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Epidemiological risk factors for HIV/TB co-infection among patients receiving antiretroviral therapy in selected hospitals in Ibadan, Nigeria: a case-control study

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Epidemiological risk factors for HIV/TB co-infection among patients receiving antiretroviral therapy in selected hospitals in Ibadan, Nigeria: a case-control study

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Abstract

Background: Despite the scale-up of antiretroviral therapy (ART), active tuberculosis (TB) remains a major complication among people living with HIV (PLHIV). This study identified epidemiological risk factors for active TB among PLHIV receiving ART in Ibadan, Nigeria.

Methods: A case–control study was conducted among 346 consenting PLHIV on ART (173 cases with active TB and 173 controls without TB) across selected hospitals in Ibadan, Nigeria. Data were collected using an interviewer-administered validated questionnaire and clinical records. Variables included socio-demographic, clinical, behavioral, psychosocial, and environmental factors. Data were analyzed using SPSS v.21 with level of significance at $p \leq 0.05$.

Results: Cases had significantly poorer clinical profiles than controls, with higher prevalence of unsuppressed viral load (69.4% vs. 32.4%, p<0.001) and CD4 count <200 cells/µL (89.6% vs. 75.7%, p=0.001). Mean ART adherence was lower among cases (11.76 ± 2.40) compared with controls (12.73 ± 1.86, p<0.001). Similarly, cases demonstrated less favorable attitudinal dispositions toward ART and TB treatment adherence than controls (17.02 ± 4.97 vs. 18.84 ± 3.66, p<0.001). In multivariate analysis, unsuppressed viral load (AOR=4.70; 95% CI: 2.80–7.87; p<0.05), CD4 count <200 cells/µL (AOR=2.60; 95% CI: 1.30–5.23; p<0.05), lower ART adherence (AOR=0.82; 95% CI: 0.71–0.94; p<0.05), and less favorable attitudinal dispositions toward treatment (AOR=0.87; 95% CI: 0.80–0.94;p<0.05) were independent predictors of HIV/TB co-infection with unsuppressed viral load being the most significant predictor (AOR=4.70; 95% CI: 2.80–7.87; p<0.05).

Conclusion: Viral load, CD4 count, ART adherence, and attitudinal dispositions are significant predictors of HIV/TB co-infection, however, viral load appears to represent an important epidemiological goal of note in treatment outcomes. There is a need to strengthen integrated HIV/TB services with a focus on improving ART adherence and addressing attitudinal dispositions of the patients along with perceptions of expected outcomes and consequences through targeted counseling and support interventions.

Clinical trial number: Not applicable

Keywords: HIV/TB co-infection, tuberculosis, antiretroviral therapy, viral load, CD4 count, ART adherence, people living with HIV, epidemiological risk factors

1. Background

Human Immunodeficiency Virus (HIV) is a viral infection that compromises the immune system, predisposing individuals to opportunistic infections such as tuberculosis (TB) among others. HIV is transmitted through infected body fluids and managed with antiretroviral therapy (ART) to prevent disease progression and transmission [1]. Tuberculosis, an airborne bacterial disease that primarily affects the lungs, commonly co-exists with HIV and remains a major public health concern despite available preventive and effective treatment strategies [2]. Since the emergence of HIV in 1981, the dual epidemic of HIV and TB has reversed gains in TB control and continues to pose a significant global health threat, particularly in sub-Saharan Africa where co-infection rates are disproportionately high [3-5]. Globally, TB accounts for nearly one-third of AIDS-related deaths, with HIV-positive individuals being 14-22 times more likely to develop active TB and experience higher mortality [5-8].

Nigeria bears a substantial burden of HIV/TB co-infection, with national prevalence estimated at 40.4% and higher rates reported in conflict-affected settings [9,10]. In Oyo State, particularly Ibadan, co-infection remains prevalent among clinic populations [11]. Although ART has improved survival outcomes, TB continues to occur among people living with HIV (PLHIV) due to multiple interacting factors. HIV-induced immunosuppression accelerates TB progression, while TB further worsens HIV disease outcomes [12]. Persistent TB incidence among PLHIV on ART has been linked to low CD4 counts, unsuppressed viral load, poor medication adherence, and broader socioeconomic and health system challenges [13,14]. Evidence also shows variability in TB incidence among individuals on ART, suggesting incomplete understanding of the dynamics elucidating why some patients develop TB while others remain disease-free [9,13].

Active TB among people living with HIV on ART is driven by a combination of clinical, behavioral, psychosocial, and environmental factors. However, few studies have assessed these factors together in a single framework [3,15,16]. The current study is guided by the epidemiological triad (agent–host–environment) and theoretical framework of Health Belief Model in addressing psycho-social and behavioural constructs. HIV and *Mycobacterium tuberculosis* are viewed as agents, clinical and behavioral characteristics as host factors, and healthcare access and social support as environmental factors. Using a case–control design, the study compared PLHIV on ART with those without active TB to identify key epidemiological risk factors involved among participants selected in Ibadan, Nigeria, aimed to inform targeted and integrated intervention strategies.

2. Methods

2.1 Study setting

This study was conducted in Ibadan, the capital of Oyo State in southwestern Nigeria. Ibadan is located approximately 150 km north of Lagos, Nigeria's commercial hub. It lies within the rainforest belt and is characterized by a high population density and diverse socioeconomic structure [11]. The city comprises 11 Local Government Areas (LGAs), making it a major health service zone within Oyo State. Healthcare services in Ibadan are delivered through a multi-tiered system, including primary, secondary, and tertiary facilities. The study was conducted in six healthcare facilities across five selected LGAs—Lagelu, Oluyole, Akinyele, Ibadan South-West, and Ibadan South-East—which represent a mix of urban and peri-urban settings within the metropolis.

2.2 Study design

The study adopted a facility-based case–control study design to identify the epidemiological risk factors for HIV/TB co-infection among patients receiving ART in selected health facilities in Ibadan. This design enabled comparison of clinical, behavioral, psychosocial, and environmental factors associated with TB co-infection between PLHIV on ART who developed active tuberculosis (cases) and those without TB (controls).

2.3 Study population and eligibility criteria

The study population comprised PLHIV receiving ART in selected health facilities across five Local Government Areas (LGAs) in Ibadan, Nigeria. These LGAs—Lagelu, Oluyole, Akinyele, Ibadan South-West, and Ibadan South-East—represent a mix of urban, semi-urban, and rural settings, capturing diverse population and socioeconomic characteristics.

Eligible participants were adults (≥18 years) receiving ART within the selected facilities. Cases included individuals with confirmed active TB or those who had recently completed TB treatment, while controls were individuals without current TB. Participants were excluded if they had been on ART for less than six months. Additionally, controls with a history of active TB within the previous six months were excluded to minimize misclassification.

