Bima Journal of Science and Technology, Vol. 9(1A) Mar, 2025 ISSN: 2536-6041

DOI: 10.56892/bima.v9i1A.1252

Appraisal of the Prevalence of Tuberculosis and Associated Risk Factors Among Patients Attending Healthcare Facilities in Bauchi North, Bauchi State, Nigeria

Zinat Mahmud[1], Auwal Magaji[1]* and Fatima Magaji Ibrahim[2]

[1]Department of Microbiology, Sa'adu Zungur University Gadau, Bauchi State, Nigeria
[2]Department of Health Education, Aminu Saleh College of Education, Azare, Bauchi State Nigeria

Corresponding Author: auwalmagajiaza@gmail.com

ABSTRACT

Tuberculosis (TB) is a highly contagious airborne disease caused by *Mycobacterium tuberculosis*, transmitted through inhalation of infected droplets. It is more prevalent among individuals with compromised immune systems. Efforts to detect and treat TB cases remained insufficient in Bauchi North. This study assessed the prevalence and risk factors of TB among patients attending healthcare facilities in Bauchi north. A total of 230 sputum samples were collected from patients exhibiting clinical signs and symptoms of TB and analyzed using the Ziehl-Neelsen (ZN) staining method. A smear of the specimen was prepared on a clean glass slide. The slide was flooded with carbol fuchsin solution, heated for about 5 minutes and allowed to cool for 2 minutes. The slide was then rinsed, flooded with acid-alcohol and kept for 2 minutes, and rinsed with water. The slide was then flooded with methylene blue for 2 minutes. The slide was then rinsed, air-dried, and examined under the oil immersion objective 100x magnification. In addition, structured questionnaires were administered to gather demographic and risk factor data. The study found an overall TB hospital based prevalence of 49.17%. Gender-based prevalence was slightly higher among females (26.67%) than males (22.50%). Age-wise, the lowest prevalence was observed among children aged 0–9 years (0.83%), while adults aged 25–64 years had the highest prevalence (25.42%). Socioeconomic and behavioral factors significantly influenced TB prevalence. Patients from low-income groups had higher prevalence (37.92%), compared to others. Contact with infected individuals (41.25%) and residence in rural areas (41.25%) were associated with higher prevalence rates. The study concluded that age, socioeconomic status, residence, and contact with infected individuals are significant risk factors for TB. These findings emphasize the need for targeted interventions, especially in vulnerable populations, to curb TB transmission in Northern Bauchi State, Nigeria.

Keywords: Appraisal, Prevalence, Tuberculosis, Healthcare, Bauchi-North

INTRODUCTION

Tuberculosis (TB) is an air borne infectious disease caused by *Mycobacterium tuberculosis,* which is transmitted through inhalation of droplets from a person with an active TB infection (WHO, 2020), and more common in people with weakened immune system including HIV/AIDs patients or those on drugs that suppress the immune system such as cancer patients organ transplant recipients, and patients with auto immune diseases (WHO, 2020). Tuberculosis (TB) has been considered as a persistent global health challenge, causing millions of deaths annually. TB ranks as the ninth leading cause of death worldwide, claiming nearly three lives every minute, and it remains the top killer among diseases caused by a single infectious agent (Uduu, 2024). Although, significant efforts and notable progress were made in combating the TB epidemic, it continues to be the most fatal

DOI: 10.56892/bima.v9i1A.1252

infectious disease, affecting people across all age groups each year (Adane *et al*., 2020). In 2019, regardless of the improvements in case detection and treatment adherence, which reduced TB mortality by 3% and the incidence rate by 2%, the WHO reported that 9.6 million people contracted TB, and 1.2 million succumbed to the disease (WHO, 2020; Uduu, 2024).

As of 2024, tuberculosis (TB) remains a major global health challenge. According to the World Health Organization (WHO), an estimated 10.8 million new TB cases were recorded worldwide, with an incidence rate of 134 cases per 100,000 populations. Despite global efforts to control the disease, TB continues to be the leading cause of death from a single infectious agent (WHO, 2024). In Nigeria, TB poses a substantial public health burden. Akinyemi *et al*., (2024) reported that Nigeria is classified as a high TB burden country, with approximately 460,000 new cases annually. The prevalence rate stands at 616 cases per 100,000 population, indicating a significant impact on the health system. Focusing on Northern Nigeria, regional studies have highlighted variations in TB prevalence. Musa *et al*., (2024) conducted a study in Gusau, Northern Nigeria, and reported a TB prevalence rate of 76.32%. The high rate was linked to socio-demographic factors such as limited education and low socio-economic status.

