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Knowledge, Attitudes, and Practices (KAP) on Tuberculosis (TB) Among Mining Communities in Gombe State, Nigeria

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ABSTRACT

Tuberculosis (TB) remains a significant public health challenge, particularly in underserved mining communities where occupational hazards, poor living conditions, and limited healthcare access exacerbate the disease burden. This study assessed the knowledge, attitudes, and practices (KAP) related to TB among mining communities in Gombe State, Nigeria, using a cross-sectional design with 292 participants. Statistical analyses, including frequency table, multivariate logistic regression, Chi-square Automatic Interaction Detection (CHAID), and latent class analysis, were employed to identify key predictors and subgroups. The findings revealed significant gaps in TB knowledge, with education level being the strongest predictor of accurate transmission knowledge (aOR = 5.60 for higher education, $p < 0.001$). Stigmatizing attitudes were prevalent, particularly among males with no formal education (41.2%) and those who believed TB is incurable (52.6%). Three distinct practice subgroups were identified: proactive practitioners (24%), moderate practitioners (42%), and low practitioners (34%). The study underscores the need for targeted interventions to address knowledge gaps, reduce stigma, and improve prevention practices. Recommendations include community education campaigns, stigma reduction programs, and tailored interventions for low-practice subgroups. These findings contribute to the global effort to combat TB by providing evidence-based insights for improving TB management in mining communities.

Keywords: Tuberculosis, Mining, Gombe, Knowledge, Attitude, and Practices.

INTRODUCTION

Tuberculosis (TB) remains one of the most pressing global public health challenges, particularly in low- and middle-income countries (LMICs) where healthcare systems are often under-resourced and overburdened (Dheda et al., 2020). Despite significant progress in global TB control efforts, the disease continues to claim millions of lives annually, with an estimated 10 million new cases and 1.5 million deaths reported in 2022 (World Health Organization [WHO], 2023). Nigeria, one of the high-burden TB countries, accounts for approximately 4.6% of the global TB burden, with mining communities being among the most vulnerable populations due to occupational hazards, poor living conditions, and limited access to healthcare services (Adepoju et al., 2021).

Mining communities are particularly at risk of TB due to the inhalation of silica dust, a well-documented risk factor for TB and silicosis (Rees & Murray, 2007). In Gombe State, Nigeria, mining activities such as limestone, gypsum, and coal extraction are prevalent, and these communities often reside in remote areas with limited access to healthcare facilities (Oluwole et al., 2022). The migratory nature of mining workforces further complicates TB control efforts, as

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miners often move between communities, potentially spreading the disease (Basu et al., 2009). Additionally, socioeconomic disparities, low health literacy, and cultural beliefs contribute to delayed diagnosis and treatment, exacerbating the TB burden in these communities (Adebayo et al., 2020).

Despite the known association between mining activities and increased TB risk, there is a paucity of research on the knowledge, attitudes, and practices (KAP) related to TB in mining communities in our settings. Understanding the KAP of these communities is critical for designing effective TB control interventions that are culturally appropriate and context-specific (Sommerland et al., 2020). Previous studies have highlighted the importance of addressing knowledge gaps, reducing stigma, and improving healthcare-seeking behaviours to enhance TB management in vulnerable populations (Nguyen et al., 2021). However, there is limited evidence on how these factors manifest in mining communities, particularly in sub-Saharan Africa, where the interplay of poverty, occupational hazards, and healthcare access creates unique challenges for TB control (Oluwole et al., 2022).

This study, therefore, seeks to address this gap by assessing the KAP related to TB among mining communities in Gombe State, Nigeria. By exploring the community's understanding of TB symptoms, transmission, and prevention, as well as their attitudes toward TB patients and healthcare-seeking behaviors, this study provides evidence-based insights that can inform targeted interventions. The findings of this study will contribute to the broader goal of reducing TB incidence and improving health outcomes in these underserved communities, aligning with the WHO's End TB Strategy, which emphasizes the importance of addressing social determinants of health and reducing health inequities (WHO, 2023). The primary aim of this study is to assess the knowledge, attitudes, and practices (KAP) related to tuberculosis (TB among miners and mining communities in Gombe State, Nigeria.