2.4 Sample size determination

The sample size was calculated for an unmatched case–control study using the formula for comparing two proportions:

$$n = \frac{(\mathrm{Z}\alpha + \mathrm{Z}\beta)^2 * 2p(1-p)}{(\mathrm{P1} - \mathrm{P0})^2}$$

where P0 is the proportion of exposure among controls, P1 is the proportion among cases, p is the average proportion (P0+P1)/2, Zα=1.96 for a 95% confidence level on the standard normal distribution accounting for type I Error, and Zβ=0.84 for 80% power accounting for Type II Error.

The exposure used for sample size estimation was poor ART adherence. The proportion of poor adherence among controls (P0=20%) was obtained from Adeoti et al. [17]. An odds ratio (OR) of 2.0 was assumed as the minimum clinically meaningful effect size to detect a significant association between poor adherence and TB co-infection.

The proportion of exposure among cases (P1) was calculated as:

$$P1 = \frac{OR * P0}{1 + P0(OR - 1)} = 0.333$$

The minimum required sample size was 173 participants per group, giving a total of 346 participants. To account for potential non-response and incomplete data, a 10% adjustment was applied, resulting in a final sample size of 382 participants (191 cases and 191 controls).

2.5 Sampling technique

A multistage sampling approach was employed for participant selection. In the first stage, six health facilities providing HIV care and treatment services were purposively selected across five Local Government Areas (LGAs) in Ibadan. These included Alegongo Primary Health Centre (Lagelu), St. Mary Catholic Hospital (Ibadan South-East), St. Anne's Hospital (Ibadan South-West), Lad Medical Center (Oluyole), Moniya General Hospital (Akinyele), and Ring Road State Hospital (Ibadan South-West). The facilities were selected based on their high patient load of PLHIV and documented burden of HIV/TB co-infection, as well as their distribution across urban and peri-urban settings.

In the second stage, the total sample size was proportionally allocated across the selected facilities, with approximately equal numbers of cases and controls recruited from each site to ensure balanced representation.

In the final stage, where up-to-date clinic registers were available, eligible participants were selected using simple random sampling from the sampling frame of PLHIV receiving ART at each facility. Where complete sampling frames were not available, consecutive sampling of eligible participants was applied.

Details of the sampling allocation across facilities are presented in Table 1.

Table 1 Sampling allocation across study facilities

Facility	LGA	Cases	Controls	Total
Alegongo PHC	Lagelu	32	32	64
St. Mary Catholic Hospital	Ibadan South-East	32	32	64
St. Anne's Hospital	Ibadan South-West	31	31	62
Lad Medical Center	Oluyole	31	31	62
Moniya General Hospital	Akinyele	32	32	64
Ring Road State Hospital	Ibadan South-West	33	33	66
Total		**191**	**191**	**382**

2.6 Data collection instruments and variables measurement

Data were collected using a structured validated interviewer-administered questionnaire designed to capture information on socio-demographic, clinical, behavioral, psychosocial, and environmental factors relevant to HIV/TB co-infection. Clinical data, including CD4 count and viral load, were extracted from participants' medical records.

2.6.1 Outcome variable

The primary outcome was active tuberculosis (TB), defined based on documented clinical diagnosis among PLHIV receiving ART. Participants were categorized as cases (with active TB or recently completed TB treatment) and controls (without current TB).

2.6.2 Explanatory variables

Explanatory variables were grouped into clinical, behavioral, psychosocial, and environmental factors.

Clinical factors: CD4 count was classified as <200 or ≥200 cells/μL, and viral load as suppressed (<1000 copies/mL) or unsuppressed (≥1000 copies/mL).

Behavioral factors: Medication adherence was self-reported assessed by using a 4-item Likert-type response scale covering ART intake, TB medication use, and clinic attendance. Items were rated on a 4-point frequency scale, reverse-coded where necessary to avoid faking responses, and transformed the item responses to weighted-aggregate score of inappropriate responses as zero and appropriate responses scoring 3 points generating adherence scores.

Psychosocial factors: The Health Belief Model facilitated constructs in the theoretical considerations of personal-level dispositions of the participants. Knowledge was measured using 10 true/false items; attitudes using 8 Likert-type response scale for items assessing treatment beliefs and stigma; and perceptions using 14 items covering susceptibility, severity, benefits, and barriers to HIV/TB treatment. Higher scores reflected better knowledge, more positive attitudes, and stronger perceptions.

Environmental factors: Healthcare access was measured using 10 items assessing structural barriers, while social support was assessed using 6 items capturing support from family, friends, and partners. Higher scores indicated greater barriers to care or lower social support.

2.6.3 Instrument validity and reliability

The questionnaire was reviewed for face, construct and content validity by subject experts. Item validity was assured by conducting Internal consistency of the response-items of the instrument and a Cronbach's alpha coefficients ranging from 0.703 to 0.910 was derived

indicating acceptable levels for the items operationalizing the variables in the study. A pretest study was conducted among 10% of the study population in a similar setting to assess reliability..

2.7 Data collection procedure

Trained research assistants administered the questionnaires under close supervision following eligibility screening and informed consent. Completed questionnaires were reviewed daily to ensure completeness and accuracy.

2.8 Statistical analysis

Data were entered, cleaned, and analyzed using the IBM SPSS Statistics v21. Data quality checks were performed, and inconsistencies were resolved by cross-referencing original data sources. Descriptive statistics were derived from transformed response items as weighted-aggregate scores to summarize characteristics of the participants. Categorical variables were presented as frequency distributions, while continuous variables were summarized using means and standard deviations. All analyses were stratified by case–control status. Independent samples t-test was used to compare mean scores between cases and controls. Multivariate logistic regression analysis was performed to identify independent predictors of active TB. Variables included clinical (viral load status, CD4 count), behavioral (medication adherence), psychosocial (knowledge, attitudinal dispositions, perceptions), and environmental factors (healthcare access and social support). Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were reported. Statistical significance was set at $p \leq 0.05$.

3. Results

Out of the 382 final sample size calculated for the study, 346 participants provided complete and valid responses and were included in the final analysis. This comprises 173 cases (HIV-positive patients with active TB) and 173 controls (HIV-positive patients without TB). The overall response rate was 90.6%. All analyses were conducted based on these valid responses.

3.1 Socio-demographic characteristics of participants

The socio-demographic characteristics of participants are presented in Table 2. The age distribution was broadly similar between cases and controls, with the majority of participants in both groups aged 30–59 years. Sex distribution was comparable across groups, with females constituting the majority (cases: 60.7%; controls: 63.6%). Most participants were married in both groups (cases: 79.8%; controls: 81.5%).

