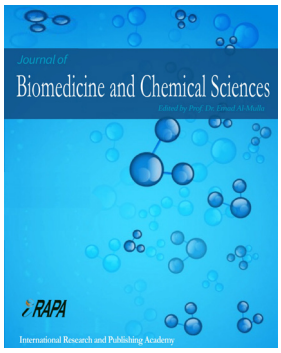
BIOMEDICINE AND CHEMICAL SCIENCES
Vol. 3 No. 4 |October, 2024 | 159-164
ISSN(e): 2790-296X | ISSN(p): 2957-5826
DOI: https://doi.org/10.5281/zenodo.15777259

04-20-BCS-5784-708



Assessing the Prevalence of Latent Tuberculosis Infection in Healthy and Immunocompromised Individuals in Dutsin-Ma Metropolis, Katsina State, Nigeria: A Cross-Sectional Study

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ARTICLE INFO

Article history:

Received on: January 26, 2024
Revised on: September 20, 2024
Accepted on: September 25, 2024
Published on: October 01, 2024

Keywords:

Diabetes mellitus
Dutsin-Ma
Human immunodeficiency virus
Immunocompromised
Latent tuberculosis
Rapid tuberculosis test card

ABSTRACT

Latent Tuberculosis Infection (LTBI) is a widespread condition affecting a significant portion of the global population. People with LTBI have a 5-10% chance of developing active Tuberculosis (TB) during their lifetime. However, there is a shortage of data on the prevalence of LTBI in healthy and immunocompromised individuals in the Dutsin-Ma metropolis. Identifying and treating LTBI is crucial for reducing the burden of TB globally. This cross-sectional study aimed to determine the prevalence of LTBI in healthy and immunocompromised patients in the Dutsin-Ma, Katsina State, Nigeria. 170 blood samples were randomly collected from participants across three (3) healthcare facilities in Dutsin-Ma in September 2023 and screened for anti-TB antibodies using the Rapid Tuberculosis Test Card™ (RTTC); 50 were healthy participants, 65 were pregnant women, 30 were HIV-positive patients, and 25 were diabetic patients. The sociodemographic data were collected and analyzed using descriptive statistics and Chi-square to test for association. Among the 170 participants tested, 12.94 % (22/170) were serologically positive for anti-TB antibodies. Several risk factors associated with LTBI were identified. However, statistically, there was not enough evidence to conclude that any of the risk factors are significantly associated with the prevalence of LTBI at 95% CI and a P-value of ≤ 0.05 in this survey. The study highlights the need for routine screening and treatment of LTBI in both healthy and immunocompromised individuals in the study locality. This is vital in reducing the global burden of LTBI and active TB infections.

INTRODUCTION

Latent Tuberculosis Infection (LTBI) is a condition where the body's immune system responds to *Mycobacterium tuberculosis* (MTB) antigens without any symptoms of active Tuberculosis (TB) infection. It is noteworthy that, not everyone who is infected with LTBI develops active TB disease, some individuals only harbour the bacteria in a dormant state. However, people with LTBI have a 5-10% chance of developing active TB during their lifetime (Bloom & Murray, 1992; World Health Organization, 2024; 2022). LTBI is a widespread condition affecting a significant portion of the global population. According to Vynnycky and Fine (2000), around one-third of the world's population is estimated to be infected with *Mycobacterium tuberculosis* (MTB), the bacteria responsible for TB infection. However, the WHO fact sheet stated that an estimated one-quarter of the world's population has been infected with the MTB bacteria (Chen et al., 2025).

