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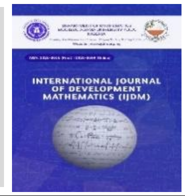

# Binary Logistic Regression Analysis of Sociodemographic and Clinical Determinants of HIV-TB Coinfection among Patients Attending HIV Clinics

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**ABSTRACT**

The study sought to determine the factors influencing Tuberculosis (TB) infection among people living with HIV in Adamawa State, Nigeria through the use of chi-square tests and binary logistic regression analysis. The study design was retrospective cross-sectional, and the source of data was a sample size of 969 patients infected with HIV from fifteen Local Government Areas (LGAs) within Adamawa State. In this case, 811 (83.7%) had no TB infection while 158 (16.3%) had TB infection, representing an infection rate of 16.3%. Five predictor variables were used; the LGA of residence, gender, current weight, age group, and current viral load. The bivariate analyses showed significant association between TB infection and LGA ($\chi^2$=176.561, p<0.001), current weight ($\chi^2$=14.428, p=0.001), and current viral load ($\chi^2$=8.096, p=0.017). Gender and age group did not show significant association. Binary logistic regression analysis indicated significant results ($\chi^2$=168.865, df=21, p<0.001), goodness of fit (Hosmer-Lemeshow p=0.546), and explained 27.2% variance in TB status. For the multivariate regression analysis, LGA and current weight were identified as independent variables. Those residing in Hong (OR = 43.951), Mayo-Belwa (OR = 8.164), Maiha (OR = 5.907), and Michika (OR = 2.997) had greater odds of having TB coinfection when compared to individuals from Yola South. Subjects with weight range between 30 and 60kg had double the risk of developing TB than individuals whose weight was greater than 60kg (OR = 2.434). In view of this result, it is imperative that resources be channeled towards the identification and treatment of patients with TB in high-risk LGAs like Hong, Mayo-Belwa, Maiha, and Michika. Efforts aimed at weight assessment must be made during the management of HIV disease especially for individuals with body mass lower than 60kg. Finally, intensified efforts towards TB case finding must be pursued in ART facilities.

## 1. Introduction

TB and HIV/AIDS form one of the most dangerous infectious diseases synergy combinations in current medicine, with each organism enhancing the other's progress and morbidity. Tuberculosis is the number one killer among PLHIV, causing one-third of all deaths caused by AIDS (World Health Organization [WHO], 2023). Pathological interaction of these two infections leads to bidirectional synergy: immunosuppression due to HIV increases the risk of acquiring an infection by M. tuberculosis and the transition from latent to active disease, while active TB infection further stimulates HIV replication, increases viral loads, reduces the amount of CD4+ T lymphocytes, and speeds up the development of immunodeficiency. PLHIV are 15 to 21 times more likely to contract active TB than individuals

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without HIV. Sub-Saharan Africa is one of the most affected regions by this tandem; 74% of the total TB/HIV patients live there, with Nigeria being among the hardest-hit nations in the world.

Indeed, Nigeria experiences a relatively high burden of both the HIV and TB pandemics globally. As of 2019, the estimated number of individuals living with HIV is 1.9 million, while the prevalence of the disease among adults aged between 15 to 49 is approximately 1.3%. In this case, Nigeria ranks among the most highly affected nations by the HIV pandemic (UNAIDS, 2019; Centers for Disease Control and Prevention [CDC], 2025). Similarly, Nigeria is ranked among the most affected nations by the TB pandemic, with the estimated rate of TB cases among the nation's population standing at approximately 219 per 100,000 population. Moreover, the co-infection prevalence rate for TB/HIV was approximately 4.9% among patients with the disease (CDC, 2025). Nonetheless, recent facility-based studies in Nigeria have indicated higher prevalence rates of the disease, where a study conducted in Enugu State found the TB/HIV co-infection rate among TB patients to be 29.0%. Thus, the possibility exists that the national figures might be underestimating the prevalence rate. As of 2023, NACA reported approximately 1,400 new HIV cases per week, implying an annual total of approximately 75,000 new infections (NACA, 2023).