3.2 Clinical characteristics of participants

The clinical characteristics of participants are presented in Table 3. A significantly higher proportion of cases had unsuppressed viral load compared to controls (69.4% vs. 32.4%, $p < 0.001$). Similarly, low CD4 count (<200 cells/µL) was more prevalent among cases than controls (89.6% vs. 75.7%, $p = 0.001$).

Table 3 Clinical characteristics of participants

Variable	Category	Control n (%)	Case n (%)	Total n (%)	p-value
Viral Load	Unsuppressed	56 (32.4)	120 (69.4)	176 (50.9)	<0.001*
	Suppressed	117 (67.6)	53 (30.6)	170 (49.1)	
CD4 Count (cells/µL)	<200	131 (75.7)	155 (89.6)	286 (82.7)	0.001*
	≥200	42 (24.3)	18 (10.4)	60 (17.3)	
Total		173 (100)	173 (100)	346 (100)	

*Chi-Sq test of goodness-of-fit showed Statistically significant at p<0.05

3.3 Medication adherence of participants

Medication adherence patterns are presented in Table 4. Cases demonstrated poorer adherence to ART compared to controls across multiple indicators. For example, a higher proportion of cases reported forgetting to take ART either some or most of the time (35.2% vs. 20.3%). Similarly, cases were more likely to intentionally skip medication when feeling better, with higher proportions reporting this behavior some or most of the time compared to controls (26.6% vs. 13.9%). Discontinuation of ART due to side effects was also more frequently reported among cases, particularly for "some of the time" (35.3% vs. 11.6%). Adherence to prescribed ART regimens was lower among cases, with fewer reporting taking medication "all of the time" (38.2% vs. 56.1%) and more reporting inconsistent adherence. Pill count adherence further supported these findings, as a greater proportion of cases reported missing 2–4 doses (45.1% vs. 16.8%).

In Table 5, overall mean ART adherence scores were lower among cases compared to controls (11.76 ± 2.40 vs. 12.73 ± 1.86, $p<0.001$).

Table 5 Comparisons of mean adherence, knowledge, attitudinal, perception, healthcare access barrier, and social support scores among participants

Variable	Cases Mean ± SD	Control Mean ± SD	Cases 95% CI	Controls 95% CI	p-value	Effect size (d)
ART adherence score	11.76 ± 2.40	12.73 ± 1.86	11.40 – 12.12	12.45 – 13.01	<0.001*	-0.453
Knowledge score	6.45 ± 3.01	6.95 ± 1.93	6.00 – 6.90	6.66 – 7.24	0.065	0.198
Attitudinal disposition score	17.02 ± 4.97	18.84 ± 3.66	16.28 – 17.77	18.29 – 19.39	<0.001*	0.418

Perception score	32.84 ± 5.38	31.51 ± 4.51	32.03 – 33.65	30.83 – 32.19	0.013	-0.269
Healthcare access barrier score	18.65 ± 5.58	18.27 ± 4.69	17.82 – 19.49	17.56 – 18.97	0.485	-0.074
Social support score	10.88 ± 4.35	11.06 ± 2.59	10.23 – 11.54	10.67 – 11.45	0.653	0.050

*Statistically significant at p<0.05; Cases are with TB and Controls are without TB

3.4 Participants' knowledge regarding HIV and TB treatment outcomes

Knowledge regarding HIV and TB treatment outcomes is presented in Table 6. Cases demonstrated better knowledge in some areas, including the recommended duration of TB treatment (76.3% vs. 49.7%). However, controls showed higher levels of correct knowledge on several critical aspects, particularly the importance of continuing treatment despite an undetectable viral load (87.3% vs. 69.9%), the implications of high viral load for treatment outcomes (86.7% vs. 64.2%), and the increased risk of active TB associated with high viral load (86.1% vs. 71.1%).

In Table 5, overall mean knowledge scores were slightly lower among cases compared to controls (6.45 ± 3.01 vs. 6.95 ± 1.93, p=0.065).

3.5 Attitudinal disposition of participants towards ART and TB treatment

Attitudinal dispositions toward ART and TB treatment are presented in Table 7. Cases were more likely than controls to express concerns related to stigma and treatment burden. A higher proportion of cases reported feeling ashamed of taking HIV medication (31.2% vs. 13.9% agreeing/strongly agreeing) and perceived ART as harmful to the body (30.6% vs. 13.9%).

Similarly, cases more frequently reported that side effects (37.6% vs. 16.7%), pill burden (33.5% vs. 15.0%), and dosing frequency (37.0% vs. 15.0%) made adherence difficult.

In Table 5, overall mean attitudinal disposition scores were lower among cases compared to controls (17.02 ± 4.97 vs. 18.84 ± 3.66, $p<0.001$).

3.6 Perceptions of susceptibility, severity, benefits, and barriers related to HIV/TB treatment adherence

Perceptions related to susceptibility, severity, benefits, and barriers to HIV/TB treatment adherence are presented in Table 8. A higher proportion of cases strongly agreed that poor adherence increases the risk of TB (57.8% vs. 31.8%) and that TB is life-threatening (56.1% vs. 37.0%). Similarly, cases were more likely to perceive a risk of infecting others if treatment is discontinued (66.5% vs. 40.5%). Also, cases more often reported that their diagnosis had negatively affected their social life (24.3% vs. 16.2% strongly agreeing).

In Table 5, overall mean perception scores were higher among cases compared to controls (32.84 ± 5.38 vs. 31.51 ± 4.51, $p=0.013$).

3.7 Barriers to healthcare access among participants

Barriers to healthcare access are presented in Table 9. Regarding geographical access, a higher proportion of cases disagreed that distance to the nearest clinic was a barrier compared to controls (57.2% vs. 31.8%). A similar pattern was observed for transportation costs, where disagreement was higher among cases (53.2% vs. 38.7%). Lack of privacy was more frequently acknowledged as a barrier among cases (15.1% agreed/strongly agreed) compared to controls

(15.6% combined agreement but with a higher proportion strongly disagreeing among controls). Perceptions of quality of care showed a notable difference, with controls more likely to strongly agree that care quality was high (76.9% vs. 52.6%). Travel time to health facilities also differed between groups, with cases more likely to report shorter travel times (<30 minutes: 43.9% vs. 35.8%).

In Table 5, overall mean healthcare access barrier scores were slightly higher among cases compared to controls (18.65 ± 5.58 vs. 18.27 ± 4.69, p=0.485).

3.8 Social support patterns of participants

Social support patterns are presented in Table 10. Regarding stigma-related isolation, most participants in both groups disagreed that people close to them avoided them because of their illness, although this perception was slightly higher among cases (7.0% vs. 4.6% agreeing/strongly agreeing). Partner support was more frequently reported among controls, with a higher proportion strongly agreeing that they received support from their spouse/partner (64.7% vs. 41.6%). However, cases more frequently reported that they could rely on friends during illness or stigma-related challenges (22.5% vs. 8.7% strongly agreeing).

