Original Article

Thyroid Function Test Abnormalities in Human Immunodeficiency Virus Positive Patients on Antiretroviral Therapy at Matyazo Health Center, Huye, Rwanda

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Abstract

Background

Thyroid dysfunction (TD) is commonly found in people living with HIV infection (PLHIV) and is exacerbated by ART. While TD is documented in PLHIV, its prevalence in Rwanda remains underexplored. This study investigated thyroid dysfunction in HIV-positive patients on ART at Matyazo Health Centre, Butare, Rwanda. The study aimed to assess the prevalence and distribution of thyroid function test (TFT) abnormalities among HIV-positive individuals receiving antiretroviral therapy (ART) at Matyazo Health Centre, Rwanda.

Methods

A cross-sectional study involving 200 participants (100 HIV-positive on ART and 100 HIV-negative controls, mainly healthcare workers and university students) was undertaken. Blood specimens were obtained for thyroid function assessments, including thyroid stimulating hormone (TSH), free thyroxine (FT4), and free triiodothyronine (FT3) when indicated. A standardised questionnaire captured sociodemographic information and clinical data were extracted from medical records.

Results

Thyroid dysfunction prevalence was greater among HIV-positive participants compared to HIV-negative controls (47% vs. 16%). The predominant abnormality was central hypothyroidism/euthyroid sick syndrome (ESS), particularly in those on ART for over 24 months. Subclinical hyperthyroidism was less common. Educational attainment (p=0.006) and employment status (p=0.028) were significantly associated with thyroid dysfunction.

Conclusion

The high prevalence of TD among HIV-positive patients on ART suggests an association between HIV infection, ART, and thyroid dysfunction, underscoring the importance of regular thyroid function screening. To build on these findings, longitudinal studies are recommended.

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Keywords: thyroid dysfunction, HIV, antiretroviral therapy (ART), central hypothyroidism, euthyroid sick syndrome (ESS)

Introduction

The butterfly shaped thyroid gland located lateral to the trachea and anterior to the lower neck, produces hormones that play an essential role in regulating metabolic functions, including maintaining cardiac rate, lipid metabolism, and skeletal growth and is therefore a key organ in the complex system of human physiology. [1, 2] The hypothalamic–pituitary–thyroid (HPT) axis regulates thyroid hormone release. TSH stimulates FT4 and FT3 secretion, which control metabolism. Human Immunodeficiency virus (HIV) infection and ART may disrupt this axis. However, the thyroid gland is susceptible to specific abnormalities including autoimmune thyroiditis, infectious causes, and drug-induced dysfunction. Because of its clinical impact, the comorbidity of thyroid dysfunction and HIV infection has become an increasing focus of research. [3] The hypothalamic–pituitary–thyroid (HPT) axis controls thyroid physiology: the hypothalamus releases TRH, stimulating the pituitary to secrete TSH, which in turn triggers the thyroid gland to release FT4 and FT3. FT4 is converted peripherally into FT3, the biologically active hormone. HIV infection and ART may disrupt this axis through immune activation, chronic inflammation, and direct drug effects.[1]

HIV causes a chronic viral infection that weakens the immune system.[4] According to UNAIDS, as of 2021, an estimated 33.9-43.8 million people worldwide were infected with HIV. The prevalence of HIV among Rwandan adults was reported to be 3% according to the Population-based HIV Impact Assessment.[5] Although a cure for HIV remains elusive, antiretroviral therapy (ART) substantially decreases viral loads in infected individuals, effectively converting HIV from a terminal illness into a chronic yet manageable condition with significantly enhanced quality of life.[4] Nevertheless, ART has its drawbacks, and growing evidence suggests that ART can impair thyroid function, resulting in diverse thyroid irregularities that complicate the clinical management of HIV-infected patients. [4] Thyroid stimulating hormone (TSH), free thyroxine (FT4), and free triiodothyronine (FT3) are critical biomarkers of thyroid function and are widely used in diagnosis. Serum TSH levels serve as the most sensitive marker of thyroid function, while FT4 reflects circulating thyroxine levels and FT3 reflects active thyroid hormone action. In combination, these biomarkers provide diagnostic insight into primary, secondary, and subclinical thyroid disorders, and are particularly useful in evaluating patients with chronic illness including HIV infection. [6]