MATERIALS AND METHODS

Study Design

This study employed a cross-sectional design to assess the knowledge, attitudes, and practices (KAP) related to tuberculosis (TB) among mining communities in Gombe State, Nigeria

Study Setting and Population

The study was conducted in mining communities within Akko Local Government Area (LGA) of Gombe State, Nigeria, which is the largest LGA in Gombe State. The L.G.A is bounded by Gombe Local Government Area to the North, Billiri Local Government to the South, Bauchi State to the West and Yamaltu-deba to the East (Ministry of Land and Survey Gombe State, 2018). According to the National Population Commission, (2006) Akko L.G.A had a population of 337,435. The L.G.A comprises three (3) Emirate Councils namely: Akko, Gona, and Pindiga with a population of 136,683, 120,850 and 79902 respectively. But according to population projection 2024 population at 3.3 annual growth rate the population of Akko L.G.A is approximately 501,394 (Figure 1). The area has diverse ethnic groups and religious origins, with 80% of its population being farmers who rely on agriculture.

Tuberculosis (TB) remains a significant public health concern in the State and in the LGA. The study focused on two selected mining communities, Piyau and Mai Ganga, which were chosen due to their high concentration of miners and their families. These communities experience unique risk factors for TB transmission, including occupational exposure, poor living conditions, and limited healthcare access.

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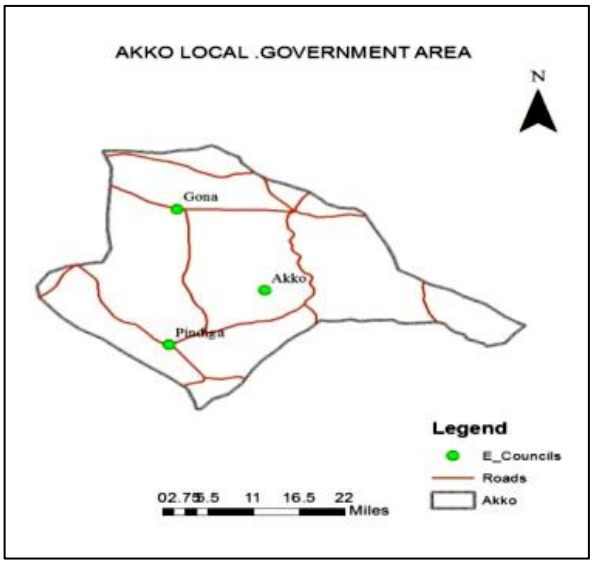

Figure 1: Map showing Akko LGA of Gombe state, Nigeria.

The study population comprised 1,602 individuals, based on population data from health facilities within Akko LGA. This population included all residents of the selected communities, with particular emphasis on miners and their families, who are at increased risk of TB due to their occupational environment and socioeconomic conditions. The diverse demographics within these communities allowed for a comprehensive analysis of knowledge, attitudes, and practices (KAP) related to TB.

Sampling Methods

Sample Size Calculation: The sample size (n) was calculated using population proportion formula. Taking into account the 5% error margin (d) and the 95% confidence interval and the prevalence of TB in mining communities in Gombe. The actual sample size for the study is calculated using the formula indicated below.

n= (Zα/2)2p (1-p)/ d2

Where:

n= required sample size

Z (1-α/2) = 95% confidence interval is equal to 1.96

P = prevalence of TB in mining communities.

d = Margin of error (5%) n= (1.69)2*0.501 (1-0.501)/ 0.052=**1602/6**

Considering10% non-respondent rate, the final sample size is **267 x 10%**

Sample = **292**

Sampling Techniques: Multi-stage sampling procedure was used for the study. In the first stage, Akko LGA was purposely selected from the 11 Local Government Areas in Gombe State due to its high concentration of mining sites and TB risk. In the Second stage, two communities (Piyau and Mai Ganga communities) were randomly selected (ballot method) from the selected LGA and in the final stage, Health Extension Workers' registration books served as the sampling frame, while the first family enrolled in the study was selected through convenience sampling.