In Table 5, overall mean social support scores were slightly lower among cases compared to controls (10.88 ± 4.35 vs. 11.06 ± 2.59, p=0.653).

3.9 Multivariate predictors of HIV/TB co-infection

In the multivariable logistic regression model, several clinical and behavioral factors were independently associated with TB co-infection among people living with HIV receiving ART

(Table 11). Unsuppressed viral load was the strongest predictor of TB co-infection (AOR = 4.696, 95% CI: 2.800–7.874, p < 0.001), followed by low CD4 count (AOR = 2.604, 95% CI: 1.298–5.226, p = 0.007). Behaviorally, better medication adherence was protective against TB co-infection (AOR = 0.820, 95% CI: 0.714–0.942, p = 0.005). In addition, attitudinal disposition toward ART and TB treatment was significantly associated with TB status, with more positive attitudes reducing the odds of co-infection (AOR = 0.871, 95% CI: 0.804–0.943, p = 0.001). Conversely, higher perception scores were associated with increased odds of TB co-infection (AOR = 1.164, 95% CI: 1.096–1.237, p < 0.001). Knowledge (AOR = 0.928, p = 0.163), healthcare access (AOR = 1.016, p = 0.564), and social support (AOR = 1.031, p = 0.401) were not statistically significant predictors in the adjusted model.

Table 11 Independent predictors of HIV/TB co-infection

Predictors	Adjusted Odds Ratio (AOR)	95% CI	p-value
Viral load	4.696	2.800–7.874	<0.001*
CD4 count	2.604	1.298–5.226	0.007*
Adherence	0.820	0.714–0.942	0.005*
Knowledge	0.928	0.836–1.031	0.163
Attitudinal disposition	0.871	0.804–0.943	0.001*
Perceptions	1.164	1.096–1.237	<0.001*
Healthcare access	1.016	0.963–1.071	0.564
Social support	1.031	0.960–1.109	0.401

Significant predictors at p < 0.05

4. Discussion

This study examined epidemiological risk factors for HIV/TB co-infection among PLHIV receiving ART in Ibadan, Nigeria. The findings show that both clinical factors (viral load and CD4 count)

and behavioral and psychosocial factors (medication adherence, attitudinal disposition, and perceptions toward treatment) were significantly associated with active TB, while knowledge, healthcare access, and social support were not independently associated. These results highlight the complex interplay of biological, behavioral, and contextual factors in shaping TB risk among people living with HIV on ART.

The findings of this study show that among all associated determinants, unsuppressed viral load appears as a significant predictor for an increased risk of active TB among PLHIV. Cases had significantly poorer viral suppression and lower CD4 counts compared to controls ($p < 0.001$). This is consistent with previous studies demonstrating that higher HIV viral load significantly increases the likelihood of developing active TB [18,19]. Similarly, Olajide et al. [20] identified viral suppression as a key predictor of favorable TB outcomes among PLHIV in Nigeria. The large effect size observed in this study further emphasizes that sustained virologic suppression remains a critical and modifiable factor in preventing TB among ART-experienced patients. However, this finding contrasts with Salihu et al. [21], who reported no significant association, possibly due to limited sample size and confounding contextual factors such as conflict. With respect to immune status, lower CD4 counts were also significantly associated with TB. This aligns with evidence showing higher TB burden among PLHIV with CD4 <200 cells/µL [9]. Advanced immunosuppression increases susceptibility to opportunistic infections, including TB, due to progressive depletion of CD4+ T lymphocytes [22]. While Salihu et al. [21] reported a non-significant increase in TB risk among individuals with low CD4 counts, other studies have demonstrated strong associations. For instance, Getu et al. [23] found that PLHIV with CD4 ≤200 cells/µL were over three times more likely to develop TB.

Poor ART adherence appears to increase susceptibility to active TB primarily through its effects on virologic failure and impaired immune recovery. In this study, cases had significantly lower adherence scores and higher levels of non-adherence compared to controls ($p < 0.001$). However, this association was attenuated after adjusting for viral load and CD4 count, suggesting that its effect is largely mediated through these clinical factors. These findings are consistent with evidence showing that suboptimal adherence is more common among TB co-infected patients and contributes to TB risk through unsuppressed viraemia [24]. Similarly, treatment interruptions have been linked to increased TB risk among PLHIV [25]. Turinawe et al. [26] further reported that unsuppressed viral load—often resulting from poor adherence—was strongly associated with active TB. In addition, a meta-analysis by Bizuneh et al. [27] identified poor adherence as a significant predictor of mortality among HIV/TB co-infected individuals. Given that poor adherence is a key driver of unsuppressed viral load [28], it may indirectly increase vulnerability to opportunistic infections such as TB by compromising immune recovery [29]. This underscores the critical role of sustained adherence to ART in preventing TB among people living with HIV.

Knowledge of HIV and TB treatment outcomes was generally high among participants and did not significantly differ between cases and controls. Although controls had slightly higher knowledge scores, the difference was not statistically significant, and no association was observed between knowledge level and TB status. This suggests that, while knowledge is important for overall health literacy, it may not be a primary determinant of active TB in this population. This finding is consistent with studies in Nigeria reporting high levels of HIV/TB-related knowledge without a corresponding protective effect against TB [30,31]. However,

evidence from other settings indicates that inadequate knowledge can contribute to higher TB burden [32,33]. Knowledge may exert an indirect effect on TB outcomes by influencing treatment behaviors. Previous studies have shown that better knowledge is associated with improved adherence and TB prevention practices [34], while poor understanding of treatment regimens can lead to medication errors and non-adherence [24,35]. Thus, although knowledge was not independently associated with TB in this study, it remains a supportive factor in promoting optimal treatment practices.

Negative attitudes toward ART and TB treatment appear to increase vulnerability to active TB, likely through their influence on treatment adherence and persistence. In this study, cases had significantly poorer attitudinal dispositions compared to controls ($p < 0.001$), with a higher proportion exhibiting negative attitudes. This finding aligns with evidence from Nigerian KAP studies linking unfavourable attitudes to poorer treatment outcomes [30]. Stigma-related attitudes, in particular, play a critical role. HIV-related stigma has been shown to negatively influence attitudes toward TB screening and treatment [36], while internalized stigma, such as shame, is associated with poorer treatment engagement and increased TB risk [37].

Perceptions of susceptibility, severity, treatment benefits, and adherence barriers were significantly higher among cases than controls, with higher perception scores associated with TB status. Although seemingly counterintuitive, this finding likely reflects the effect of disease experience, as individuals diagnosed with TB are more likely to receive intensive counselling and health education, thereby increasing their awareness of HIV/TB risks. This interpretation is consistent with studies showing that HIV/TB patients exposed to regular counselling report stronger perceptions of disease severity and treatment benefits [24]. Similarly, Ojomo et al.