A complex clinical phenomenon exists between thyroid dysfunction, ART and HIV infection. Evidence from studies conducted in Romania and India suggests a potential link between HIV infection, ART, and thyroid dysfunction, highlighting the urgency of exploring this area further.[7–9] A 2014 Nigerian study revealed that HIV-infected patients were more prone to exhibiting low free triiodothyronine (fT3) and low free thyroxine (fT4) levels, accompanied by normal thyroid-stimulating hormone (TSH), compared to apparently healthy controls. The pathological changes reported have been attributed to the infiltration of the thyroid gland by HIV resulting in the destruction of thyroid cells, or abnormal coordination of the pituitary-thyroid axis.[10] According to Hoffmann et al. (2007), 1–2% of HIV-positive individuals were diagnosed with hyperthyroidism, and 35% showed thyroid function abnormalities, primarily indicative of subclinical forms.[11] The use of ART has also been associated with hyperthyroidism, especially during immune reconstitution, often leading to Grave's disease.[9] Despite evidence from studies done in different geographical settings, the thyroid function status of Rwandans infected with HIV and on ART remains largely unexplored. This is despite the high prevalence of infectious diseases, and the various nutritional, environmental and lifestyle factors that could potential predispose HIV-infected Rwandans to a higher risk of thyroid dysfunction.

By evaluating thyroid function in HIV positive participants on ART, this study sought to determine the prevalence, associations and trends of thyroid dysfunction in patients presenting at Matyazo Health Centre, Butare, Rwanda. Studies from Romania and India reported increased prevalence of hypothyroidism and subclinical thyroid dysfunction among HIV-infected individuals on ART, highlighting regional variability and the need for contextual research.[7–9]

Methods

Study setting and design

This study was conducted at Matyazo Health Centre located in Huye district, and Matyazo sector in southern Rwanda from November 2023 to January 2024. The study site offers comprehensive HIV care and treatment services to an estimated catchment population of approximately 30,000 individuals in the southern province of Rwanda. A quantitative cross-sectional study was conducted involving HIV-positive patients on ART and an HIV-negative control group. The study was structured to compare thyroid function test results across these groups, stratified by ART duration.

Participant recruitment

HIV-negative participants were recruited from the same Matyazo Health Centre, primarily comprising healthcare workers and University of Rwanda students. They were considered 'apparently healthy' if they had no prior diagnosis of thyroid disease, were not on chronic medication, and had no acute illness at the time of recruitment.

The study population consisted of individuals infected with HIV and on ART, aged ≥18 years and who were willing to provide written informed consent. All HIV-infected participants were in a stable clinical condition and were out patients. Individuals infected with HIV who had prior diagnosis of a thyroid disorder before their HIV diagnosis and the start of ART were excluded from the study. Furthermore, individuals with a history of thyroid gland surgery or radiation, and those with kidney or liver failure, or co-infected with hepatitis B or C, were also excluded.

Sample size and sampling strategy

Participants were categorized post hoc into ART ≤24 months, ART >24 months, and HIV-negative groups, reflecting post-stratification rather than true stratified sampling.

The sample size was determined using Cochran's formula for cross-sectional studies,[12] based on an estimated prevalence of thyroid function test abnormality of 12.6%. A sample size of 170 was calculated but this was inflated to 200 participants to cater for possible incomplete data.

Cochran's formula used to determine the sample size:

$n0=Z^2p\ (1-P)\ /e^2$

Where:

n0 = initial sample size

Z= Z-score (based on the desired confidence level, e.g., 1.96 for 95% confidence)

p = estimated proportion of the population with the characteristic of interest (if unknown, 0.5 is used for maximum variability)

e = margin of error (precision level, e.g., 0.05 for 5%)

This study employed a stratified sampling strategy. Participants were categorised into three groups: those receiving ART for ≤24 months, those on ART >24 months or longer, and a third group comprising HIV-negative individuals. In total, 100 HIV-negative participants were included, along with 100 participants living with HIV consisting of 13 who had been on ART ≤24 months or less and 87 who had been on ART for >24 months. The 24-month cutoff was chosen because immune reconstitution and metabolic adaptations typically stabilise within the first two years of ART, making it a clinically meaningful threshold for assessing thyroid function changes.