Adamawa State, which falls under the North-East geopolitical region of Nigeria, provides an interesting backdrop for a TB/HIV coinfection study. Adamawa State is known to have recorded high HIV prevalence rates than the national average due to social and cultural issues, migration within the Nigerian-Cameroon border, poverty, low literacy rate, lack of medical facilities, and displacement within the Lake Chad Basin due to insurgence attacks (Nwachinemere et al., 2025). Recently, there has been a worrying trend of increasing cases of new HIV infections reported in Adamawa State, with about 8,850 new cases reported since 2022 up to mid-2025, consisting of 2,700 new cases in 2022, more than 2,500 new cases in 2023, 2,227 new cases in 2024, and 1,423 new cases in the first six months of 2025 (Daily Trust, 2025; Premium Times, 2025). In addition to the rising number of HIV cases, TB transmission continues unabated in all the fifteen LGAs of Adamawa State. Moreover, there have been reports on the inadequacy of information concerning TB-HIV coinfections in Adamawa State, especially among nomadic groups and rural communities where cattle herding and crop production are rampant (Daily Trust, 2025).

Several individual-level and structural variables impact the risk of TB/HIV co-infections. Biologically, HIV-induced suppression of the immune system, usually quantified using CD4 cell counts, is the primary determinant for TB susceptibility since depletion of CD4+ cells destroys the only cellular defense against mycobacteria. Viral load is another related indicator, and high viral load means that HIV remains uncontrolled, rapidly deteriorating immunity and increasing vulnerability to infections, such as TB. According to the research conducted in Uganda on multidrug-resistant TB patients, there was a significant correlation between weight and HIV status among the patients, as people with a body weight of 50 kilograms or above were less likely to have HIV than those who weighed less than 30 kilograms. Hence, nutritional status, indicated by body weight, is one of the crucial co-factors for TB/HIV risk, as malnutrition adversely impacts immune response and increases susceptibility to active TB disease (Gebremichael, 2020; Bwogi et al., 2025).

Apart from the biological risk factors, other structural and demographic factors may modify the association between TB and HIV co-infections. The geographical location plays a pivotal role since people living near dense settlements with high population density, crowded living spaces, poor ventilation, and inadequate access to diagnostic and therapeutic services will experience spatial disparities in the incidence of TB infections and co-infections. For instance, researchers conducting studies on co-infection in Uganda concluded that using binary logistic regression analysis was more appropriate in modeling co-infection outcomes than modified Poisson regression. The variable sex produced inconsistent results in different populations. Differences in physiological characteristics in immunity, behavior, occupation, and unequal access to ART facilities may affect the risks of co-infection among men and women. Evidence suggests that male patients who receive higher education and work in the public sector were more likely to acknowledge the relationship between TB and HIV infections. It is plausible that age acts as a risk modifier because the elderly have been infected with HIV for longer periods than younger patients, increasing immunosuppression and susceptibility to TB.

In spite of the fact that the TB/HIV dual epidemic has been reported as highly prevalent and serious in Nigeria, and also in spite of knowledge of the vulnerability of Adamawa State to both conditions, it appears that there is no adequate characterization of the independent predictors of TB co-infection among HIV patients within Adamawa State. Most researches concerning HIV/AIDS prevalence and management in Nigeria have been carried out at the national level, involving analyses of national seroprevalence levels, treatment coverage statistics, and risk factors (NACA, 2023; Nwachinemere et al., 2025). There seems to be a dearth of multivariate analytical studies investigating the relationship between HIV status and TB status while controlling for other variables at the local government area level. The geographical variation of TB/HIV co-infection within the fifteen LGAs of Adamawa State has never been estimated, resulting in inadequate information available to healthcare program managers as regards where to allocate their limited screening, diagnosis, and treatment efforts. Furthermore, patient-level predictors like gender, body mass index, age group, and viral load status have never been isolated using multivariate statistical modeling as independent contributors to TB co-infection risk (Ezeilo et al., 2023; Ahmadu et al., 2024).