[30] reported generally poor baseline perceptions, suggesting that improved perceptions may develop following diagnosis rather than act as a preventive factor. Thus, the higher perception scores observed among cases likely represent reactive learning rather than protection against TB. This pattern aligns with the Health Belief Model, which posits that direct disease experience strengthens perceived susceptibility and severity, thereby acting as a cue to action [38].

The study shows that participants with active TB perceived greater structural barriers to healthcare access compared to controls, particularly in terms of distance to health facilities and transportation costs. This finding is consistent with previous studies identifying financial and geographic barriers as major constraints to HIV care access [39,40]. Other studies have also highlighted health system challenges such as inadequate infrastructure and human resources as barriers to HIV/TB care [41]. However, the similarity in mean healthcare access scores between cases and controls suggests that these barriers are widespread among people living with HIV, regardless of TB status. This aligns with findings that limited healthcare access is a general challenge in HIV care and may increase overall vulnerability to TB [4,9,42].

Multivariate analysis showed that clinical factors were the strongest predictors of active TB among PLHIV, with unsuppressed viral load emerging as the most significant and modifiable risk factor, followed by low CD4 count. These findings reinforce the central role of virologic and immunologic control in preventing TB among individuals on ART. Similar evidence has been reported in Nigeria and other sub-Saharan African settings, where viral load and immune status consistently predict TB co-infection [9,20,43,44]. Turinawe et al. [26] demonstrated a strong association between unsuppressed viral load and active TB, supporting the indirect pathway observed in this study, where adherence lost significance after adjusting for viral load and CD4

count. Behavioral and psychosocial factors showed weaker but meaningful associations. Adherence and attitudinal disposition were protective, while higher perception scores were associated with TB, likely reflecting post-diagnosis awareness. These findings are consistent with Health Belief Model-informed studies, which suggest that psychosocial factors influence treatment behaviors but operate through clinical pathways. A systematic review by Lawal et al. [24] similarly reported that while positive attitudes support adherence, effective virologic suppression remains the primary determinant of TB outcomes.

The findings of this study highlight the need to strengthen integrated HIV/TB programs with a strong focus on routine viral load monitoring and CD4 count surveillance as core strategies for early identification of individuals at high risk of TB co-infection. Policies should prioritize ensuring sustained virologic suppression through intensified adherence support interventions, including differentiated service delivery models, patient-centered counseling, and targeted follow-up for individuals with poor adherence. In addition, psychosocial interventions addressing treatment attitudes and risk perceptions should be incorporated into routine HIV care, alongside continuous patient education during clinic visits. Strengthening these components within ART programs will improve early detection of treatment failure, reduce TB incidence among PLHIV, and enhance overall treatment outcomes.

This study has some limitations. Its cross-sectional case-control design limits the ability to establish temporal or causal relationships between identified predictors and TB co-infection. In addition, reliance on self-reported measures for behavioral and psychosocial variables may introduce recall and social desirability bias. Being a facility-based study may also limit generalizability to all people living with HIV in the community. Despite these limitations, the

study provides important and context-specific evidence by integrating clinical, behavioral, psychosocial, and environmental determinants within a single analytical framework. The use of multivariate analysis further strengthens the robustness of the findings by identifying independent predictors of TB co-infection. Therefore, the results remain highly relevant for informing targeted interventions and improving integrated HIV/TB control strategies in similar resource-limited settings.

5. Conclusions

This study identified key epidemiological risk factors for active TB among PLHIV on ART in Ibadan, Nigeria. Viral load suppression and CD4 count were the strongest predictors, underscoring the central role of virologic control and immune status in TB prevention. Medication adherence and attitudinal disposition showed modest protective effects, suggesting indirect influence through their impact on viral suppression. Knowledge did not significantly differentiate cases from controls. Higher perception scores among TB cases likely reflect post-diagnosis experience and counselling rather than a preventive effect. Healthcare access and social support were not independent predictors after adjustment. Maintaining sustained viral suppression and immune recovery remains critical for reducing TB risk among PLHIV.

List of abbreviations

ART – Antiretroviral Therapy

CI – Confidence Interval

HIV – Human Immunodeficiency Virus

LGA – Local Government Area

PLHIV – People Living with HIV

TB – Tuberculosis

WHO – World Health Organization

CD4 – Cluster of Differentiation 4 (CD4 T-lymphocyte / CD4 cell count indicator of immune status in HIV)

Statements and Declarations

Ethical approval and consent to participate

The study adhered strictly to international ethical guidelines as enshrined in the Declaration of Helsinki. Ethical approval for the study was obtained from the Oyo State Ministry of Health Research Ethics Committee with an approval number NHREC/OYOSHRIEC/10/11/22. Written informed consent was obtained from all participants prior to data collection. Confidentiality was strictly maintained by anonymizing all data and removing personal identifiers. Data were securely stored and accessible only to the research team.

Consent for publication

Not applicable

Availability of data and materials

The datasets supporting the conclusions of this article are included within the article (and its additional files).

Competing interests

The authors declare that they have no competing interests.

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Authors' contribution

Adesewa Ajibade and Atulomah Nnodimele contributed to the conceptualization and research design of the study. Adesewa Ajibade also coordinated data collection, conducted the data analysis, interpreted the results, and drafted the initial manuscript. Atulomah Nnodimele provided overall supervision, validated the study instruments, critically reviewed the manuscript, and approved the final version for publication. Luke Oche Peter contributed to the research design, drafting of the manuscript, and final revision of the manuscript. All authors read and approved the final manuscript.

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592 Referral Hospital, South Wollo, Northeast Ethiopia, 2020: a case-control study. *PLoS*

593 *One.* 2021;16(3):e0248490.