Data Collection

Data were collected through face-to-face interviews using a structured questionnaire that was translated into Hausa, the local language, to ensure comprehension and accuracy. The questionnaire was divided into four sections: demographic information, knowledge of TB, attitudes toward TB, and practices related to TB. Seven trained community health volunteers conducted the interviews over a period of three days. Each interview lasted approximately 30 minutes, and each fieldworker completed 14 interviews per day. To ensure data quality, the researchers supervised the data collection process, conducted periodic checks, and randomly revisited households to verify the accuracy of the responses.

Data Analysis

Data were analyzed using MS Excel, SPSS version 26.0, and STATA version 17. Descriptive statistics, including frequencies and percentages, were used to summarize the data. Cross-tabulations were performed to explore associations between variables such

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as education level and knowledge of TB. The dual use of SPSS and STATA ensured robustness and cross-validation of the results.

Ethical Considerations

Ethical clearance for this study was obtained from the Gombe State Ministry of Health, Research and Ethics Committee (REC) and approval was granted. Informed consent was obtained from all participants before the interviews. Participants were informed of their right to withdraw from the study at any time without consequences. Confidentiality and anonymity were maintained throughout the study, and data were used solely for research purposes.

RESULT S

Demographic Data

The demographic data reveal that the majority of participants were male (65.41%), reflecting the gender dynamics typical of mining communities where men are predominantly engaged in mining activities. The age distribution shows that 41.10% of participants were between 18–35 years, indicating a relatively young population. This is significant because younger individuals are more likely to be mobile and engaged in high-risk behaviors that could contribute to TB transmission.

Table 1: Demographic Data

RESPONSES	FREQUENCY N= 292	PERCENTAGE (%)
Community		
Mai Ganga	152	52.05%
Piyau	140	47.95%
Gender		
Female	101	34.59%
Male	191	65.41%
Age		
0-17	2	0.68%
18-35	120	41.10%
36-53	94	32.19%
54 and Above	76	26.03%
Marital Status		
Divorced	1	0.34%
Married	251	85.96%
Single	33	11.30%
Widowed	7	2.40%
Education		
Elementary/Primary	81	27.74%
High school/Secondary	130	44.52%
Higher education	17	5.82%
None of the above	14	4.79%
None fomal	50	17.12%
Income per Month		
Less than N30,000	204	69.86%
N 90,000– 119,999	8	2.74%
N120,000 and above	1	0.34%
N30,000 – 59,999	63	21.58%
N60,000 – 89,999	16	5.48%
Distance to Health		

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Facilty		
<30 Minutes	213	72.95%
30 – 60 Minutes	61	20.89%
I don't know	18	6.16%

Source: Field Survey, 2024

In terms of education, 44.52% of participants had completed high school/secondary education, while 17.12% had no formal education. This disparity in educational attainment may influence health literacy and the ability to understand and adopt TB prevention practices. Additionally, 69.86% of participants earned less than N30,000 per month, highlighting the socioeconomic challenges faced by these communities, which could limit access to healthcare and increase vulnerability to TB.

Most participants (72.95%) lived within 30 minutes of a healthcare facility, suggesting relatively good geographic access to healthcare services. However, 20.89% reported a 30–60-minute travel time, which could still pose a barrier to timely healthcare access, especially for those with limited transportation options.

Knowledge about TB

Table 2 presents an overview of participants' knowledge regarding TB symptoms, transmission, and prevention. The findings reveal both strengths and gaps in TB awareness, highlighting areas for targeted public health interventions. A majority (77.05%) of participants reported having heard of TB, indicating a foundational level of awareness. However, 22.95% had never heard of the disease, suggesting that certain populations remain underserved in TB-related health education. The most commonly recognized symptoms were fatigue (17.81%) and persistent cough lasting two weeks or more (15.75%), while weight loss (8.56%) was the least recognized symptom. The relatively low awareness of TB symptoms, particularly weight loss and night sweats, could contribute to delayed diagnosis and treatment-seeking behavior.

Table 2: Knowledge of TB Symptoms, Transmission, and Prevention.