Data collection methods

Structured questionnaires were used to collect socioclinicodemographic data from the participants.

Such information included age, gender, education attainment, employment status, cigarette smoking status, weight, height, duration since HIV diagnosis, length of time on ART, latest CD4 cell count, and HIV viral load test results, confirmed co-infection status with hepatitis B and C, and presence of signs and symptoms of thyroid dysfunction (hypothyroidism and hyperthyroidism). To verify the questionnaire's validity and reliability, a pilot study was conducted to assess question clarity and comprehension. Following feedback, necessary revisions were made to enhance the questionnaire's validity and reliability.

Laboratory testing

A 5 mL venous blood sample was obtained via venipuncture from the medial cubital fossa. After clotting, the samples underwent centrifugation for 3 minutes at 3000 rpm. The resulting serum was stored in cryovials at -20○ C. The serum samples were thawed only once before measurement of TSH, FT4 and FT3 using the Fortress enzyme linked immunosorbent assays (ELISA) (Fortress Diagnostics, Antrim, United Kingdom). [13,14] Reflex testing was adopted in which TSH was used as a screening test and if abnormal serum FT4 was then measured. The FT3 was only measured when TSH was low and FT4 was normal to confirm possible T3 thyrotoxicosis.[15] All assays were performed in accordance with principles of good clinical laboratory practice. The reference ranges for TSH, FT4, and FT3 used to interpret the results in this study were as follows:

- TSH: 0.27 – 4.20 μIU/mL
- FT4: 2.00 – 4.40 ng/dl
- FT3: 0.93 – 1.70 pg/ml

The various possible interpretations of the TFT profile results are presented in Table 1

Table 1. Interpretation of TFT results according to categorization of the different clinical conditions associated with the thyroid gland.[15]

Diagnosis	Expected Thyroid Function Test Findings		
	TSH	FT4	FT3
Normal	Normal	Normal	Normal
Primary hyperthyroidism	Low	High	High
Subclinical hyperthyroidism	Low	Normal	Normal
T3 toxicosis	Low	Normal	High
Thyroiditis orT4 ingestion	Low	High	Normal
Euthyroid sick syndrome/Central hypothyroidism	Low	Low	Low
Primary hypothyroidism	High	Low	Low
Subclinical hypothyroidism	High	Normal	Normal
TSH producing adenoma	High	High	High

Data analysis

Data from this study were recorded onto a Microsoft Excel spreadsheet and exported for statistical analysis to STATA version13 (StataCorp, College Station, Texas, USA). Categorical variables were described using counts and proportions. Parametric continuous data were expressed as mean and standard deviation (SD), whereas non-parametric numerical data were summarized using median and interquartile range (IQR). Mean/median TSH and FT4 concentrations were compared for different defined strata. The prevalence of thyroid dysfunction was determined along with the 95% confidence interval. Associations between thyroid function abnormalities and related factors were assessed using the Chi-square test or Fisher's exact test, with statistical significance set at p-value<0.05.

Ethical Approval

Ethical approval to conduct the study was granted by the University of Rwanda's College of Medicine and Health Sciences Institutional Review Board (IRB) (CMHS/IRB/358/2023). Permission to enroll participants was granted by Kabutare District Hospital administration that regulates Matyazo Health Centre. Participation in the study was voluntary, and written informed consent was obtained from each participant before enrollment. Participants were free to withdraw from the study at any stage without penalty. Participant confidentiality was maintained by using unique study identification numbers and data was stored in password- protected databases accessed only by authorized study personnel. Participants with abnormal laboratory findings were referred to the relevant clinical departments for management.