The WHO's End TB strategy focuses on evaluating the TB epidemic and advancing efforts in diagnosis, treatment, and prevention. This approach includes ambitious targets for 2030, such as achieving 90% TB case detection and treatment rates, particularly among high-risk populations, along with a 90% cure rate for diagnosed cases (WHO, 2024). TB transmission is largely driven by environmental and personal risk factors. Social and behavioral factors such as smoking, alcohol consumption, khat chewing, and indoor air pollution are significant contributors (Olalere *et al*., 2022). Individuals with chronic illnesses like diabetes, cancer, and HIV, which weaken the immune system, those in close contact with active pulmonary tuberculosis (PTB) patients, intravenous drug users, recipients of immunosuppressive therapies, and healthcare workers are at heightened risk of contracting TB (Olalere *et al*., 2022).

To enhance control measures, it is crucial to reassess patient characteristics and identify contributing risk factors. Efforts to detect and treat TB cases are insufficient in Bauchi North, necessitating updated information on associated risks to establish health priorities, allocate resources effectively, and monitor the emergence of drug resistance for better anti-TB drug management. This study aims to provide current insights into the prevalence and associated factors contributing to TB development, and to support health programmers in prioritizing interventions in Bauchi North, Bauchi State Nigeria.

MATERIALS AND METHODS

Study Design and Population

Cross-sectional study was conducted on patients of all ages and sexes, attending health care facilities in Azare metropolis with clinical signs and symptoms of tuberculosis. All patients with no signs and symptoms of tuberculosis, and those who did not agreed to participate in the study were excluded.

Sample Size Determination

The sample size was calculated using the formula:

$$n = \frac{(Z\,\alpha/2)^2 \,X\, P(1-P)}{d^2}$$

Where:

n = sample size

DOI: 10.56892/bima.v9i1A.1252

P = prevalence reported to be 19.14% in the Northern Nigeria by Olalere *et al*., (2022)

d = margin of error (5% will be taken for this study)

$Z\alpha/2$ = critical value (1.96 for 95% confidence level)

Therefore, approximately 230 patients with signs and symptoms of tuberculosis infections, attending health care facilities in Bauchi North were enrolled in the study.

Data Collection

A total of 230 sputum samples were collected from patients attending Extreme Hospital Azare, Bauchi North, Bauchi State, Nigeria. These patients presented with clinical signs and symptoms consistent with tuberculosis (TB). The collected samples were properly labeled and transported under appropriate conditions to the laboratory for microbiological examination. In addition, structured questionnaires were administered to obtain demographic information and assess potential risk factors associated with TB infection. Informed consent was sought from all participants before sample collection and questionnaire administration, in accordance with established research ethics guidelines (Olalere *et al*., 2022).

Detection of the TB pathogen

Ziehl-Neelsen (ZN) method was used to detect the presence of *Mycobacterium tuberculosis* in clinical specimens. A smear of the specimen was prepared on a clean glass slide. The smear was air-dried and fixed by passing it 2–3 times through the flame of a Bunsen burner. The slide was then flooded with carbol fuchsin solution, ensuring the smear is completely covered. This was then heated for about 5 minutes. The slide was then allowed to cool for 1–2 minutes. The slide was then rinsed with tap water to remove excess stain. The slide was then flooded with acid-alcohol and kept for 2–3 minutes. This was then rinsed with tap water. The slide was then flooded with methylene blue for 1–2 minutes. The slide was then gently rinsed with tap water and air-dried. The slide was then examined under the oil immersion objective 100x magnification. Bright red bacilli visible on the smear indicated the presence of *Mycobacterium tuberculosis* (Leboffe and Pierce, 2019).

RESULTS

The current study revealed that, the overall hospital based prevalence of tuberculosis among the patients in Northern Bauchi State Nigeria was 49.17%. On the gender basis the study recorded the prevalence of 26.67% and 22.50% among females and males respectively. Similarly, the study showed that, the lower prevalence of 0.84% was recorded among children aged 0-9years, while, the highest prevalence of 25.42% was seen among adults aged 25-64 years. Also, the prevalence of 6.25%, 7.08% and 9.58% were noticed among adolescents (10-19 years), young adults (20-24years) and elderly (65 years and above) patients respectively (Figure 1).