Aspect of Knowledge	Frequency (N=292)	Percentage (%)
Awareness of TB		
Heard of TB	225	77.05%
Never heard of TB	67	22.95%
Common Symptoms of TB		
Persistent cough (2 weeks or more)	46	15.75%
Chest pain	38	13.01%
Fatigue	52	17.81%
Night sweats	39	13.36%
Weight loss	25	8.56%
Perceived Transmission		
Through air (correct)	98	33.56%
Through handshakes (incorrect)	45	15.41%
Through sharing utensils	32	10.96%
Don't know	117	40.07%
Prevention and Cure		
TB is curable	166	56.85%
TB is not curable	37	12.67%

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Aspect of Knowledge	Frequency (N=292)	Percentage (%)
Don't know	89	30.48%
Prevention Methods		
Covering mouth when coughing	78	26.71%
Avoiding crowded places	98	33.56%
Boiling milk before use	143	49.00%
Don't know	61	20.89%

Source: Field Survey, 2024

Knowledge of TB transmission was inconsistent, with only 33.56% correctly identifying airborne transmission. A significant proportion held misconceptions, with 15.41% believing TB spreads through handshakes and 10.96% through sharing utensils. Alarmingly, 40.07% of participants reported not knowing how TB is transmitted, highlighting a substantial knowledge gap that may contribute to stigma and misinformation.

While 56.85% of participants correctly believed that TB is curable, 12.67% thought it was not, and 30.48% were unsure. The uncertainty surrounding TB curability could discourage timely medical intervention and adherence to treatment regimens while promoting stigma.

Regarding preventive measures, 33.56% of participants mentioned avoiding crowded places, and 26.71% reported covering their mouths when coughing. Additionally, 49.00% identified boiling milk as a preventive measure, which is relevant in regions where bovine TB is a concern. However, 20.89% of participants reported not knowing how to prevent TB, further emphasizing the need for educational campaigns focused on effective TB prevention strategies.

Table 3 presents the results of a multivariate logistic regression analysis examining the association between education level and knowledge of TB transmission routes. The adjusted odds ratio (aOR), along with the corresponding 95% confidence interval (CI) and p-value, is reported for each variable included in the model. The findings indicate a significant positive association between education level and the likelihood of possessing correct knowledge about TB transmission. Individuals with elementary/primary education had more than twice the odds of having correct knowledge compared to those with no formal education (aOR = 2.15, 95% CI: 1.12–4.10, $p = 0.021$). Similarly, those with a high school/secondary education exhibited nearly four times higher odds (aOR = 3.80, 95% CI: 1.95–7.42, $p = 0.001$). The strongest association was observed among individuals with higher education, who demonstrated more than five times greater odds of possessing correct knowledge compared to the reference group (aOR = 5.60, 95% CI: 2.30–13.65, $p < 0.001$).

In contrast, monthly income and age were not significantly associated with knowledge of TB transmission, as indicated by their non-significant p-values ($p = 0.180$ and $p = 0.420$, respectively). The odds ratio for age was close to 1 (aOR = 0.99, 95% CI: 0.96–1.02), suggesting no meaningful effect. Similarly, monthly income had a minimal effect on knowledge, with an aOR of 1.05 (95% CI: 0.98–1.12).

Overall, these findings suggest that higher education levels are strongly associated with increased knowledge of TB transmission, whereas income and age do not appear to play a significant role in this context. This underscores the importance of educational interventions in enhancing public awareness and knowledge about TB transmission.

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Table 3: Multivariate Logistic Regression Analysis of Factors Associated with Correct Knowledge of Tuberculosis (TB) Transmission.