594 Table 2 Socio-demographic characteristics of respondents

VARIABLES	Control Group N=173	Case Group N=173	
	Frequency N (%)	Frequency N (%)	Total
Age:			
18–19	4 (2.3)	4 (2.3)	8(2.3)
20–29	30 (17.3)	9 (5.2)	39(11.3)
30–39	50 (28.9)	50 (28.9)	100(28.9)
40–49	42 (24.3)	56 (32.4)	98(28.3)
50–59	30 (17.3)	37 (21.4)	67(19.4)
60–69	15 (8.7)	14 (8.1)	29 (8.4)
70–79	2 (1.2)	3 (1.7)	5 (1.4)
Sex:			
Male	63 (36.4)	68 (39.3)	131(37.9)
Female	110 (63.6)	105 (60.7)	215(62.1)
Religion:			
Christianity	105 (60.7)	93 (53.8)	198(57.2)
Islam	57 (32.9)	77 (44.5)	134(38.7)
Traditional	11 (6.4)	3 (1.7)	14(4.0)
Ethnicity:			
Yoruba	128 (74.0)	152 (87.9)	280(80.9)
Igbo	29 (16.8)	15 (8.7)	44(12.7)
Hausa	11 (6.4)	5 (2.9)	16(4.6)
Others	5 (2.9)	1 (0.6)	6(1.7)
Marital Status:			
Single	21 (12.1)	18 (10.4)	39(11.3)
Married	141 (81.5)	138 (79.8)	279(80.6)
Divorced	11 (6.4)	17 (9.8)	28(8.1)
Education:			
No Education	0 (0.0)	8 (4.6)	8(2.3)

VARIABLES	Control Group N=173	Case Group N=173	
Primary	29 (16.8)	55 (31.8)	84(24.3)
Secondary	108 (62.4)	87 (50.3)	195(56.4)
Tertiary	36 (20.8)	23 (13.3)	59(17.1)
Occupation:			
Student	9 (5.2)	7 (4.0)	16(4.6)
Business Owner	82 (47.4)	57 (32.9)	139(40.2)
Artisan	60 (34.7)	65 (37.6)	125(36.1)
Civil Servant	5 (2.9)	0 (0.0)	5(1.4)
Private Sector	16 (9.2)	43 (24.9)	59(17.1)
Unemployed	1 (0.6)	1 (0.6)	2(0.6)

595 Results are presented as frequencies and percentages

596

597 Table 4 Medication adherence pattern of participants

Variable	Category	Control n (%)	Case n (%)	Total n (%)
Forget to take ART	All of the time	10 (5.8%)	24 (13.9%)	34 (9.8%)
	Most of the time	6 (3.5%)	13 (7.5%)	19 (5.5%)
	Some of the time	29 (16.8%)	48 (27.7%)	77 (22.3%)
	None of the time	128 (74.0%)	88 (50.9%)	216 (62.4%)
Decide not to take ART (feel better)	All of the time	3 (1.7%)	2 (1.2%)	5 (1.4%)
	Most of the time	5 (2.9%)	13 (7.5%)	18 (5.2%)
	Some of the time	19 (11.0%)	33 (19.1%)	52 (15.0%)
	None of the time	146 (84.4%)	125 (72.3%)	271 (78.3%)
Stop ART due to side effects	All of the time	1 (0.6%)	2 (1.2%)	3 (0.9%)
	Most of the time	4 (2.3%)	7 (4.0%)	11 (3.2%)
	Some of the time	20 (11.6%)	61 (35.3%)	81 (23.4%)
	None of the time	148 (85.5%)	103 (59.5%)	251 (72.5%)
Take ART as prescribed	None of the time	6 (3.5%)	1 (0.6%)	7 (2.0%)
	Some of the time	11 (6.4%)	34 (19.7%)	45 (13.0%)

Variable	Category	Control n (%)	Case n (%)	Total n (%)
	Most of the time	59 (34.1%)	72 (41.6%)	131 (37.9%)
	All of the time	97 (56.1%)	66 (38.2%)	163 (47.1%)
Missed clinic appointments (last 3 months)	None	135 (78.0%)	84 (48.6%)	219 (63.3%)
	1	27 (15.6%)	60 (34.7%)	87 (25.1%)
	2	4 (2.3%)	15 (8.7%)	19 (5.5%)
	3	4 (2.3%)	11 (6.4%)	15 (4.3%)
	≥4	3 (1.7%)	3 (1.7%)	6 (1.7%)
Pill count adherence	>5 missed doses	5 (2.9%)	5 (2.9%)	10 (2.9%)
	2–4 missed doses	29 (16.8%)	78 (45.1%)	107 (30.9%)
	≤1 missed dose	139 (80.3%)	90 (52.0%)	229 (66.2%)

598 Results are presented as frequencies and percentages

599

600 Table 6 Participants' knowledge regarding HIV and TB treatment outcomes

Variable	Category	Control n (%)	Case n (%)	Total n (%)
TB treatment ≥6 months	Incorrect	87 (50.3%)	41 (23.7%)	128 (37.0%)
	Correct	86 (49.7%)	132 (76.3%)	218 (63.0%)
Stop TB treatment when symptoms disappear	Incorrect	112 (64.7%)	107 (61.8%)	219 (63.3%)
	Correct	61 (35.3%)	66 (38.2%)	127 (36.7%)
Without HIV treatment, CD4 decreases and worsens TB outcomes	Incorrect	57 (32.9%)	71 (41.0%)	128 (37.0%)
	Correct	116 (67.1%)	102 (59.0%)	218 (63.0%)
Continue treatment despite undetectable viral load	Incorrect	22 (12.7%)	52 (30.1%)	74 (21.4%)

Variable	Category	Control n (%)	Case n (%)	Total n (%)
Take HIV drugs daily even without symptoms	Correct	151 (87.3%)	121 (69.9%)	272 (78.6%)
	Incorrect	18 (10.4%)	24 (13.9%)	42 (12.1%)
Cough of any duration suggests TB	Correct	155 (89.6%)	149 (86.1%)	304 (87.9%)
	Incorrect	23 (13.3%)	42 (24.3%)	65 (18.8%)
Latent TB not infectious but HIV increases risk	Correct	150 (86.7%)	131 (75.7%)	281 (81.2%)
	Incorrect	81 (46.8%)	93 (53.8%)	174 (50.3%)
High viral load indicates poor treatment outcome	Correct	92 (53.2%)	80 (46.2%)	172 (49.7%)
	Incorrect	23 (13.3%)	62 (35.8%)	85 (24.6%)
Low CD4 (<200) increases TB complications	Correct	150 (86.7%)	111 (64.2%)	261 (75.4%)
	Incorrect	80 (46.2%)	72 (41.6%)	152 (43.9%)
High viral load increases risk of active TB	Correct	93 (53.8%)	101 (58.4%)	194 (56.1%)
	Incorrect	24 (13.9%)	50 (28.9%)	74 (21.4%)
	Correct	149 (86.1%)	123 (71.1%)	272 (78.6%)

601 Results are presented as frequencies and percentages

602

603 Table 7 Attitudinal disposition of participants towards ART and TB treatment

Variable	*Category	Control n (%)	Case n (%)	Total n (%)
Benefits of HIV treatment outweigh side effects	SD	1 (0.6%)	1 (0.6%)	2 (0.6%)
	D	9 (5.2%)	30 (17.3%)	39 (11.3%)
	A	24 (13.9%)	23 (13.3%)	47 (13.6%)
	SA	139 (80.3%)	119 (68.8%)	258 (74.6%)
Should continue HIV medication as prescribed	SD	0 (0.0%)	3 (1.7%)	3 (0.9%)