The study found that, socioeconomic status was significantly associated with tuberculosis (TB) prevalence ($p < 0.05$). Patients from low-income families had the highest prevalence of 37.92%, compared to 5.83% among middle-income individuals and 5.42% among those from high-income families ($\chi^2 = 82.38$, $p = 0.00$).

Contact with infected individuals also showed a significant association with TB prevalence ($p < 0.05$). The prevalence was markedly higher (41.25%) among those who had contact with TB-infected persons, compared to 7.92% among those without such contact ($\chi^2 = 123.20$, $p = 0.00$).

Bima Journal of Science and Technology, Vol. 9(1A) Mar, 2025 ISSN: 2536-6041

DOI: 10.56892/bima.v9i1A.1252

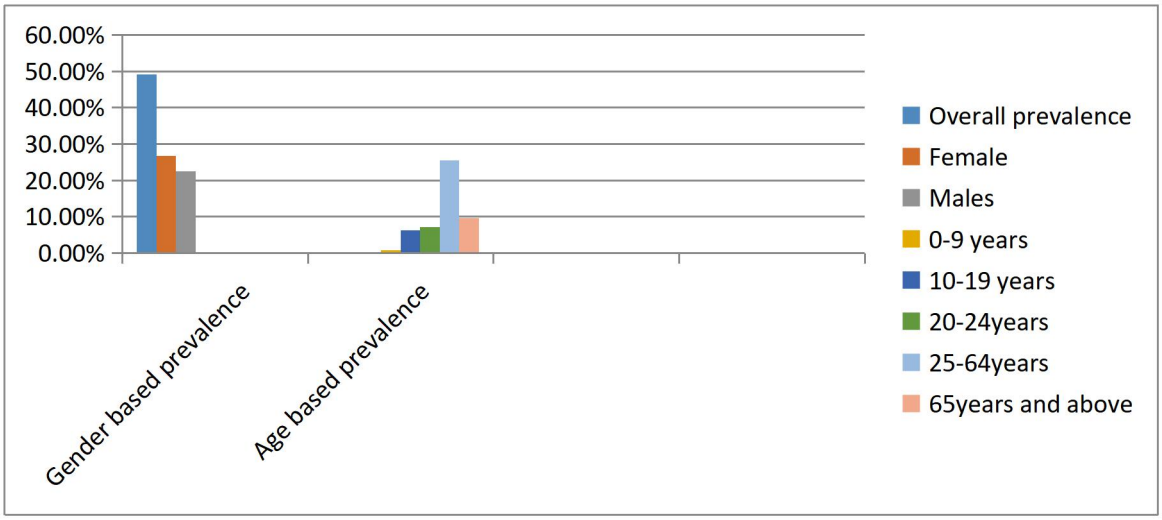

Figure 1: Prevalence of TB in relation to gender and age of the patients.

Smoking status did not show a statistically significant association with TB prevalence ($p > 0.05$). The prevalence among smokers was 1.25%, while non-smokers had a prevalence of 47.92% ($\chi^2 = 2.63$, $p = 0.11$).

Similarly, organ transplant status was not significantly associated with TB prevalence ($p > 0.05$). The prevalence among transplant recipients was 1.25%, whereas non-transplanted individuals had a prevalence of 47.92% ($\chi^2 = 0.16$, $p = 0.69$).

Diabetes status showed no significant association with TB prevalence ($p > 0.05$). The prevalence among diabetic patients was 7.50%, while non-diabetic individuals had a prevalence of 41.67% ($\chi^2 = 3.06$, $p = 0.08$).

In contrast, HIV status was not significantly associated with TB prevalence ($p > 0.05$). The prevalence among HIV-positive individuals was 42.50%, compared to 6.67% among HIV-negative individuals ($\chi^2 = 0.85$, $p = 0.36$).

Finally, residence was significantly associated with TB prevalence ($p < 0.05$). Patients residing in rural areas had a much higher prevalence (41.25%) than those from urban areas (7.92%) ($\chi^2 = 132.09$, $p = 0.00$) (Table 1).

Table 1: Prevalence of tuberculosis in relation to the risk factors of the infection.