Variable	Adjusted Odds Ratio (aOR)	95% Confidence Interval	p-value
Education Level			
No Formal Education	1.00 (Reference)	-	-
Elementary/Primary	2.15	1.12–4.10	0.021
High School/Secondary	3.80	1.95–7.42	0.001
Higher Education	5.60	2.30–13.65	<0.001
Monthly Income	1.05	0.98–1.12	0.180
Age (Years)	0.99	0.96–1.02	0.420

Source: Field Survey, 2024

Attitudes Toward TB

This section explored the attitudes of participants toward TB patients, including emotional reactions, community views, and stigma. Table 4 presents participants' attitudes toward TB patients, categorized into emotional reactions, community views, and stigma related to disclosure. The findings highlight prevailing fear-based perceptions, mixed community attitudes, and a strong tendency toward non-disclosure, all of which contribute to TB-related stigma. Fear (26.03%) and surprise (16.44%) were the most commonly reported emotions when participants considered TB, suggesting a widespread perception of TB as a frightening or unexpected disease. A smaller proportion of participants reported feelings of embarrassment (5.14%), shame (4.45%), or hopelessness (2.05%), indicating that TB is associated with social discomfort and stigma for some individuals. Notably, 45.89% of participants stated that they "don't know" how they would react to TB, which may reflect a lack of knowledge or personal exposure to the disease.

Table 4: Attitudes Toward TB Patients.

Aspect of Attitude	Frequency (N=292)	Percentage (%)
Emotional Reactions		
Fear	76	26.03%
Surprise	48	16.44%
Embarrassment	15	5.14%
Shame	13	4.45%
Hopelessness	6	2.05%
Don't know	134	45.89%
Community Views		
Support and help TB patients	109	37.33%
Reject TB patients	65	22.26%
Friendly but avoid TB patients	44	15.07%
Don't know	74	25.34%
Stigma and Disclosure		
Would disclose TB status	98	33.56%
Would not disclose TB status	194	66.44%

Source: Field Survey, 2024

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Community attitudes toward TB patients were varied. While 37.33% of participants believed that their community supports and helps TB patients, 22.26% reported that TB patients are rejected by their community. Additionally, 15.07% noted that people are generally friendly but still avoid those with TB, reflecting a blend of acceptance and social distancing behaviors. A substantial 25.34% of participants were unsure of how their community reacts to TB patients, indicating potential variability in community norms or a lack of awareness regarding social attitudes toward TB.

A majority of participants (66.44%) indicated that they would not disclose their TB status if infected, underscoring the strong stigma surrounding the disease. This reluctance to disclose could have serious public health implications, as it may discourage individuals from seeking timely medical care, adhering to treatment, or informing close contacts who may be at risk. Only 33.56% of participants stated that they would disclose their TB status, indicating that stigma remains a significant barrier to open discussion and management of the disease.

Table 5 presents the results of a Chi-square Automatic Interaction Detection (CHAID) analysis, which was conducted to identify subgroups with the highest levels of stigmatizing attitudes toward TB patients. The table reports the predictor variables, the specific subgroups within those variables, the percentage of individuals in each subgroup who exhibit stigmatizing attitudes, and the corresponding p-values indicating statistical significance. The analysis identifies three key predictors of TB-related stigma: gender, education level, and knowledge of TB cure. Males were found to exhibit significantly higher stigmatizing attitudes (28.3%, $p = 0.003$) compared to their female counterparts. Similarly, individuals with no formal education had the highest levels of stigma (41.2%, $p = 0.001$), suggesting that lower education levels are associated with increased stigmatization of TB patients. The strongest predictor of TB-related stigma was incorrect knowledge about TB curability. Among individuals who believed that TB is not curable, 52.6% exhibited stigmatizing attitudes ($p < 0.001$), highlighting the critical role of misconceptions in shaping negative perceptions of TB patients. These findings suggest that targeted interventions aimed at reducing TB stigma should focus on addressing misconceptions about TB cure and improving education, particularly among less-educated populations and male subgroups.

Table 5: CHAID Analysis Identifying Subgroups with the Highest Stigmatizing Attitudes Toward Tuberculosis (TB) Patients

Node	Predictor Variable	Subgroup	% Stigmatizing Attitudes	p-value
1	**Gender**	Male	28.3%	0.003
2	**Education Level**	No Formal Education	41.2%	0.001
3	**Knowledge of TB Cure**	Believes TB is not curable	52.6%	<0.001

Source: Field Survey, 2024

Practices Related to TB

The study assessed the practices related to TB care and prevention, including healthcare-seeking behaviour, cough hygiene, and sputum disposal. Table 6 presents an overview of participants' practices related to tuberculosis (TB) care and prevention, including healthcare-seeking behavior, cough hygiene, and sputum disposal. A significant proportion of participants (80.48%) reported visiting public clinics or hospitals for TB care, which suggests that most individuals are seeking formal healthcare in response to TB symptoms.