The present study seeks to analyze data collected from HIV positive individuals in fifteen LGAs in Adamawa State of Nigeria using chi-square tests of independence and binary logistic regression in order to isolate and measure the independent predictors of TB positivity in this group. Binary logistic regression is used to estimate the log-odds of TB positivity as a linear combination of predictor variables when the outcome variable is dichotomous, as in the present study where the presence of TB is recorded as positive or negative among HIV positive patients (Hosmer et al., 2013; Kleinbaum & Klein, 2010). In particular, the use of binary logistic regression enables the estimation of the odds ratios for TB positivity with their 95% confidence intervals.

## 2. Methodology

### 2.1 Area of study

Yola is the capital city of Adamawa State, which is situated in the northeastern region of Nigeria. It acts as both an administrative and economic hub of the state. Yola lies at latitudes 7° and 11°N and at longitudes 11° and 14°E. It occupies an area of about 39,742 $km^2$ (15,342 sq meter). The state has boundaries with other states like Gombe, which lies to the northwest, Taraba which lies to the southwest, Borno, which lies to the northeast, and Cameroon, which lies to the east. The average annual temperatures vary between 24°c and 34°c. There are numerous indigenous ethnic communities in Yola such as Fulani, Bwatiye, and Chamba. The economic system of Yola involves agriculture and commerce where most individuals are farmers and traders.

### 2.2 Method of Data Collection

The secondary data in this study were retrieved from the health clinics that were registered at the Specialized hospital in Yola, Adamawa State. These data are based on the HIV patients who suffer from Tuberculosis. This study applied a cross-sectional design where data are analyzed retrospectively. In this case, it involves an analysis of past data that were documented in order to determine the factors responsible for the development of TB in the HIV patients. Both descriptive and inferential statistical techniques, which include logistic regression, were used.

### 2.3 Study Population and Setting

The subjects for this research include patients with HIV admitted in hospitals with a TB diagnosis in Yola, Adamawa State. The population involves people of different ages, sexes, and socioeconomic statuses with an HIV infection.

### 2.4 Data Collection and Variables:

Data were collected from patient registers and clinical records. The variables are categorized as follows:

**Dependent Variable:** TB Status (Dichotomous: Positive or Negative).

**Independent Variables (Predictors):**

Local government area (L.G.A): (Fufore, Ganye, Gombi,…Yola south).

Sex: (Male, Female).

Weight: (<30kg, 30-60kg, >60kg).

Age: (<20 years, 20-40 years, >40 years).

Current viral load: Undetectable, Suppressed, Unsuppressed.

The information obtained from the patient's files was processed in IBM SPSS Statistics (Version 27.0) after being inputted, checked, and coded. There were three types of statistical analysis techniques used to achieve the objectives of the study, namely descriptive analysis to evaluate frequency and percentages, tests of independence, and binary logistic regression analysis. These techniques were chosen because of their relevance to analyze the relationship of categorical and binary variables.

**2.5 Descriptive Statistics**

Frequency distribution tables and percentages were used to summarize the socio-demographic characteristics of the TB patients and the prevalence of HIV co-infection.

**2.6 Chi-Square Test of Independence**

A Chi-square test was conducted to determine if there is a significant association between TB status and the predictor variables. The null hypothesis ($H_0$) assumed independence, while the alternative hypothesis ($H_1$) assumed the variables are dependent.

Pearson's chi-squared test is used to determine whether there is a statistically significant difference between the expected frequencies and the observed frequencies in one or more categories of a contingency table.

Pearson's chi-square $\chi^2$ test formula to calculate the test statistic is given by:

$$\chi^2 = \sum_{i=1}^{n} \frac{\left(O_f - E_f\right)^2}{E_f} \quad (1)$$

where:

$\chi^2$ is the chi-square test statistic

Σ is the summation operator (it means "take the sum of")

$O_f$ is the observed frequency

$E_f$ is the expected frequency

The chi-square test for a two-way table with r rows and c columns uses critical values from the chi-square distribution with (r – 1) (c – 1) degrees of freedom. Where r is the number of rows and c is the number of columns. The decision rule for this test stated that Reject $H_o$ if $\chi^2_{cal} > \chi^2_{tab}$, otherwise do not reject $H_o$.

