 ^b | 2 ± 1.2 ^b | 8.61 | <0.001 |
| T ₄ | 8.9 ± 2.4 ^a | 11.4 ± 0.5 ^b | 8.6 ± 1.5 ^a | 35.31 | <0.001 |
| T ₃ | 2.2 ± 1.1 ^a | 2.4 ± 0.5 ^a | 1.4 ± 0.5 ^b | 17.49 | <0.001 |
| ft ₄ | 27 ± 8.5 ^a | 23.1 ± 5.8 ^b | 42.5 ± 8.4 ^c | 64.27 | <0.001 |
| ft ₃ | 3.2 ± 1.2 ^a | 2.8 ± 0.7 ^b | 2.7 ± 0.9 ^b | 3.851 | 0.024 |

a,b,c values with different superscripts are significantly different from one another at $p < 0.05$.

the control and the HIV positive not on HAART. The level of T₄ was significantly higher in HIV patients not on HAART than in the controls and the HIV patients on HAART. The level of T₃ was significantly lower in the Controls than in both HAART and non-HAART patients.

Distribution of hormonal dysfunction across the groups

Table 4 showed the distribution of thyroid hormone dysfunction (abnormal) across the groups. The comparison of the prevalence showed that there was a significant difference ($p < 0.05$) in the distribution of TSH, ft₄, and ft₃ dysfunction across the group. The TSH dysfunction was significantly lower in controls when compared to the patients on HAART but not significant with patients who are not on HAART. The prevalence of ft₄ dysfunction across the groups was significantly different from each other. ft₄ dysfunction was significantly higher in controls when compared to. The prevalence of ft₃ dysfunction in patients on HAART was significantly higher than those not on HAART, but there was no significant difference in the prevalence of ft₃ dysfunction between control and patients on HAART.

Distribution of thyroid hormone dysfunction across the duration of haart for the patients on haart

Table 5 showed the prevalence of thyroid dysfunction across the duration of HAART for the patients on HAART. The distribution table showed that the distribution of each hormonal dysfunction was statistically not significant $p > 0.05$.

Lipid profile level across the serostatus groups

Table 6 showed the mean concentrations of T-Chol, TG, Hdl-c, Ldl-c, and VLDL-c levels between the serostatus. The mean Total Cholesterol (163.5 ± 22.7), Triglyceride (163.5 ± 22.7),

Table 4: Distribution of Hormonal dysfunction across the groups.

| Variables | No | On HAART (%) | Not On HAART (%) | Control (%) | p - value |
|-----------------|----------|------------------------|-------------------------|-------------------------|-----------|
| TSH | Normal | 36 (75.0) | 42 (89.4) | 29 (96.7) | 0.02 |
| | Abnormal | 12 (25.0) ^a | 5 (10.6) ^{a,b} | 1 (3.3) ^b | |
| T ₄ | Normal | 46 (95.8) | 47 (100) | 30 (100) | 0.34 |
| | Abnormal | 2 (4.2) | 0 (0) | 0 (0) | |
| ft ₄ | Normal | 16 (33.3) | 28 (59.6) | 0 (0) | <0.001 |
| | Abnormal | 32 (66.7) ^a | 19 (40.4) ^b | 30 (100) ^c | |
| ft ₃ | Normal | 41 (85.4) | 47 (100.) | 27 (90.0) | 0.01 |
| | Abnormal | 7 (14.6) ^a | 0 (0) ^b | 3 (10.0) ^{a,b} | |
| Total | | 48 (100) | 47 (100) | | |

a,b,c values with different superscripts across the row are significantly different from one another at $p < 0.05$.