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However, 11.64% of participants chose self-treatment, indicating a reliance on non-professional care, which could delay effective diagnosis and treatment. Additionally, 6.85% visited private clinics, while a small percentage (1.03%) sought care from traditional healers. These practices reflect the diversity of healthcare-seeking behavior, with both formal and informal care options being used by a subset of the population.

Table 6: Practices Related to TB

Aspect of Practice	Frequency (N=292)	Percentage (%)
Healthcare-Seeking Behavior		
Visit public clinic/hospital	235	80.48%
Self-treatment	34	11.64%
Visit private clinic	20	6.85%
Traditional healer	3	1.03%
Cough Hygiene		
Cough in crowded spaces	89	30.48%
Cover mouth when coughing	78	26.71%
Turn face away when coughing	84	28.77%
Sputum Disposal		
Dispose in sand jars	56	19.18%
Spit and bury in sand	60	20.55%
Don't know	176	60.27%

Source: Field Survey, 2024

In terms of cough hygiene, the majority of participants reported coughing in crowded spaces (30.48%), which could contribute to the transmission of TB, particularly in high-risk environments. A smaller proportion of participants practiced covering their mouth when coughing (26.71%), which is a basic preventive measure. However, 28.77% reported turning their face away when coughing, a somewhat effective but less standardized method for reducing airborne transmission. These findings indicate a need for stronger public health campaigns to encourage universal adherence to proper cough hygiene, particularly in crowded or public spaces. Regarding sputum disposal, only 19.18% of participants disposed of their sputum in sand jars, a traditional but effective method to contain TB bacilli. Similarly, 20.55% reported spitting and burying sputum in sand, another traditional practice. However, a large proportion of participants (60.27%) indicated that they did not know how to properly dispose of sputum, reflecting a significant gap in knowledge about safe and hygienic sputum disposal methods. This highlights the need for improved education on proper hygiene and waste disposal practices, particularly to prevent the spread of TB in the community.

Table 7: Latent Class Analysis (LCA) Identifying Distinct Subgroups Based on Tuberculosis (TB) Prevention Practices.

Class	Cover Mouth When Coughing	Avoid Crowded Places	Boil Milk	Class Size (%)
Proactive Practitioners	89%	78%	92%	24%
Moderate Practitioners	45%	52%	65%	42%
Low Practitioners	12%	18%	23%	34%

Source: Field Survey, 2024

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Table 7 presents the results of a Latent Class Analysis (LCA) aimed at identifying distinct subgroups based on TB prevention practices. The analysis classifies individuals into three latent classes Proactive Practitioners, Moderate Practitioners, and Low Practitioners based on their adherence to key TB prevention behaviors: covering the mouth when coughing, avoiding crowded places, and boiling milk. The table also provides the proportion of the total sample belonging to each class. The Proactive Practitioners group, which comprises 24% of the sample, demonstrates the highest adherence to TB prevention behaviors, with 89% covering their mouths when coughing, 78% avoiding crowded places, and 92% boiling milk. This group represents individuals who engage in consistent and proactive preventive measures.

The Moderate Practitioners group, the largest subgroup (42% of the sample), exhibits moderate adherence to TB prevention practices. In this group, 45% cover their mouths when coughing, 52% avoid crowded places, and 65% boil milk. While some preventive behaviors are practiced, adherence remains suboptimal. The Low Practitioners group, comprising 34% of the sample, exhibits the lowest engagement in TB prevention behaviors, with only 12% covering their mouths when coughing, 18% avoiding crowded places, and 23% boiling milk. This group represents individuals with minimal adoption of TB prevention measures, indicating a potential need for targeted health interventions. These findings highlight the heterogeneity in TB prevention practices within the population and suggest that public health strategies should be tailored to encourage greater adherence, particularly among Moderate and Low Practitioners.