Variables	Positive	Prevalence (%)	χ^2	*p-value*
Socioeconomic status:				
Low class	91	37.92	82.38	0.00*
Middle class	14	5.83		
High class	13	5.42		
Contac with infected person:				
Contacted	99	41.25	123.20	0.00*
Not contacted	19	7.92		
Smoking cigarette:				
Smoker	3	1.25	2.63	0.11
Non-smoker	115	47.92		
Organ transplant:				
Transplanted	3	1.25	0.16	0.69
Not transplanted	115	47.92		
Diabetes status:				
Positive	18	7.50	3.06	0.08

DOI: 10.56892/bima.v9i1A.1252

Negative	100	41.67		
HIV status				
Positive	102	42.50	0.85	0.36
Negative	16	6.67		
Residence:				
Urban	19	7.92	132.09	0.00*
Rural	99	41.25		

X^2: Chi square value, "*": significant at 0.05 level of significance

The results for the bivariate and multivariate logistics regression analyses revealed that, the crude odds ratio (COR) and confidence interval (CI) for the males were [COR(CI 95%): 1.225 (0.738-2.034)]. For the age, [COR(CI 95%): 23.00 (2.475-213.702)] were recorded among patients aged 0-9years, [COR(CI 95%): 3.067 (1.053-8.934)] were seen among patients aged 10-19years, [COR(CI 95%): 2.368 (0.811-6.911)] were noticed among patients of 20-24years of age, and [COR(CI 95%): 3.629(1.518-8.678)] were recorded among patients aged 25-64years. Furthermore, the study indicated that, the crude odds ratio of [COR(CI 95%): 0.093(0.042-0.207)] and [COR(CI 95%):1.639(0.683-3.933)] were recorded among low-income and middle-income patients respectively. Also, the result revealed [COR(CI 95%): 0.027(0.013-0.056)] among those who had contact with TB infected individuals. Among smokers, [COR(CI 95%):3.470 (0.706-17.058)] were noticed. For the patients who undergone organ transplant, [COR(CI 95%): 1.437(0.236-8.761)] were recorded. Similarly, [COR(CI 95%): 0.487(0.215-1.104)] and [COR(CI 95%): 1.400(0.683-2.868)] were noticed among diabetic and HIV patients respectively. For those from urban areas, the study revealed [COR(CI 95%): 46.538(21.693-99.842)] (Table 2).

On the other hand, the adjusted odds ratios (AOR) and confidence interval (CI) were computed on age, socioeconomic status, contact history and residence of the patients, where [AOR(CI 95%): 4.146(0.070-243.950)] were seen among patients aged 0-9years, [AOR(CI 95%): 0.640(0.112-3.639)] among those aged 10-19years of old, [AOR(CI 95%): 0.365(0.047-2.823)] among those aged 20-24 years, and [AOR(CI 95%): 0.350(0.069-1.769)] among adults aged 25-64 years of age. Also, among low and middle income patients, [AOR(CI 95%): 1.379(0.324-5.867)] and [AOR(CI 95%): 4.060(1.096-15.045)] were respectively recorded. Furthermore, [AOR(CI 95%):0.047(0.013-0.168)] were noticed among patients who had contact with an infected individual. Lastly, [AOR(CI 95%):42.681(14.140-128.835)] were recorded among patients from urban areas (Table 2).

Table 2: Bivariate and multivariate logistics regression analyses for the risk factors associated with tuberculosis.

Variables	Frequencies			COR (95% CI)	AOR (95% CI)
	Positive (%)	Negative (%)	Total (%)		
Sex:					
Male	54(22.50)	62(25.83)	116(48.33)	1.225 (0.738-2.034)	
Female	64(26.67)	60(25.00)	124(51.67)	1	
Age:					
Children (0-9 years)	2(0.83)	8(3.33)	10(4.17)	23.00 (2.475-213.702)*	4.146(0.070-243.950)
Adolescents (10-19 years)	15(6.25)	16(6.67)	31(12.92)	3.067 (1.053-8.934)*	0.640(0.112-3.639)