Variable	*Category	Control n (%)	Case n (%)	Total n (%)
	D	1 (0.6%)	3 (1.7%)	4 (1.2%)
	A	26 (15.0%)	22 (12.7%)	48 (13.9%)
	SA	146 (84.4%)	145 (83.8%)	291 (84.1%)
Convinced of effectiveness of HIV medication	SD	1 (0.6%)	4 (2.3%)	5 (1.4%)
	D	2 (1.2%)	7 (4.0%)	9 (2.6%)
	A	28 (16.2%)	24 (13.9%)	52 (15.0%)
	SA	142 (82.1%)	138 (79.8%)	280 (80.9%)
Feel ashamed taking HIV medication	SA	13 (7.5%)	33 (19.1%)	46 (13.3%)
	A	11 (6.4%)	21 (12.1%)	32 (9.2%)
	D	103 (59.5%)	60 (34.7%)	163 (47.1%)
	SD	46 (26.6%)	59 (34.1%)	105 (30.3%)
ART is harmful to the body	SA	11 (6.4%)	13 (7.5%)	24 (6.9%)
	A	13 (7.5%)	40 (23.1%)	53 (15.3%)
	D	84 (48.6%)	70 (40.5%)	154 (44.5%)
	SD	65 (37.6%)	50 (28.9%)	115 (33.2%)
Side effects make adherence difficult	SA	16 (9.2%)	36 (20.8%)	52 (15.0%)
	A	13 (7.5%)	29 (16.8%)	42 (12.1%)
	D	61 (35.3%)	69 (39.9%)	130 (37.6%)
	SD	83 (48.0%)	39 (22.5%)	122 (35.3%)
Number of pills discourages adherence	SA	14 (8.1%)	30 (17.3%)	44 (12.7%)
	A	12 (6.9%)	28 (16.2%)	40 (11.6%)
	D	104 (60.1%)	52 (30.1%)	156 (45.1%)
	SD	43 (24.9%)	63 (36.4%)	106 (30.6%)
Frequency of pills discourages adherence	SA	16 (9.2%)	42 (24.3%)	58 (16.8%)
	A	10 (5.8%)	22 (12.7%)	32 (9.2%)
	D	105 (60.7%)	41 (23.7%)	146 (42.2%)
	SD	42 (24.3%)	68 (39.3%)	110 (31.8%)

*Categories: SA (Strongly agree), A (Agree), D (Disagree), SD (Strongly disagree). Results are presented as frequencies and percentages

607 Table 8 Participants' perceptions of susceptibility, severity, benefits, and barriers related to

608 HIV/TB treatment adherence

Variable	*Category	Control n (%)	Case n (%)	Total n (%)
If I do not take my ART drugs properly, I am likely to have TB	SD	10 (5.8%)	6 (3.5%)	16 (4.6%)
	D	86 (49.7%)	9 (5.2%)	95 (27.5%)
	A	22 (12.7%)	58 (33.5%)	80 (23.1%)
	SA	55 (31.8%)	100 (57.8%)	155 (44.8%)
If I do not adhere to my HIV/TB treatment, my health condition will worsen	SD	3 (1.7%)	8 (4.6%)	11 (3.2%)
	D	11 (6.4%)	3 (1.7%)	14 (4.0%)
	A	26 (15.0%)	43 (24.9%)	69 (19.9%)
	SA	133 (76.9%)	119 (68.8%)	252 (72.8%)
If I stop treatment, I am at risk of infecting others	SD	3 (1.7%)	6 (3.5%)	9 (2.6%)
	D	69 (39.9%)	12 (6.9%)	81 (23.4%)
	A	31 (17.9%)	40 (23.1%)	71 (20.5%)
	SA	70 (40.5%)	115 (66.5%)	185 (53.5%)
I believe TB requires serious and consistent treatment	SD	8 (4.6%)	3 (1.7%)	11 (3.2%)
	D	42 (24.3%)	13 (7.5%)	55 (15.9%)
	A	57 (32.9%)	68 (39.3%)	125 (36.1%)
	SA	66 (38.2%)	89 (51.4%)	155 (44.8%)
I consider TB a life-threatening disease	SD	10 (5.8%)	14 (8.1%)	24 (6.9%)
	D	72 (41.6%)	16 (9.2%)	88 (25.4%)
	A	27 (15.6%)	46 (26.6%)	73 (21.1%)
	SA	64 (37.0%)	97 (56.1%)	161 (46.5%)
Incentives like free medicines, food, or easy access to health services help me maintain adherence	SD	1 (0.6%)	2 (1.2%)	3 (0.9%)
	D	6 (3.5%)	0 (0.0%)	6 (1.7%)
	A	45 (26.0%)	54 (31.2%)	99 (28.6%)
	SA	121 (69.9%)	117 (67.6%)	238 (68.8%)
TB/ART treatment improves my health condition	SD	1 (0.6%)	2 (1.2%)	3 (0.9%)
	D	3 (1.7%)	1 (0.6%)	4 (1.2%)
	A	36 (20.8%)	16 (9.2%)	52 (15.0%)
	SA	133 (76.9%)	154 (89.0%)	287 (82.9%)
Multidisciplinary care and availability of laboratory tests support my continued treatment	SD	2 (1.2%)	3 (1.7%)	5 (1.4%)
	D	5 (2.9%)	1 (0.6%)	6 (1.7%)

Variable	*Category	Control n (%)	Case n (%)	Total n (%)
	A	39 (22.5%)	53 (30.6%)	92 (26.6%)
	SA	127 (73.4%)	116 (67.1%)	243 (70.2%)
Lack of family acceptance or exclusion makes adhering to treatment more difficult	SD	22 (12.7%)	57 (32.9%)	79 (22.8%)
	D	25 (14.5%)	38 (22.0%)	63 (18.2%)
	A	103 (59.5%)	61 (35.3%)	164 (47.4%)
	SA	23 (13.3%)	17 (9.8%)	40 (11.6%)
Pill characteristics are troublesome	SD	20 (11.6%)	59 (34.1%)	79 (22.8%)
	D	24 (13.9%)	31 (17.9%)	55 (15.9%)
	A	99 (57.2%)	62 (35.8%)	161 (46.5%)
	SA	30 (17.3%)	21 (12.1%)	51 (14.7%)
TB/HIV diagnosis affected my social life	SD	30 (17.3%)	38 (22.0%)	68 (19.7%)
	D	41 (23.7%)	36 (20.8%)	77 (22.3%)
	A	74 (42.8%)	57 (32.9%)	131 (37.9%)
	SA	28 (16.2%)	42 (24.3%)	70 (20.2%)
Advice from healthcare provider motivates me	SD	1 (0.6%)	2 (1.2%)	3 (0.9%)
	D	1 (0.6%)	1 (0.6%)	2 (0.6%)
	A	28 (16.2%)	17 (9.8%)	45 (13.0%)
	SA	143 (82.7%)	153 (88.4%)	296 (85.5%)
Physical weakness/illness motivates adherence	SD	6 (3.5%)	2 (1.2%)	8 (2.3%)
	D	10 (5.8%)	5 (2.9%)	15 (4.3%)
	A	38 (22.0%)	34 (19.7%)	72 (20.8%)
	SA	119 (68.8%)	132 (76.3%)	251 (72.5%)
Confidence in taking ART despite challenges	SD	3 (1.7%)	3 (1.7%)	6 (1.7%)
	D	5 (2.9%)	3 (1.7%)	8 (2.3%)
	A	30 (17.3%)	23 (13.3%)	53 (15.3%)
	SA	135 (78.0%)	144 (83.2%)	279 (80.6%)