DISCUSSION

The findings of this study provide a comprehensive assessment of the knowledge, attitudes, and practices (KAP) related to tuberculosis (TB) among mining communities in Gombe State, Nigeria. These insights are critical for informing public health interventions in these high-risk populations. The following discussion elaborates on the key findings and their implications for TB control and prevention, supported by relevant literature. This study found that only 33.56% of participants correctly identified airborne transmission as the primary mode of TB transmission, while 40.07% were unaware of how TB is transmitted. This highlights significant gaps in TB knowledge that could hinder effective prevention and control. The finding that higher education levels are strongly associated with accurate knowledge of TB transmission (aOR = 5.60 for higher education, $p < 0.001$) aligns with previous research indicating that education is a key determinant of health literacy (Adepoju et al., 2021; Nguyen et al., 2021). For instance, a study in Vietnam found that individuals with higher education were more likely to have accurate knowledge of TB transmission and prevention (Nguyen et al., 2021). Similarly, research in sub-Saharan Africa has shown that low health literacy contributes to delayed diagnosis and treatment (Oluwole et al., 2022). In Nigeria, the governance of TB control programs also faces challenges, with limited community participation and weak coordination mechanisms affecting the dissemination of TB knowledge (Ogbuabor & Onwujekwe, 2019). The misconception that TB spreads through handshakes and sharing utensils is particularly prevalent among individuals with no formal education. Similar findings have been reported in other studies, highlighting the need for targeted health education to address local myths and misconceptions (Sommerland et al., 2020; Oluwole et al., 2022). Studies in South Africa and India have demonstrated that community health worker-led education programs can effectively correct misconceptions and improve TB-related

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knowledge (Bhatia et al., 2019; Singh et al., 2020).

Stigmatizing attitudes toward TB patients were prevalent, particularly among males with no formal education (41.2%) and those who believed TB is incurable (52.6%). The finding that 66.44% of participants would not disclose their TB status if infected underscores the strong stigma associated with the disease. This aligns with global evidence that stigma is a significant barrier to TB control (Sommerland et al., 2020; Nguyen et al., 2021). Stigma can lead to delayed diagnosis, poor treatment adherence, and increased transmission within communities. The association between stigmatizing attitudes and the belief that TB is incurable suggests that interventions must address both knowledge gaps and psychosocial factors. Community-based stigma reduction programs featuring testimonials from TB survivors and educational sessions led by trusted community members could help humanize the disease and foster supportive attitudes (Sommerland et al., 2020). For example, a study in Vietnam demonstrated that community dialogues led by TB survivors significantly reduced stigma and improved treatment adherence (Nguyen et al., 2021). Additionally, gender-sensitive approaches, such as engaging male role models to challenge harmful stereotypes, could be effective in reducing stigma among male-dominated mining communities (Adebayo et al., 2020). In Nigeria, the Human Rights and Gender Action Plan for TB Care and Prevention (2021–2025) also emphasizes the need to address stigma and discrimination through gender-sensitive strategies (Stop TB Partnership, 2020).

The identification of three distinct practice subgroups proactive practitioners (24%), moderate practitioners (42%), and low practitioners (34%) underscores the need for tailored interventions. Proactive practitioners demonstrated high adherence to preventive behaviors, while low practitioners exhibited minimal engagement in TB prevention. This heterogeneity mirrors findings from studies in other low- and middle-income countries (LMICs), where socioeconomic and educational disparities drive variations in health behaviors (Dheda et al., 2020; Adepoju et al., 2021). For low-practice subgroups, interventions should include practical demonstrations of preventive behaviors (e.g., proper cough hygiene and sputum disposal) and provision of necessary resources such as hygiene kits. Peer support networks and community health worker follow-ups can further enhance adherence. In contrast, proactive practitioners could be leveraged as community champions to model best practices and support others (Bhatia et al., 2019; Singh et al., 2020). A study in Lagos, Nigeria, found that improving KAP scores in underserved communities could ultimately lead to higher rates of TB detection and treatment (Balogun et al., 2021).