DOI: 10.56892/bima.v9i1A.1252

Young adults (20-24years)	17(7.08)	14(5.83)	31(12.92)	2.368 (0.811-6.911)	0.365(0.047-2.823)
Adults (25-64years)	61(25.42)	76(31.67)	137(57.08)	3.629(1.518-8.678)*	0.350(0.069-1.769)
Elderly (65years and above)	23(9.58)	8(3.33)	31(12.92)	1	
Socioeconomic status:					
Low class	91(37.92)	24(10.00)	115(47.92)	0.093(0.042-0.207)*	1.379(0.324-5.867)
Middle class	14(5.83)	64(26.67)	78(32.50)	1.639(0.683-3.933)	4.060(1.096-15.045)*
High class	13(5.42)	34(14.17)	47(19.58)	1	1
Contac with infected person:					
Yes	99(41.25)	16(6.67)	115(47.92)	0.027(0.013-0.056)*	0.047(0.013-0.168)*
No	19(7.92)	106(44.17)	125(52.08)	1	1
Smoking:					
Yes	3(1.25)	7(2.92)	10(4.12)	3.470 (0.706-17.058)	
No	115(47.92)	115(47.92)	230(95.83)	1	
Organ transplant:					
Yes	3(1.25)	3(1.25)	6(2.50)	1.437(0.236-8.761)	
No	115(47.92)	119(49.58)	134(55.83)	1	
Diabetes status:					
Positive	18(7.50)	9(3.75)	27(11.25)	0.487(0. 215-1.104)	
Negative	100(41.67)	113(47.08)	213(88.75)	1	
HIV status					
Positive	102(42.50)	21(8.75)	123(51.25)	1.400(0.683-2.868)	
Negative	16(6.67)	101(42.08)	117(48.75)	1	
Residence:					
Urban	19(7.92)	110(45.83)	129(53.75)	46.538(21.693-99.842)*	42.681(14.140-128.835)*
Rural	99(41.25)	12(5.00)	111(46.25)	1	1

"COR" is crude odds ratio, "AOR" is adjusted odds ratio, "CI" is confidence interval, "*" is significant at $p<0.05$

DISCUSSION

The present study revealed an overall hospital based prevalence of tuberculosis (TB) of 49.17% among suspected cases attending health facilities in Bauchi North, Bauchi State, Nigeria. This prevalence is notably high compared to some studies conducted in other regions, highlighting the public health significance of TB in this area. A prevalence of 26.67% was observed in females, while 22.50% was recorded in males, deviating from the typical trend of higher TB prevalence in males reported in several studies.

Olalere *et al*., (2022), who reported a prevalence of 19.14% in Jigawa State, with males being more affected than females. Similarly, Aliyu *et al*., (2013), reported a prevalence of 23% in Northern Nigeria, further supporting the observation of regional variations in TB prevalence. Internationally, Ghiya *et al*. (2009), reported a comparable prevalence of 49.2% in India, while Cain *et al*., (2007), found a lower prevalence of 38% in Cambodia, and Mihir *et al*. (2011), documented 33% in India, demonstrating the global burden of TB.

The World Health Organization (WHO) in 2019 reported a higher burden of TB among males than females globally. This trend was corroborated by studies from Mekonnen *et al*., (2015), in Ethiopia, Yang *et al*., (2014) in Northeast China, Abdallah *et al*., (2012) in

DOI: 10.56892/bima.v9i1A.1252

Sudan, and Olalere *et al*., (2022) in Jigawa State, which all reported higher prevalence rates in males. The findings in this study, however, suggest a reversal of this trend in Bauchi North, with females showing a slightly higher prevalence. This could be due to various sociocultural or biological factors, including access to healthcare, stigma, or differences in exposure risks (Olalere *et al*., 2022) that require further investigation.

The observed high prevalence in this study may reflect challenges in TB control measures, including delayed diagnosis, inadequate treatment coverage, and socioeconomic factors prevalent in the region. The differences in gender distribution across studies emphasize the need for tailored intervention strategies that consider regional and demographic factors.

The current study also, revealed variations in tuberculosis (TB) prevalence across different age groups, with the highest prevalence of 25.42% observed among adults. This was followed by 9.58% among the elderly, 7.08% among young adults, 6.25% among adolescents, and the lowest prevalence of 0.83% among children. These findings indicate that TB predominantly affects adults in this region, aligning with observations from other studies.