Results

A total of 200 participants comprising 161 (80.5%) females and 39 (19.5%) males were enrolled in the study and stratified based on the duration on ART with a third group serving as an apparently healthy control group. Altogether, 13 (6.5%) participants among the HIV-positive participants had received ART for ≤24 months while 87 (43.5%) HIV participants had been on ART for >24 months, and 100 participants were HIV negative. All HIV positive individuals were in a stable clinical condition with no opportunistic infections reported. The sociodemographic and clinical characteristics of the study participants are presented in Table 2.

Table 2. Sociodemographic and Clinical Characteristics of the Study Participants (n=200)

Variable*	Overall	≤24 months on ART n=13	>24 months on ART n=87	HIV Negative n=100	p-value
Gender					
Female	161(80.5)	11(84.6)	64(73.6)	86(86.0)	
Male	39(19.5)	2(15.4)	23(26.4)	14 (14.0)	0.094
Age (years) Median (IQR)	48 (40-58.5)	42(34-47)	44(37-54)	54(42.5-65)	**<0.001**
BMI Kg/m^2 Median (IQR)	21.3(19.3-25)	19.3(18.3-21.7)	20.1(18.5-22.0)	22.5(20.3-24.6)	**<0.001**
Current smoker	24(12.0)	2(15.4)	18(20.7)	4(4.0)	**0.002**
Educational attainment					
No formal education	92(46.7)	2(15.4)	30(34.5)	60(61.9)	**0.001**
Primary	95(48.2)	9(69.2)	51(58.6)	35(36.1)	
Secondary	7(3.6)	1(7.7)	5(5.8)	1(1.0)	
Tertiary	3(1.5)	1(7.7)	1(1.2)	1(1.0)	
Employment Status					
Farmer	169(84.5)	9(69.2)	67(77.0)	93(93.0)	**0.007**
Other jobs	13(6.5)	1(7.7)	7(8.1)	5(5.0)	
Unemployed	18(9.0)	3(23.1)	13(14.9)	2(2.0)	

Key: *All n (%) unless stated otherwise, IQR: Interquartile range; HIV: Human immunodeficiency virus, BMI: Body Mass Index, ART: Antiretroviral therapy. Kruskal Wallis test used to compare medians. Proportions compared using the Chi-square tests and Fishers exact where appropriate. Statistical significance was defined as $p < 0.05$.

The overall median (IQR) age was 48 years (IQR 49-58.5), but HIV-negative participants were significantly older 54(IQR 42.6-65) years (p=0.0001) compared to 42(IQR 34-47) years and 44(IQR 37-54) years for those on ART for <24 months and ≥24 months respectively. Of the 200 participants, only 24 (12%) smoked cigarettes and of these significantly more were HIV infected and on ART for ≥24 months compared to HIV-negative participants and those who had been on ART for <24months (p=0.002). Educational attainment was significantly different according to HIV infection status and duration on ART with >50% of the participants having attained at most no higher than primary school education (p=0.001). Furthermore, significantly more participants were farmers; 84.5% (n=169) with the remainder either unemployed or engaged in other occupational activities.

The prevalence and pattern of thyroid function abnormalities in HIV-positive patients receiving ART

Altogether, as indicated in Table 3, 63 (31.5%) (95% Confidence Interval (CI): 25.1-38.4) of the 200 participants had abnormal TFT parameters. HIV-infected participants showed a significantly higher rate of thyroid function test (TFT) abnormalities; 47% (95% CI: 36.9 %-57.2%) compared to the HIV uninfected participants; 16 % (95%CI: 9.4- 24.7%) p < 0.001. Central hypothyroidism/ sick euthyroid was the commonest TFT abnormality observed in 46 (23%) participants overall. Significantly, more HIV positive participants (32%) had central hypothyroidism/sick euthyroid syndrome compared to 14% in HIV-negative participants. Among the 32% participants with central hypothyroidism/ euthyroid sick syndrome, 27(31.0%) had been on ART for >24months compared to 5(38.5%) among those for ≤24 months. Subclinical hyperthyroidism was observed in 17(8.5%) of the participants overall, the majority of whom n=14(16.1%) had been on ART for >24months. Subclinical hyperthyroidism was detected in a small proportion (2%, n=2) of HIV-negative participants.