**2.7 Logistic Regression Model**

Binary logistic regression is used because the dependent variable is dichotomous. The model predicts the probability of being TB positive based on the selected predictors. The logistic regression equation is defined as:

$$p(x) = \frac{e^{(\beta_0+\beta_1 x_1+\beta_2 x_2+\beta_3 x_3+\beta_4 x_4+\beta_5 x_5)}}{1+e^{(\beta_0+\beta_1 x_1+\beta_2 x_2+\beta_3 x_3+\beta_4 x_4+\beta_5 x_5)}} \quad (2)$$

The logit transformation in terms of $p(x)$ is defined as

$$g(x) = ln\left[\frac{p(x)}{1-p(x)}\right] = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 \quad (3)$$

where:

$g(x)$ = is the logit function
In denotes the natural logarithm
$x_1$= L.G.A
$x_2$= Sex
$x_3$=Weight
$x_4$= Age

$x_5$= Current viral load
$p(x)$ = is the probability that the dependent variable equals a case, given some linear combination of the predictors.
$\beta_0$ is the intercept from the linear regression equation (the value of the criterion when the predictor(s) equal zero)
$\beta_i$ $(i = 1,2,3,4,5)$ is the regression coefficient of the predictors base.
$e$ denotes the exponential function

### 2.8 Model Evaluation Criteria

The model's performance and fit are assessed using:
**Omnibus Test of Model Coefficients:** To test if the predictors significantly improve the model.
**Odds Ratio (OR):** A measure of association that quantifies the odds of an outcome occurring in one group relative to a reference group.
**-2 Log Likelihood (-2LL):** To measure how well the model explains the variations in the data.
**Pseudo R-Squared (Nagelkerke R-Squared):** To estimate the proportion of variance in TB status explained by the model.
**Classification Table:** To determine the sensitivity (correctly predicted positives) and specificity (correctly predicted negatives) of the model.

## 3. Results and Discussion

### 3.1 Study Sample Characteristics

A total of 969 people living with HIV accessing care services at ART clinics from fifteen LGAs of Adamawa State, Nigeria, were used for the present analysis. Out of these, 811 (83.7%) people were found not to be suffering from TB and 158 (16.3%) had TB; hence, a prevalence rate of 16.3% was recorded for TB/HIV co-infection. It is evident that the observed prevalence rate is considerably high compared to the national average of around 4.9% for TB patients in Nigeria (Centers for Disease Control and Prevention, 2025) but similar to the findings of facility-based studies conducted in Nigeria.

### 3.2 Bivariate Analysis

The chi-square results for the relationship between the status of TB and the various variables under consideration showed that there were statistically significant relationships between TB status and Local Government Area ($\chi^2$=176.561, p<0.001), weight ($\chi^2$=14.428, p=0.001), and current viral load ($\chi^2$=8.096, p=0.017). On the other hand, no statistically significant relationship was observed for the variables age categories ($\chi^2$=0.025, p=0.987) and sex ($\chi^2$=0.994, p=0.319). The highest number of individuals infected with TB/HIV infection is found in Yola North (275 positives, 28.4%), highest percentage in Mayo-Belwa (71 positives out of 71, 56 negatives) and lowest in Yola South (144 positives out of 14 negatives). There is no TB positive cases recorded in Fufure, Song and Toungo. Being a determinant, the weight factor displayed an inverse correlation with positivity for TB infection. This was illustrated by the highest number of individuals within the 30-60 kg category with positive results, totaling 526 out of a total of 969 positive results (54.3%), while the number was far lower in the category above 60 kg (255, 26.3%). Looking at the viral load variable, most individuals found positive for TB were recorded to have high viral loads (>1000 copies/ml), totaling 752 out of 969 positives (77.6%).