Kolonji *et al*. (2016), reported a prevalence of 15.5% among patients under 30 years and 20.4% among those above 30 years, emphasizing the greater burden of TB in older age groups. Similarly, Telisinghe *et al*., (2014) highlighted that TB predominantly affects adults in South Africa. Similar trend also noted by Kazi *et al*., (2010) in Pakistan and Malawi. Olalere *et al*., (2022) observed a similar age-related distribution of TB in Jigawa State, Nigeria, further supporting the notion that adults bear the highest TB burden across diverse geographical settings.

The higher prevalence among adults in this study could be attributed to increased exposure to risk factors such as occupational hazards, crowded living conditions, and weakened immunity due to comorbidities or lifestyle factors. The relatively lower prevalence among children and adolescents may reflect reduced exposure or the protective effects of Bacillus Calmette-Guérin (BCG) vaccination, although this warrants further investigation.

These findings underscore the importance of targeted TB control strategies focusing on adults and the elderly, who represent the most affected groups. Public health interventions should prioritize early diagnosis, improved treatment adherence, and community education for these high-risk age groups to reduce transmission and mortality rates. Further research is needed to explore the factors contributing to age-related differences in TB prevalence and to design effective age-specific prevention and control measures.

The current study also, highlighted a significant association between socioeconomic and health-related factors and the prevalence of the tuberculosis. The observed high prevalence among patients from low-income families aligns with previous studies by Margolis *et al.,* (2013), Hussain *et al*., (2003) and Rueda *et al*., (2014), who also documented a similar trend. This association may be attributed to limited access to healthcare services, inadequate hygiene, and poor living conditions commonly experienced by individuals from low-income households, which could facilitate the transmission and persistence of infections.

A notable finding in this study is the high prevalence among patients who had contact with infected individuals. This underscores the importance of direct transmission in the spread of the infection, emphasizing the need for targeted interventions to break transmission

DOI: 10.56892/bima.v9i1A.1252

chains, such as public health education on infection prevention and control measures.

Similarly, the study revealed a higher prevalence of the infection among patients from rural areas, corroborating findings by Olalere *et al*., (2022), who also reported a significant burden of infection in rural settings. The disparity between rural and urban prevalence may be attributed to poor healthcare infrastructure, lack of awareness about disease prevention, and proximity to environmental reservoirs conducive to the infection.

Interestingly, the study observed a high prevalence among HIV-positive patients, consistent with the findings of Harris *et al*., (2004), who reported a similar trend for tuberculosis. HIV-induced immunosuppression likely predisposes individuals to opportunistic infections, including the one under investigation, highlighting the need for integrated care for co-infected patients.

On the contrary, the lower prevalence among smokers, diabetic patients, and organ transplant recipients might reflect the negligible numbers of these subgroups in the current study population. It is also possible that smokers and diabetic patients engage in regular medical follow-ups that facilitate early diagnosis and management, thereby reducing the burden of the infection.

The current study identified HIV, rural settings, contact with infected individuals, and socioeconomic status as significant risk factors associated with the prevalence of tuberculosis (TB). These findings reinforce the multifactorial nature of TB transmission and progression, emphasizing the interplay of social, economic, and health-related factors.

The high prevalence of TB among HIV-positive patients observed in this study is consistent with previous findings by Harris *et al*. (2004) and Olalere *et al*. (2022) HIV-induced immunosuppression weakens the body's defense against TB, making co-infection common and more severe. This highlights the critical need for integrated TB and HIV care programs to mitigate the burden of co-infection and improve patient outcomes.

Socioeconomic status was another significant factor associated with TB in this study, corroborating the findings of Margolis *et al.,* (2013), Hussain et al., (2003) and Rueda *et al*., (2014). Poverty limits access to healthcare, adequate nutrition, and proper housing, creating an environment conducive to the development and spread of TB. Additionally, poor hygienic conditions, often linked to low socioeconomic status, may further exacerbate TB transmission risks.

The study also identified rural settings as a key risk factor, consistent with observations by Olalere *et al*., (2022). Limited healthcare infrastructure, poor access to diagnostic and treatment facilities, and a higher prevalence of environmental TB reservoirs in rural areas may contribute to the elevated risk. Strengthening healthcare delivery systems in rural settings and improving accessibility to TB care can play a vital role in reducing TB prevalence.

Furthermore, the high prevalence of TB among individuals with direct contact with infected persons emphasizes the role of close interpersonal interactions in TB transmission. This finding underscores the importance of public health measures, such as active case finding, contact tracing, and education on infection prevention strategies, to reduce the risk of transmission in households and communities.