Table 3.The prevalence and spectrum of TFT abnormalities among the study participants (n=200)

Variable	Overall	≤24 months on ART n=13	>24 months on ART n=87	HIV Negative n=100	p-value
Thyroid hormone* (Median (IQR)					
TSH (μIU/ml)	0.54(0.19-0.94)	0.17(0.07-0.71)	0.30(0.12-0.65)	0.80(0.45-1.03)	**<0.001**
FT_4 ng/dl)	0.77(0.59-0.96)	0.77(0.75-0.93)	0.82(0.66-1.00)	0.56(0.47-0.77)	**0.0082**
Presumptive Thyroid function abnormalities					
Normal	137(68.5)	7(53.9)	46(52.9)	84(84.0)	**<0.001**
ESS or Central Hypothyroidism	46(23.0)	5(38.5)	27(31.0)	14(14.0)	
Subclinical Hyperthyroidism	17(8.5)	1(7.7)	14(16.1)	2(2.0)	

Key: ESS: Euthyroid Sick Syndrome, IQR: Interquartile range; TSH: Thyroid Stimulating Hormone; FT4: Free thyroxine. TSH and FT4 results group comparisons done using the Kruskal Wallis test and proportions compared using the Chi-square test. A p-value of 0.05 was used as the threshold for statistical significance.

Correlates of thyroid dysfunction in HIV-positive patients on ART attending Matyazo health center

The correlates of thyroid function status are presented in Table 4. Only educational attainment (p=0.006) and employment status (p=0.028) were significant correlates of abnormal thyroid function tests. However, the thyroid function status was comparable in terms of the other variables such as age, BMI, CD4 copies/ml, viral load, smoking status, duration since HIV infection, duration on ART, and ART regimen among the three thyroid function status groups as presented in Table 4.

Table 4. Correlates of thyroid function tests abnormalities (n=200)

Variable*	Thyroid Function Status			p-value
	Central Hypothyroidism/ ESS (n=46)	Normal (n=137)	Subclinical Hyperthyroidism (n=17)	
Age (Years)	44.5(37-58)	49(40-61)	45(41-48)	0.143
BMI	20.5(19.3-23.0)	21.4(19.4-23.2)	22.0(18.7-22.7)	0.692
CD4 copies/ml	417(337-544)	493(360-554)	513(383-610)	0.209
Cigarette smokers	8(17.4)	15(10.9)	1(5.9)	0.366
Educational attainment n (%)				
None	19(41.3)	69(51.1)	4(25.0)	**0.006**
Primary	26(56.5)	60(44.4)	9(56.3)	
Secondary	1(2.2)	5(3.7)	1(6.3)	
Tertiary	0	1(0.7)	2(12.5)	
Employment Status n (%)				
Farmer	36(78.3)	120(87.6)	13(76.5)	**0.028**
Other jobs	1(2.2)	10(7.3)	2(11.8)	
Unemployed	9(19.6)	7(5.1)	2(11.8)	
Duration since HIV infection n (%)				
<1year	1(3.1)	1(2.0)	0	0.752
1-5years	8(25.0)	13(25.5)	2(13.3)	
5-10years	8(25.0)	18(35.3)	4(26.7)	
>10years	15(46.9)	19(37.3)	9(60.0)	
Duration on ART				
≤24months	5(15.6)	6(13.2)	1(6.7)	0.706
>24months	27(84.4)	46(86.8)	14(93.3)	
ART Regimen				
DTG/3TC/TDF	2(6.3)	4(7.6)	1(6.7)	1.000
DTG/ABC/3TC	30(93.8)	49(92.5)	14(93.3)	

Key: *Median (IQR) unless otherwise stated; ART antiretroviral therapy, DTG: Dolutegravir, 3TC: Lamivudine, TDF: Tenofovir, ABC: Abacavir, HIV: Human Immunodeficiency virus, ESS: Sick Euthyroid Syndrome. Proportions were compared using the Chi-square test, with statistical significance set at $p < 0.05$.