**Table 1: Contingency Table Showing the Observed, Percentage and the Expected Counts, Chi-square and P-value of TB Status of HIV Patients**

| Factors | TB Status of HIV Patients | | χ² Value | p-value |
|---|---|---|---|---|
| | Negative n (%) | Positive n (%) | | |
| **Local Government Area (LGA)** | | | | |
| Fufore | 6 (0.6%) | 0 (0.0%) | | |
| Ganye | 65 (6.7%) | 9 (1%) | 176.561 | 0.001* |
| Gombi | 1 (0.1%) | 1 (0.1%) | | |

| | | | | |
|---|---|---|---|---|
| Guyuk | 1 (0.1%) | 1 (0.1%) | | |
| Hong | 4 (0.4%) | 16 (1.7%) | | |
| Jada | 2 (0.2%) | 1 (0.1%) | | |
| Maiha | 9 (0.9%) | 4 (0.4%) | | |
| Mayo-Belwa | 71 (7.3%) | 56 (5.8%) | | |
| Michika | 43 (4.4%) | 14 (1.4%) | | |
| Mubi South | 75 (7.7%) | 6 (0.6%) | | |
| Numan | 51 (5.3%) | 6 (0.6%) | | |
| Song | 53 (5.5%) | 0 (0.0%) | | |
| Toungo | 11 (1.1%) | 0 (0.0%) | | |
| Yola North | 275 (28.4%) | 30 (3.1%) | | |
| Yola South | 144 (14.9%) | 14 (1.4%) | | |
| **Total** | **811 (83.7%)** | **158 (16.3%)** | | |
| **Sex** | | | | |
| Male | 306 (31.6%) | 53 (5.5%) | | |
| Female | 510 (52.6%) | 105 (10.8%) | 0.994 | 0.319 |
| **Total** | **811 (83.7%)** | **158 (16.3%)** | | |
| **Current Weight** | | | | |
| < 30 kg | 30 (3.1%) | 7 (0.7%) | | |
| 30–60 kg | 526 (54.3%) | 106 (10.9%) | 14.428 | 0.001* |
| > 60 kg | 255 (26.3%) | 26 (2.7%) | | |
| **Total** | **811 (83.7%)** | **158 (16.3%)** | | |
| **Age Group** | | | | |
| < 20 years | 59 (6.1%) | 11 (1.1%) | | |
| 20–40 years | 417 (43.0%) | 81 (8.4%) | 0.025 | 0.987 |
| > 40 years | 355 (36.6%) | 66 (6.8%) | | |
| **Total** | **811 (83.7%)** | **158 (16.3%)** | | |
| **Current Viral Load** | | | | |
| Undetectable (0 copies/mL) | 31 (3.2%) | 1 (0.1%) | | |
| Suppressed (≤ 1000 copies/mL) | 28 (2.9%) | 1 (0.1%) | 8.096 | 0.017* |
| Unsuppressed (> 1000 copies/mL) | 752 (77.6%) | 156 (16.1%) | | |
| **Total** | **811 (83.7%)** | **158 (16.3%)** | | |

*Note. * p < 0.05. Percentages are based on the total sample (N = 969). Reference categories for logistic regression are shown in square brackets.*

**Baseline Classification Accuracy (Null Model)**

Table 2 displays the classification performance of the null (intercept-only) logistic regression model, which includes no predictor variables and serves as the baseline benchmark.

**Table 2: Classification Table of TB Status of HIV Patients**

| **Observed** | **Predicted: Negative** | **Predicted: Positive** | **% Correct** |
|---|---|---|---|
| TB Status — Negative | 811 | 0 | 100.0 |
| TB Status — Positive | 158 | 0 | 0.0 |
| Overall Percentage | | | 83.7 |

Table 2 shows that the null model without predictors classified all 969 cases into the negative TB category; it was able to predict all 811 patients with negative TB (100%), but was unable to classify any of the positive TB patients (0%).

Hence, the accuracy rate of 83.7% is the result of the base rate of TB.