Interestingly, Harris *et al*., (2004) highlighted poor diet and overcrowding as significant contributors to TB spread, which were not directly assessed in the current study. Future

DOI: 10.56892/bima.v9i1A.1252

research should explore these additional factors to provide a more comprehensive understanding of TB risk determinants in the study region.

Statistically, the study indicated significant associations among the socioeconomic status, contact with infected person and residence of the patients, and the development and spread of tuberculosis.

It was also noticed from the crude odds ratios that, children were 23 times, adolescents and adults each were 3 times, and young adults were 2 times more likely to develop tuberculosis than elderly individuals. Furthermore, the study indicated that, patients from low income families were 11 times more likely to develop tuberculosis than those from high class families. Also, the patients who had contact with an infected person were 38 times more likely to develop the infection than those who were not. The study also showed that, patients from rural areas were 47 times more likely to develop the infection than those from urban areas.

On the other hand, the adjusted odds ratio indicated no significant difference in the likelihood of developing the infection across the different age groups. On the socioeconomic status of the patients, it was noticed that, middle class patients were 4 time more likely to develop the infection than patients from high income families. Also, the patients who had contact with an infected individual were 21 times more likely to develop the infection than those who had not. Similarly, it was noticed that, patients from rural areas were 43 times more likely to develop tuberculosis than those from urban areas.

CONCLUSION

The overall prevalence of tuberculosis (TB) among suspected cases attending health facilities in Bauchi North, Bauchi State, Nigeria was found to be 49.17% and higher (26.67%) among females. Highest prevalence of 25.42% was also observed among adults. Among the risk factors assessed in the study, HIV, socioeconomic status, contact with an infected individual, and residence of the patients were found to be significantly associated with the development and spread of tuberculosis among the studied population. These findings emphasized the need for targeted public health interventions that integrate TB and HIV care, improve living standards, and enhance healthcare access in rural and low-income communities. Such measures will be instrumental in reducing the burden of TB and achieving global TB control goals.

REFERENCES

Abdallah, T.M., Siddig, M.F. & Ali, A.A. (2012), Seroprevalence of HIV Infection among Tuberculosis Patients in Kassala, Eastern Sudan, *Journal of AIDS and HIV Research* 3(8): 161-163.

Akinyemi O. O., Okonkwo, T. M., & Yusuf, I. A. (2024). Statistical overview on tuberculosis in Nigeria: Epidemiological insights and public health implications. *Journal of Communicable Diseases*, 7(1), 45-58.

Aliyu, G., El-Kamary, S.S., Abimiku, A., Ezati N., Mosunmola, I. & Hungerford, L. (2013), Mycobacterial etiology of pulmonary tuberculosis and association with HIV infection and multidrug resistance in Northern Nigeria. *Tuberculosis Research and Treatment;* 650561:1–9.

Cain, K.P., Kanara, N., Laserson, K.F.,Vannarith, C., Sameourn, K., Samnang, K., Qualls, M.L., Wells, D. & Varma, J.K. (2007), The Epidemiology of HIV Associated Tuberculosis in Rural Cambodia.,

DOI: 10.56892/bima.v9i1A.1252

International Journal Tuberculosis and Lung Diseases; 11(9):1008-1013.

Ghiya, R., Naik, E., Casanas, B., Izurieta, R., & Marfatia , Y. (2009) . Clinico - epidemiological profile of HIV/TB coinfected patients in Vadodara, Gujarat. *Indian Journal of Sexually Transmitted Diseases and AIDS*, 30(1): 10–15. doi.org/10.4103/0253-7184.55472

Harris J. B., Siyambango M., Levitan E. B., Maggard K. R., Hatwiinda S., Foster E. M., Chamot E., Kaunda K., Chileshe C., Kruuner A., Henostroza G. & Reid S. E., (2004), Derivation of a tuberculosis screening rule for sub-Saharan African prisons. International Journal of Tuberculosis and Lung Diseases, 18(7):774–780. Doi: 10.5588/ijtld.13.0732

Hussain H., Akhtar S. & Nanan D., (2003), Prevalence of and risk factors associated with Mycobacterium tuberculosis infection in prisoners, North West Frontier Province, Pakistan. *International Journal of Epidemiology,* 32(5):794–799. doi:10.1093/ije/dyg247.