Discussion

The present study determined the prevalence, spectrum and risk factors of thyroid dysfunction in HIV-positive participants compared to HIV-negative participants. The relationship between the type of antiretroviral therapy (ART) regimen and the occurrence of thyroid dysfunction was also examined. Findings from the present study revealed an overall prevalence of thyroid function tests abnormalities of 31.5% but HIV positive participants had a significantly higher frequency of TFT abnormalities (47%) compared to the apparently healthy controls (16%). The most predominant TFT abnormality reflected the euthyroid sick syndrome whose profile also matches central hypothyroidism. Notably, median TSH levels, although within the reference interval were significantly higher in the HIV-negative group, while median FT4 levels were significantly higher in the HIV-infected group. Other than occupation and educational attainment, there were no significant correlates of abnormal TFT findings were found.

Our observation of a higher rate of thyroid function test (TFT) abnormalities in HIV-positive patients on ART is consistent with the results of similar studies conducted in Nigeria,[10] France,[7] and Germany.[16] In contrast to a Thai study, the prevalence of thyroid dysfunction found in our study was significantly higher.[17] The causes of TFT abnormalities in HIV positive participants on ART are multifactorial. Infection with the virus itself can lead to thyroid dysfunction due to underlying inflammation, damage and autoimmune responses that will mediate the release of thyroid hormones into circulation. Additionally, no significant associations were found between different ART regimens, duration on ART and TFT abnormalities, antiretroviral drugs have been reported to affect thyroid function in different ways.[18] Tenofovir (TDF) has been reported to decrease TSH levels leading to hypothyroidism,[19] whilst abacavir (ABC) has been reported by others to increase both FT4 and FT3 levels. In addition, patients who switched to a dolutegravir (DTG) based ART regimen have also been reported to develop clinical and biological hyperthyroidism.[20] The HIV positive participants in the present study were either on DTG/3TC/TDF or on DTG/ABC/3TC. The predominance of central hypothyroidism/euthyroid sick syndrome (ESS) observed may be explained by chronic inflammation, immune dysregulation, nutritional deficiencies, or mitochondrial toxicity associated with long-term ART.[21,22] The lack of association between ART regimen and thyroid status could reflect the relatively uniform use of DTG-based regimens in this cohort, minimizing detectable regimen-specific differences. Associations with occupation and educational attainment may reflect broader socioeconomic influences on thyroid health, including nutrition, psychosocial stress, and health-seeking behavior.[23] These findings underscore the complex interplay between biological and social determinants of thyroid dysfunction among people living with HIV infection.

The predominant pattern of thyroid dysfunction found in this study was euthyroid sick syndrome (ESS) that we were not able to distinguish from central hypothyroidism. This abnormality is characterised by variably low TSH and FT4 and high reverse T3 (RT3).[24] The second most prevalent thyroid function disorder was subclinical hypothyroidism characterised by elevated TSH with normal FT4. Among the controls ESS/central hypothyroidism was also the most prevalent TFT abnormality. These findings were however, in discordance with findings from a study by Ukodei et al who found that primary hypothyroidism and isolated low FT4 levels were the most common thyroid abnormalities in HIV-positive individuals, whereas subclinical hypothyroidism was more common among controls.[25] Other studies also reported a high prevalence of primary hypothyroidism and subclinical hypothyroidism.[17,26] In contrast, a Brazilian study found that subclinical hypothyroidism was the predominant form of thyroid dysfunction

among its participants.[27] Possible reasons for these differences could be due to variations in study populations, such as age, sex, and comorbidities; geographical and ethnic differences; diagnostic criteria; sample sizes; and the methods used for sample analysis. Additionally, variations in the duration and severity of HIV infection among the studied populations could contribute to the observed discrepancies. Similarly, in concordance with one report, No participants were diagnosed with hyperthyroidism in the current study. Notably, the absence of hyperthyroidism cases in our study contrasts with previous reports that documented instances of overt hyperthyroidism.[28]