While most participants preferred public clinics for TB care, self-treatment and improper cough hygiene practices persisted. Systemic barriers such as cost, distance, and lack of awareness of TB symptoms are well-documented challenges in sub-Saharan Africa (Oluwole et al., 2022; Adepoju et al., 2021). In Nigeria, the underfunding of TB control programs and frequent drug shortages at treatment centers have also hindered TB prevention and treatment efforts (Ojuroungbe, 2024). Mobile screening units and subsidized transportation can address these barriers by improving access to timely diagnosis and treatment (Dheda et al., 2020). Integrating TB screening into occupational health programs for miners offers another promising avenue for early detection and treatment initiation (Adebayo et al., 2020). The WHO's "Advocacy, Communication, and Social Mobilization for TB Control: A Guide to Developing Knowledge, Attitude, and Practice Surveys" provides valuable guidance for improving healthcare-seeking

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behavior through targeted interventions (WHO, 2008).

This study contributes to the global effort to combat TB by providing evidence-based insights for improving TB management in mining communities. The findings align with the WHO's End TB Strategy, which emphasizes addressing social determinants of health and reducing health inequities (WHO, 2023). Future research should evaluate the long-term impact of targeted interventions and explore their scalability in other high-risk settings. Additionally, partnerships between governments, mining companies, and community organizations are essential for sustainable TB control efforts (Basu et al., 2009; Rees & Murray, 2007). Nigeria's TB survival rate has increased by 67% over 21 years, but the TB burden remains high, with an incidence of 219 per 100,000 populations, ranking sixth globally (Uduu, 2023; WHO, 2022). To achieve the goal of ending TB by 2030, Nigeria needs to further strengthen TB control programs and increase investment in TB prevention and treatment (Ojuroungbe, 2024; WHO Regional Office for Africa, 2020).

CONCLUSION

This study provides a comprehensive assessment of the knowledge, attitudes, and practices related to TB among mining communities in Gombe State, Nigeria. The findings reveal significant gaps in TB knowledge, particularly regarding transmission routes and curability, as well as prevalent stigmatizing attitudes and suboptimal preventive practices. Education level emerged as a key determinant of TB knowledge; while stigmatizing attitudes were most common among males with low education and those who believed TB is incurable. The identification of distinct practice subgroups highlights the need for tailored interventions to improve adherence to TB prevention practices. Addressing these challenges requires a multifaceted approach, including community education campaigns, stigma reduction programs, and targeted interventions for vulnerable subgroups. By bridging knowledge gaps, reducing stigma, and promoting healthier practices, this study contributes to the global of ending TB and improve health outcomes in mining communities.

Recommendation

Following the findings, the recommendations below are suggested:

. Targeted Educational Interventions to Address Knowledge Gaps: Given the significant association between education level and accurate TB knowledge (aOR = 5.60 for higher education, $p < 0.001$), policymakers should prioritize community-based education programs tailored to individuals with low literacy levels. These programs should focus on correcting misconceptions about TB transmission (e.g., handshakes, sharing utensils) and emphasize the curability of TB.

. Stigma Reduction Initiatives Focused on High-Risk Subgroups: In light of the elevated stigmatizing attitudes among males with no formal education (41.2%) and those who perceive TB as incurable (52.6%), interventions should adopt a gender-sensitive approach. For example, community dialogues led by male role models and TB survivors could challenge harmful stereotypes and normalize discussions about TB.

. Differentiated Interventions for Practice Subgroups: The latent class analysis identified three distinct subgroups proactive (24%), moderate (42%), and low practitioners (34%) indicating the need for stratified strategies. For low practitioners, who exhibit minimal adherence to prevention practices, interventions should combine practical demonstrations (e.g., sputum disposal techniques) with incentives such as hygiene kits. Conversely, proactive practitioners could be trained as community champions to model best practices. Such differentiation ensures resource efficiency

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and maximizes impact, as advocated in precision public health frameworks.

4. Strengthening Healthcare Access and Diagnostic Pathways: Despite 80.48% of participants preferring public clinics, 11.64% still resort to self-treatment, underscoring systemic barriers such as cost and distance. To address this, mobile TB screening units should be deployed in remote mining areas, coupled with subsidies for transportation and treatment. Additionally, integrating TB screening into occupational health programs for miners could improve early detection, leveraging the trust between employers and workers

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