Kazi A. M., Shah A., Jenkins C. A., Shepherd B. E. & Vermund S. H., (2010), Risk factors and prevalence of tuberculosis, human immunodeficiency virus, syphilis, hepatitis B virus, and hepatitis C virus among prisoners in Pakistan. *International Journal of Infectious Disease,*14(3):e60–6. doi:10.1016/j.ijid.2009.11.012.

Kolonji G. M., De Connick G., Ngongo L. O., Nsaka D. K., Kabengele T., Kandolo F. T., Ilunga-Ilunga F., Adelin A. & Giet D., (2016), Prevalence of tuberculosis and associated risk factors in the Central Prison of MbujiMayi, Democratic Republic of Congo, *Tropical Medicine and Health,* 44:30, DOI 10.1186/s41182-016-0030-9

Leboffe M. J. & Pierce B. E., (2019). *Microbiology Laboratory Theory & Application Essentials*. Morton Publishing. p. 179. ISBN 9781640430327.

Margolis B., Al-Darraji H., Wickersham J. A/. Kamarulzaman A. & Altice F. L., (2013), Prevalence of tuberculosis symptoms and latent tuberculous infection among prisoners in northeastern Malaysia. *International Journal of Tuberculosis and Lung Disease*, 17(12):1538–44. doi:10.5588/ijtld.13.0193.

Mekonnen, D., Admassu, A., Mulu, W., Amor, A., Benito, A. & Gelaye, W. (2015). Multidrug and heteroresistant *Mycobacterium tuberculosis* and associated gene mutations in Ethiopia. *International Journal of Infectious Diseases*; 39:34–38.

Mihir, K.B., Trailokya, N.N., Mrinmoy, G. Sarojit, J. & Phalguni, D. (2011). Pulmonary Tuberculosis a m o n g H I V Seropositives Attending a Counseling Center in Kolkata, *Indian Journal of Public Health*; 55: 212-218.

Musa B. M., Abubakar A. U., & Lawal A. R. (2024). Prevalence, clinical characteristics, and treatment outcomes of tuberculosis in Northern Nigeria. *BMC Infectious Diseases*, 24(103), 1-12.

Olalere O. S., Olley M., Clement O. O. & Paul I. H., (2022), Prevalence of M. tuberculosis and Associated Risk Factors Among Suspected Patients in Federal Medical Centre Birnin Kudu, Jigawa State, *Sokoto Journal of Medical Laboratory Science*, 7(2): 20 -

DOI: 10.56892/bima.v9i1A.1252

30. https://dx.doi.org/10.4314/sokjmls.v7i2.3

Rueda Z. V., Arroyave L., Marin D., López L., Keynan Y., Giraldo M. R.,Pulido H. & Arbelaez M. P., (2014), High prevalence and risk factors associated with latent tuberculous infection in two Colombian prisons. *International Journal of Tuberculosis and Lung Disease,* 18(10):1166–71. doi:10.5588/ijtld.14.0179.

Telisinghe L., Fielding K. L., Malden J. L., Hanifa Y., Gavin J., Churchyard A. D. & Grant S. C., (2014), High tuberculosis prevalence in a South African prison: the need for routine tuberculosis screening. *PLoS ONE.,* 9(1):e87262. doi:10.1371/journal.pone.0087262.

Uduu O., (2024), *Nigeria's TB survival rate increases by 67% in 21 years,* Dataphyte; https://www.dataphyte.com/latest-reports/nigerias-tb-survival-rate-increases-by-67-in-21/

WHO (2019). Global Tuberculosis Programme: Global tuberculosis report. Geneva: World Health Organization;10: 1123-1128

WHO, (2024), *Global Tuberculosis Report 2024*, Geneva: World Health Organization.

WHO. (2030), *Nigeria re-commits to eradicating tuberculosis and controlling non communicable diseases*: https://www.afro.who.int/news/nigeria-re-commits-eradicating-tuberculosis-and-controllingnoncommunicable-diseases-2030#:~:text=This%20is%20in%20part%20as,1%25%20to%20alcohol%20use%20disorder

Yang, Y., Zhou, C., Shi, L. & Meng, H. (2014). Prevalence and characterization of drug resistant tuberculosis in a local hospital of Northeast China. *International Journal of Infectious Disease*; 22:83–86.