Table 5: Distribution of Thyroid Hormone Dysfunction across the duration of HAART for the patients on HAART.

| Variables | Group | 1 - 2 yrs | 3 - 4 yrs | 5 - 6 yrs | p - value |
|-----------------|----------|-----------|-----------|-----------|-----------|
| TSH | Normal | 8 (57.1) | 19 (82.6) | 8(80.0) | 0.21 |
| | Abnormal | 6 (42.9) | 4 (17.4) | 2(20.0) | |
| T ₄ | Normal | 13 (92.9) | 22 (95.7) | 10(100) | 1.00 |
| | Abnormal | 1 (7.1) | 1 (4.3) | 0 (0) | |
| ft ₄ | Normal | 6 (42.9) | 7 (30.4) | 2 (20.0) | 0.46 |
| | Abnormal | 8 (57.1) | 16 (69.6) | 8 (80.0) | |
| ft ₃ | Normal | 11 (78.6) | 19 (82.6) | 10(100) | 0.43 |
| | Abnormal | 3 (21.4) | 4 (17.4) | 0 (0) | |
| Total | | 14 (100) | 23 (100) | 10(100) | |

Table 6: Lipid profile level across the serostatus groups.

| Variables | Serostatus | | t - value | p - value |
|-----------|-------------------|-------------------|-----------|-----------|
| | Positive (n = 95) | Negative (n = 30) | | |
| Tchol | 163.5 ± 22.7 | 188.6 ± 14.1 | 7.23 | <0.001 |
| TG | 71.9 ± 11.4 | 89 ± 10.9 | 7.24 | <0.001 |
| HDL | 42.8 ± 2.9 | 43.3 ± 4.1 | 0.69 | 0.41 |
| LDL | 34.9 ± 13.4 | 38.5 ± 8.4 | 1.76 | 0.17 |
| VLDL | 14.2 ± 2.4 | 17.7 ± 2.2 | 7.12 | <0.001 |

and very low-density lipoprotein (14.2 ± 2.4) of the HIV-positive patients were significantly ($p < 0.05$) lower than that of the HIV negative subject. The level of HDL and LDL was lower in HIV positive than the HIV negative, but the mean difference analysis showed that the difference was statistically not significant ($p > 0.05$).

Discussion

This study is aimed at evaluation of thyroid dysfunction and dyslipidemia to determine the relationship between thyroid hormone levels in HIV positive subjects compared with the HIV negative controls. The HIV positive subjects are grouped into 1 and 2 for those on HAART and naïve subjects respectively while group 3 are the negative control subjects.

On the basis of the age group of the subjects, the subjects were grouped into four; 30 years and below, between 31 and 40 years, between 41 and 50 years, and between 51 and 60 years. Their mean ages are 27.0 ± 3.7, 36.1 ± 2.7, 45.9 ± 3 and 57.0 ± 1.9 respectively. The study also grouped the HIV-positive subjects according to their HIV duration; between 1-2 years (29.8%), 3-4 years (48.9%), and 5 - 6 years (21.3%).

The sociodemographic data of the study population shows that more than 50% of the study population were young subjects aged 31 to 40 years. This is similar to reports from two studies conducted in Osun and Enugu states where subjects aged 30 years - 39 years were found to have the highest percentage [58% and 40.9% respectively]. The mean age of the two study populations also supported the fact that many of the subjects were young individuals. This finding is also consistent with a higher prevalence of HIV infection seen in the reproductive age group [15 years - 49 years] compared to other age groups [15]. In terms of gender, females were more than twice the number of males. This suggests that females were twice more likely to have HIV infection than males.



Higher prevalence in females compared to males was also found in some studies carried out in the central and southern parts of Nigeria [15,16] This is however contrary to what was found in some studies carried out in foreign countries where men dominated more than half of the study population [17]. The reason for the disparity may partly be due to increased homosexuality practices outside Nigeria [18]. Another reason for the gender disparity seen in this study may be due to the cultural practice in our society, in which a man is allowed to marry more than one wife [19]. Therefore, an HIV-infected man can infect all his wives. Another reason may be natural events that give females more opportunity to be screened than their male counterparts e.g. during antenatal care, childbirth, child care, immunization, and so on.