**Classification Accuracy of the Full Model**

Table 3 presents the classification accuracy of the full logistic regression model incorporating all predictor variables.

| Observed | Predicted: Negative | Predicted: Positive | % Correct |
|---|---|---|---|
| TB Status — Negative | 790 | 21 | 97.4 |
| TB Status — Positive | 124 | 24 | 21.5 |
| **Overall Percentage** | | | **85.0** |

By using all the predictor variables, the model managed to accurately predict TB negative subjects among 790 out of 811 total subjects (97.4%), while it successfully predicted TB positive among 24 out of 158 TB positive cases (21.5%). The enhancement from 0.0% to 21.5% for the prediction of positive TB is the only one which adds clinically any value compared with the null model. Although the sensitivity for predicting positive TB remains rather low (21.5%), this is indeed an enhancement because of the predictive power inherent within predictor variables, especially LGA and weight predictors. Overall, the accuracy of classification was 85%.

**Omnibus Test of Model Coefficients**

The statistical significance of the overall logistic regression model was evaluated using the Omnibus Test of Model Coefficients, reported in Table 4.

**Table 4: Omnibus Test of Model Coefficients**

| | $\chi^2$ | df | Sig. |
|---|---|---|---|
| Step 1 — Step | 168.865 | 21 | < 0.001* |
| Step 1 — Block | 168.865 | 21 | < 0.001* |
| Step 1 — Model | 168.865 | 21 | < 0.001* |

*Note. * p < 0.001.*

The Omnibus test from Table 4 assesses the increase in the goodness-of-fit of the model after accounting for all predictor variables compared to the null model. According to Table 4, the chi-square statistic for the model is 168.865 and the degrees of freedom is 21 ($p < 0.001$). This finding is statistically significant at the Step, Block, and Model levels because of the inclusion of all predictor variables simultaneously, which indicates that all predictor variables, considered together, significantly contribute to explaining variability in the TB outcome.

**Model Summary**

The pseudo-$R^2$ statistics and −2 Log Likelihood value for the fitted model are reported in Table 5.

**Table 5: Model Summary**

| Step | -2 Log Likelihood | Cox & Snell $R^2$ | Nagelkerke $R^2$ |
|---|---|---|---|
| 1 | 692.965 | 0.160 | 0.272 |

From Table 5, the −2 Log Likelihood of 692.965 can be seen to represent the amount of variance that remains unexplained by the regression model. From the Cox & Snell $R^2$ of 0.160, the model can be seen to account for about 16.0% of the total variation related to TB status. The Nagelkerke $R^2$ measure, which adjusts the Cox & Snell index to run between 0 and 1, is 0.272.

**Hosmer–Lemeshow Goodness-of-Fit Test**

The overall goodness of fit of the logistic regression model was assessed using the Hosmer–Lemeshow test, the results of which are presented in Table 6.

**Table 6: Hosmer and Lemeshow Test**

| Step | $\chi^2$ | df | Sig. |
|---|---|---|---|
| 1 | 6.915 | 8 | 0.546 |

Hosmer-Lemeshow Chi-Square Test uses risk categories created based on the deciles of predicted probabilities and then compares observed with expected frequencies. From Table 4.6, it is evident that the value of chi-square obtained from the test is 6.915, with 8 degrees of freedom and a probability value of 0.546. This indicates that the p-value is greater than 0.05, meaning that we cannot reject the null hypothesis, and thus the model fits well to the data.

**Binary Logistic Regression Analysis**

A multiple logistic regression analysis was performed using TB status as the response variable and all five predictors included in the analysis simultaneously. This regression analysis was significant (Omnibus Test: $\chi^2 = 168.865$, df = 21, $p < 0.001$), which means that the combination of the predictor variables helped to explain a significant amount of variance in TB status. The goodness-of-fit test (Hosmer-Lemeshow Test) showed no significance ($\chi^2 = 6.915$, df = 8, $p = 0.546$). This confirms that the logistic regression model is well calibrated. The Nagelkerke $R^2$ was 0.272, meaning that the variation in the outcomes for TB was explained by about 27.2%. The model had an overall classification rate of 85.0% and specificity of 97.4% in predicting TB-negative individuals while the sensitivity was 21.5%.