609 *Categories: SA (Strongly agree), A (Agree), D (Disagree), SD (Strongly disagree). Results are
610 presented as frequencies and percentages

611

612 Table 9 Barriers to healthcare access among participants

Variable	*Category	Control n (%)	Case n (%)	Total n (%)
Distance to nearest clinic	SD	14 (8.1)	14 (8.1)	28 (8.1)
	D	55 (31.8)	99 (57.2)	154 (44.5)
	A	18 (10.4)	12 (6.9)	30 (8.7)

Variable	*Category	Control n (%)	Case n (%)	Total n (%)
	SA	86 (49.7)	48 (27.7)	134 (38.7)
Transportation costs	SD	15 (8.7)	5 (2.9)	20 (5.8)
	D	67 (38.7)	92 (53.2)	159 (46.0)
	A	17 (9.8)	17 (9.8)	34 (9.8)
	SA	74 (42.8)	59 (34.1)	133 (38.4)
Long waiting times	SD	35 (20.2)	28 (16.2)	63 (18.2)
	D	107 (61.8)	117 (67.6)	224 (64.7)
	A	15 (8.7)	7 (4.0)	22 (6.4)
	SA	16 (9.2)	21 (12.1)	37 (10.7)
Unfriendly staff	SD	36 (20.8)	62 (35.8)	98 (28.3)
	D	110 (63.6)	84 (48.6)	194 (56.1)
	A	13 (7.5)	5 (2.9)	18 (5.2)
	SA	14 (8.1)	22 (12.7)	36 (10.4)
Lack of privacy	SD	43 (24.9)	91 (52.6)	134 (38.7)
	D	103 (59.5)	56 (32.4)	159 (46.0)
	A	16 (9.2)	2 (1.2)	18 (5.2)
	SA	11 (6.4)	24 (13.9)	35 (10.1)
Work/family commitments	SD	36 (20.8)	57 (32.9)	93 (26.9)
	D	111 (64.2)	70 (40.5)	181 (52.3)
	A	14 (8.1)	19 (11.0)	33 (9.5)
	SA	12 (6.9)	27 (15.6)	39 (11.3)
Poor roads/security	SD	39 (22.5)	53 (30.6)	92 (26.6)
	D	60 (34.7)	84 (48.6)	144 (41.6)
	A	16 (9.2)	14 (8.1)	30 (8.7)
	SA	58 (33.5)	22 (12.7)	80 (23.1)
Limited clinic hours	SD	37 (21.4)	57 (32.9)	94 (27.2)
	D	115 (66.5)	82 (47.4)	197 (56.9)
	A	9 (5.2)	11 (6.4)	20 (5.8)
	SA	12 (6.9)	23 (13.3)	35 (10.1)
Quality of care	SD	2 (1.2)	3 (1.7)	5 (1.4)
	D	9 (5.2)	55 (31.8)	64 (18.5)
	A	29 (16.8)	24 (13.9)	53 (15.3)
	SA	133 (76.9)	91 (52.6)	224 (64.7)
Travel time <30 min		62 (35.8)	76 (43.9)	138 (39.9)
Travel time 30–60 min		43 (24.9)	75 (43.4)	118 (34.1)

Variable	*Category	Control n (%)	Case n (%)	Total n (%)
Travel time >60 min		65 (37.6)	19 (11.0)	84 (24.3)
Travel time Don't Know		3 (1.7)	3 (1.7)	6 (1.7)

613 *Categories: SA (Strongly agree), A (Agree), D (Disagree), SD (Strongly disagree). Results are
614 presented as frequencies and percentages

615 Table 10 Social support patterns of participants

Variable	*Category	Control n (%)	Case n (%)	Total n (%)
People close to me avoid me because of my illness	SA	5 (2.9%)	8 (4.6%)	13 (3.8%)
	A	3 (1.7%)	4 (2.3%)	7 (2.0%)
	D	110 (63.6%)	99 (57.2%)	209 (60.4%)
	SD	55 (31.8%)	62 (35.8%)	117 (33.8%)
I receive support from my partner/spouse	SA	112 (64.7%)	72 (41.6%)	184 (53.2%)
	A	40 (23.1%)	53 (30.6%)	93 (26.9%)
	D	4 (2.3%)	20 (11.6%)	24 (6.9%)
	SD	17 (9.8%)	28 (16.2%)	45 (13.0%)
I receive support from family to stay healthy	SA	117 (67.6%)	115 (66.5%)	232 (67.1%)
	A	35 (20.2%)	20 (11.6%)	55 (15.9%)
	D	4 (2.3%)	14 (8.1%)	18 (5.2%)
	SD	17 (9.8%)	24 (13.9%)	41 (11.8%)
I feel uncomfortable sharing with friends	SA	99 (57.2%)	83 (48.0%)	182 (52.6%)
	A	19 (11.0%)	24 (13.9%)	43 (12.4%)
	D	33 (19.1%)	54 (31.2%)	87 (25.1%)
	SD	22 (12.7%)	12 (6.9%)	34 (9.8%)

Variable	*Category	Control n (%)	Case n (%)	Total n (%)
I can count on friends during illness/stigma	SA	15 (8.7%)	39 (22.5%)	54 (15.6%)
	A	15 (8.7%)	14 (8.1%)	29 (8.4%)
	D	94 (54.3%)	74 (42.8%)	168 (48.6%)
	SD	49 (28.3%)	46 (26.6%)	95 (27.5%)
I don't get the emotional support I need from family	SA	16 (9.2%)	33 (19.1%)	49 (14.2%)
	A	4 (2.3%)	1 (0.6%)	5 (1.4%)
	D	103 (59.5%)	51 (29.5%)	154 (44.5%)
	SD	50 (28.9%)	88 (50.9%)	138 (39.9%)

*Categories: SA (Strongly agree), A (Agree), D (Disagree), SD (Strongly disagree). Results are presented as frequencies and percentages

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- HIVTBDataset.xls