In the present study, we were unable to distinguish between ESS and central hypothyroidism since these required additional tests such as the thyrotropin releasing hormone test, reverse T3 (RT3) and imaging studies among other tests. HIV positive patients on antiretroviral therapy (ART) with stable disease, normal CD4 counts, and virally suppressed may still experience euthyroid sick syndrome (ESS) due to various factors. One possible cause is the mitochondrial toxicity of certain ART medications, which can disrupt thyroid function. Additionally, persistent immune activation causes chronic inflammation, which although subdued, may still persist and affect thyroid hormone levels.[23] Metabolic changes, such as insulin resistance, can also contribute to ESS in this population. Lipodystrophy, a condition characterized by abnormal fat distribution, can affect thyroid function, even in patients with stable disease.[29] Recent research indicates that certain individuals with sick euthyroid syndrome (SES) may actually experience temporary central hypothyroidism. In HIV positive patients, this can be triggered by the infection itself, medications used to treat HIV, or malnutrition and cachexia.[30] The development of SES is complex, often involving multiple factors. The SES poses a significant threat to health and well-being, leading to severe consequences if left untreated. Untreated SES triggers a cascade of harmful effects, notably increasing the risk of cardiovascular disease due to altered lipid profiles and chronic inflammation. This heightened risk predisposes individuals to heart attacks, strokes, and premature mortality.[28] Chronic thyroid hormone imbalances also impair cognitive function, affecting mental clarity, memory, and reaction times. This cognitive decline significantly impacts daily life, exacerbating the disease burden. Prompt diagnosis and management are therefore crucial to mitigate these adverse outcomes, improve quality of life, and prevent long-term consequences of SES.

The median (IQR) ages of HIV positive patients on ART for ≤24 months and on ART for >24 months was 42 (34-47) and 44 (37-54) years respectively, which was comparable to findings from a study done in Nigeria conducted by Omolumen et al.[31] which found that HIV infection was widespread among individuals aged 15-49, a key reproductive age group. The thyroid gland size normally diminishes with age; thus, hypofunction is commonly observed with increasing age. [32] The participants in our study were relatively older, with a mean age that was somewhat high (48.9 years) and this could have confounded the notably high rate of thyroid dysfunction found in this study. There were four times more female participants in the present study compared to males. Likewise, research done by Adesegun et al. and Ukodei Idowu et al., both conducted in Nigeria but in different states, reported a high number of female participants in their studies, that were twice the number of male participants.[25,33] The predominance of females in studies enrolling participants from health centres may be attributed to variations in how individuals seek medical care , with females having a higher likelihood of being enrolled compared to males due to events like antenatal care, immunization, childbirth, and being guardians and carers for the most members of the family.[34] Additionally, females are more susceptible

to developing thyroid disorder compared to males, which may also contribute to their higher representation in the study.[35]

Limitations and strengths of the study

The major limitation of this study is its cross-sectional design, which disallows the determination of cause-and-effect relationships between HIV and thyroid dysfunction patterns. Furthermore, the relatively small sample size, which restricts the generalizability of our results, and the potential influence of non-thyroidal illness on thyroid function in both cases and controls, introducing possible confounding variables. However, the study have some strengths as it enrolled HIV-positive subjects and control groups that provide valuable insights into the prevalence and types of thyroid dysfunction in these populations, we also used well-established diagnostic criteria and robust methodologies for data collection and analysis. Furthermore, our study highlights the need for further investigation with larger, more diverse samples and longitudinal study designs to better understand the complex relationship between HIV and thyroid dysfunction.

Conclusion

This study uncovered a surprisingly high rate of thyroid problems in HIV-positive patients undergoing antiretroviral therapy (ART), hinting at a possible link between HIV, ART, and thyroid health. While the study's design prevents conclusive proof of causality, the findings emphasize the need for regular thyroid function checks in this population, especially among older individuals, women, and those with prolonged HIV infection.
Furthermore, further research is necessary to explore the underlying causes and risk factors, including immune system imbalance, inflammation, and specific antiretroviral medications, to improve care for HIV-infected individuals.

Conflict of interest

All authors declared no conflict of interest.

Authors' contribution

ET, JAN, VN, all contributed with the conception, design and writing of the manuscript, data collection and interpretation, HTM contributed with the conception, design and writing of the manuscript and interpretation, CM contributed with writing of the manuscript, data analysis and interpretation.

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