**Table 5: Binary Logistic Regression Analysis of Predictors of TB Status Among HIV-Positive Patients**

| Variables | B | S.E. | Wald | p-value | OR [Exp(B)] |
|---|---|---|---|---|---|
| **Local Government Area (LGA) [Reference: Yola South]** | | | | | |
| Fufore | -19.214 | 163,650.000 | 0.000 | 0.999 | 0.000 |
| Ganye | 0.261 | 0.459 | 0.324 | 0.569 | 1.298 |
| Gombi | 2.282 | 1.449 | 2.481 | 0.115 | 9.796 |
| Guyuk | 2.564 | 1.488 | 2.970 | 0.085 | 12.988 |
| Hong | 3.783 | 0.638 | 35.159 | 0.001* | 43.951 |
| Jada | 1.492 | 1.284 | 1.351 | 0.245 | 4.448 |
| Maiha | 1.776 | 0.681 | 6.807 | 0.009* | 5.907 |
| Mayo-Belwa | 2.100 | 0.338 | 38.649 | 0.001* | 8.164 |
| Michika | 1.097 | 0.423 | 6.721 | 0.010* | 2.997 |
| Mubi South | -0.130 | 0.514 | 0.064 | 0.800 | 0.878 |
| Numan | 0.125 | 0.519 | 0.058 | 0.809 | 1.133 |
| Song | -18.896 | 5,478.397 | 0.000 | 0.997 | 0.000 |
| Toungo | -18.956 | 12,026.135 | 0.000 | 0.999 | 0.000 |
| Yola North | 0.191 | 0.344 | 0.308 | 0.579 | 1.211 |
| **Sex [Reference: Female]** | | | | | |
| Male | -0.060 | 0.210 | 0.083 | 0.774 | 0.942 |
| **Current Weight [Reference: > 60 kg]** | | | | | |
| < 30 kg | 1.204 | 0.699 | 2.966 | 0.085 | 3.332 |
| 30–60 kg | 0.890 | 0.253 | 12.344 | 0.001* | 2.434 |
| **Age Groups [Reference: > 40 years]** | | | | | |
| < 20 years | -0.625 | 0.530 | 1.392 | 0.238 | 0.535 |
| 20–40 years | -0.265 | 0.209 | 1.612 | 0.204 | 0.767 |
| **Current Viral Load [Reference: Unsuppressed (> 1000 copies/mL)]** | | | | | |
| Undetectable (0 copies/mL) | -0.411 | 0.434 | 0.896 | 0.344 | 0.663 |
| Suppressed (≤ 1000 copies/mL) | -0.213 | 0.420 | 0.257 | 0.612 | 0.808 |
| **Constant** | | | | | |
| Constant | -2.564 | 0.546 | 22.067 | 0.001* | 0.077 |

*Note. B = logistic regression coefficient. S.E. = standard error. Wald = Wald chi-square statistic. OR = odds ratio [Exp(B)]. * p < 0.05. Ref = reference category (Yola South for LGA; Female for sex; > 60 kg for weight; > 40 years for age; Unsuppressed for viral load).*

**Independent Predictors of TB Status**

**Local Government Area of Residence:** The most significant independent variable that influenced TB positivity was

LGA. Subjects from the LGA Hong had about 44 times more chance of TB positivity than those who resided in Yola South, (OR = 43.95, 95% CI: 12.59-153.45, $p < 0.001$). Mayo-Belwa had a significantly high odds ratio (OR = 8.16, 95% CI: 4.21-15.82, $p < 0.001$), then Maiha (OR = 5.91, 95% CI: 1.56-2

**Current Weight:** The other important independent variable was the weight of participants. Individuals falling within the weight range of 30-60 kg were 2.43 times more likely to have TB infection than individuals weighing more than 60 kg (OR = 2.43; 95% CI = 1.48-4.00; $p < 0.001$). Participants weighing below 30 kg were 3.33 times more likely to develop TB, but without statistical significance ($p = 0.085$).