The mean levels of TSH, T_4 , T_3 , and fT_3 were found to be higher in HIV-positive than the HIV-negative control. This is in contrast to what was reported by Collazos, et al. [20] but in agreement with Palanisamy, et al. [21] in India where fT_3 was lower with higher fT_4 and TSH among subjects with HIV compared with controls. In Ibadan Southwestern Nigeria, Abbiyesuku, et al. [22] also found higher TSH levels among HIV patients compared with controls. It has been shown that abnormal thyroid function is not uncommon in HIV and there may be a number of contributory factors [23-25]. However, the level of fT_4 in HIV-positive was lower than HIV-negative compared to fT_3 which is still within the normal reference range. Statistically using an independent sample *t* - test there is a significant difference between the serostatus in the various thyroid hormone levels except for fT_3 which is not statistically significant.

Furthermore, the level of TSH and fT_3 is significantly higher in group 1 subjects than the group 2 and 3 subjects. A similar observation was reported by Verma, et al. [26] and Shujing, et al. [27] in which thyroid dysfunction was significantly more frequent in the HAART group 1 than in group 2. Also, T_4 is significantly higher in group 2 subjects than the group 1 and 3 subjects. T_3 is significantly lower in group 3 subjects than in group 1 and 2 subjects.

In the distribution of TSH, fT_4 , and fT_3 dysfunction across the group; TSH dysfunction is significantly lower in group 3 subjects compared to subjects in group 1 but not with group 2 subjects. The prevalence of fT_4 dysfunction across the groups is significantly different from each other. while the prevalence of fT_3 dysfunction in patients on HAART. There is no significant difference in the prevalence of fT_3 dysfunction between group 2 and 3 subjects. Across the duration for subjects on HAART which are grouped into 1 - 2 years, 3 - 4 years, and 5 - 6 years, statistically, there is no significant difference in thyroid hormone dysfunction.

Mean levels of total cholesterol, triglyceride, and VLDL were statistically higher in group 3 subjects than in group

1 and 2 subjects but the difference in the level of various lipid profiles between patients on HAART and HAART naïve patients was not significant. The level of HDL and LDL was equally not significant between the various groups. These findings also concur with the results of Ebuehi, et al. 2015 [5] in Changes of Serum Cortisol, Thyroid Hormones, and Lipid profiles in Nigerian Men and women on 1st and 2nd Line Antiretroviral Therapy for 52 weeks.

The most common pattern of thyroid dysfunction among subjects in this study was primary hypothyroidism, followed by isolated low fT_4 . Among the controls, the most common thyroid dysfunction was subclinical hypothyroidism. Similar findings were reported by Ketsamathi, et al. [28] in Bangkok. Several studies have also found primary hypothyroidism as the most frequent thyroid abnormality among their study population Uloko, et al. [29]. However, Gagnon, et al. [30] in Toronto, Canada, and Guilherme, et al. [31] in Rio de Janeiro, Brazil, reported subclinical hypothyroidism as the most common pattern of thyroid dysfunction among their subjects. The longer duration of HIV infection among subjects in those studies and the fact that many of the patients were not on HAART may explain the difference. Some studies have reported an association between HAART use and overt hypothyroidism Uloko, et al. 2020 [29]. The isolated fT_4 found in this study were also reported by Rasoolinejad, et al. [32] in Tehran, Iran, and Abbiyesuku, et al. [22] in Ibadan, Nigeria as the most common thyroid dysfunction among their subjects. This abnormality could be due to sick euthyroid syndrome in the setting of advanced HIV infection. They could also be due to clinical and subclinical opportunistic infections.

Conclusion

It has been shown that abnormal thyroid function is not uncommon in HIV and there may be a number of contributory factors. This may have a major impact on the quality of life and many people with HIV may benefit from testing of hormone level and supplementation if appropriate. Regular monitoring of the thyroid hormones and lipid profile of HIV-positive individuals will be clinically useful in determining those who may have a higher risk of thyroid dysfunction or Cardiovascular Disease. Larger multicentre studies will be useful in determining the progression of thyroid dysfunction and dyslipidaemia in HIV-positive patients over time. Because the safety of HAART drugs has been well established, however more research is needed to broaden the choice of drugs available for treating HIV infection in these individuals where it may be necessary to switch to other types of PI-based therapy or a different class of HAART.

Consent

As per international or university standards, participants' written consent has been collected and preserved by the authors.



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