**Non-Significant Predictors:** However, sex (OR = 0.94, $p = 0.774$), age categories (OR = 0.54, $p = 0.238$ for those younger than 20 and OR = 0.77, $p = 0.204$ for those 20-40 years), and current viral load (undetectable: OR = 0.66, $p = 0.344$; suppressed: OR =

## 4. Discussion of Findings

Co-infection between TB and HIV was recorded in 16.3% of 969 individuals who were found to be HIV-positive in Adamawa State, Nigeria, a rate which is considerably higher than the national average of 4.9% (CDC, 2025) but which parallels facility-based records from Enugu State, where the rate is 29.0%, and Ethiopia, where the co-infection rate is 24.6% (Ekwueme et al., 2018; Getaw & Tigu, 2024). The most interesting result in this study was the geographical heterogeneity in terms of the risk for co-infection with TB and HIV. Individuals from Hong LGA had nearly 44 times the odds of testing positive for TB infection than did individuals from Yola South (OR = 43.95, $p < 0.001$), followed by Mayo-Belwa (OR = 8.16), Maiha (OR = 5.91), and Michika (OR = 2.99). The clustering in certain LGAs could reflect cross-border migration with Cameroon, poor health facilities in rural areas, crowded accommodation, and late diagnosis of the condition (Nwachinemere et al., 2025; Ahmadu et al., 2024). Another significant determinant in our sample population was current body weight, with individuals weighing 30-60 kg being more likely to be positive for TB infection than those whose weight exceeded 60 kg (OR = 2.43, p <

Unlike some other research, the variables sex, age group, and viral load did not independently predict TB infection status among people living with HIV in this study. The insignificant role of viral load is surprising given the biological plausibility of viremia on immune dysregulation (WHO, 2023). Possible reasons for the non-independence include a one-time measurement of the viral load, small sample size (n=107) of the unsuppressed category, and possible attenuation due to the influence of geography and weight (Yang et al., 2023). The lack of association between sex and TB infection status differs from studies conducted in Iran (male OR=1.91) and Enugu (female predominance) where context may influence the sex effect differently (Mirahmadizadeh et al., 2023; Ekwueme et al., 2018). The model fits adequately (HL $\chi^2$=4.158, p=0.546) and explains 27.2% of variation in TB infection outcomes (Nagelkerke $R^2$=0.272), similar to models in Zambia (Mwansa et al., 2025).

Such results are quite significant from clinical and programmatic perspectives. The geographic variability observed in the distribution of cases indicates the necessity for allocating TB screening and treatment resources to LGAs where the disease burden is higher, namely Hong, Mayo-Belwa, Maiha, and Michika. Weight appears to play an important role in determining the susceptibility to tuberculosis, which indicates that TB screening in ART centers should be based on weight with preference given to individuals weighting up to 60 kg. Moreover, weight-based evaluation of TB risks is necessary for addressing the problem of low body weight and preventing its adverse effects.

## 5. Conclusion

The study findings confirm that TB-HIV co-infection is a serious public health concern in Adamawa State because its prevalence is very high at 16.3%, which is considerably higher than that observed across the country. Geographical location was confirmed as the first major determinant of co-infection because the residents of Hong, Mayo-Belwa, Maiha, and Michika LGAs were found to be at high risk of developing TB compared to the residents of Yola South LGA. The large variation can be explained by differences in access to healthcare services, living environments, migration patterns, and TB case-finding efforts conducted within various regions of the state. Nutritional status, measured as the body weight proxy variable, turned out to be the second most important determinant of co-infection because patients with a body weight of 30-60 kg were found to have a higher risk of TB infection. This highlights the significance of the factor of nutritional deficiency in enhancing vulnerability to infection among HIV patients due to weak immunity. Whereas the present viral load was significantly associated with TB status in bivariate analysis ($\chi^2 = 8.096$, $p = 0.017$), whereby majority of TB patients (77.6%) had non-suppressed viral load, it did not become an independent predictor in multivariate logistic regression model. In addition, age group and gender were not statistically significant predictors of TB infection status among people on antiretroviral therapy. The high significance of geographical and nutritional factors in this case calls for strategic interventions targeting LGAs that have the high TB/HIV burden and underweight HIV patients in Adamawa State.

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