The risk for TB infection is particularly high for immunocompromised individuals with weakened immune systems, such as those living with the Human Immunodeficiency Virus (HIV), malnutrition, pregnancy or other underlying health conditions. In the World Health Organization's Global Report 2022, an estimated 10.6 million people fell ill with tuberculosis (TB) worldwide, including 5.8 million men, 3.5 million women, and 1.3 million children. The

How to Cite:

Mzungu, I., Tyough, V. V., & Alabi, E. D. (2024). Assessing the Prevalence of Latent Tuberculosis Infection in Healthy and Immunocompromised Individuals in Dutsin-Ma Metropolis, Katsina State, Nigeria: A Cross-Sectional Study. *Biomedicine and Chemical Sciences, 3*(4), 159–164. https://doi.org/10.5281/zenodo.15777259

Publisher's Note:

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report emphasized that TB is present in all countries and age groups (Chen et al., 2025). These reports revealed that TB infections have continued to be a significant health problem worldwide, with Nigeria accounting for 8% of the global incident cases in 2016. However, these numbers could be underestimated since only a small portion of TB cases were officially reported in 2015 (Gazette, 2009). In 2019, TB was responsible for the highest number of deaths globally according to the World Health Organization, and in 2020, it was ranked second only to COVID-19 as the leading cause of death from a single infectious agent.

In addition, about 28% of global maternal mortality occurs for reasons other than problems related to childbirth, such as TB infections, which still play a significant role in maternal mortality (Say et al., 2014). Furthermore, the co-infection of TB with diabetes and HIV has been described as one of the most expensive and challenging health issues of our era due to its negative impact on the immune system (Dixon, 2007; Harries et al., 2013). Several reports have suggested that most TB patients reside in low and low-middle-income countries. The incidence of extensively drug-resistant tuberculosis has further raised worries about the spread of drug-resistant TB in regions where tuberculosis and HIV co-infection are common (Raviglione, 2006; Van-Rie & Enarson, 2006). Although, individuals with LTBI do not transmit MTB to others as they are not contagious. However, their hidden infection may progress into active TB disease if their immune system becomes compromised (Migliori et al., 2021). This necessitates the need for routine testing for LTBI to reduce the global burden of LTBI and active TB infections.

Over the years, several methods have been used to diagnose active TB and LTBI, including Tuberculin Skin Test (TST), sputum smears, cultures, and chest x-rays. TST uses purified protein derivative (PPD) and has been used for almost a century to detect LTBI. However, TST has limitations such as reader variability and false-positive outcomes due to cross-reactivity with environmental non-tuberculous *Mycobacterium* and Bacillus Calmette-Guérin (BCG) vaccine. Furthermore, the test procedure is inconvenient for patients who need to return after 48-72 hours to get the test read (Pesanti, 1994; Lyashchenko et al., 2000).

On the other hand, newer tests such as Polymerase chain reaction-DNA amplification (PCR-DNA Amplification) and Interferon Gamma Release Assays (IGRAs) were recently developed. However, these newly developed methods (PCR-DNA Amplification and IGRA) are not cost-effective, require laboratory equipment, skilled personnel, and expertise, and may not be practical and affordable in rural settings, particularly in low and low-middle-income countries. To prevent the spread of MTB infections, it is crucial to identify both individuals with LTBI and those with active TB infections, which is vital for effective TB control globally. Several strategies, including contact monitoring and targeted testing and treatment, have been developed to detect and manage LTBI (World Health Organization, 2022).

The Rapid Tuberculosis Test Card is a rapid immunochromatographic test for the qualitative detection of anti-TB (*M. tuberculosis, M. bovis,* and *M. africanum*) antibodies (all isotypes: IgG, IgM, and IgA) in human serum or plasma which are present during MTB infections (Gounder et al., 2002). However, studies have shown that antibody tests have low reliability for diagnosing active tuberculosis because people with LTBI, a history of MTB infection, BCG vaccination, or infection with other Mycobacteria infections besides *M. tuberculosis* may have antibodies against *Mycobacterium tuberculosis*. This issue with antibody tests is often considered a drawback and can lead to false positive results (Gounder et al., 2002). Several studies have been conducted on the co-infection of MTB with HIV in the Northwestern region of Nigeria. However, there is a lack of data on the prevalence of LTBI in healthy and immunocompromised individuals in the Dutsin-Ma metropolis. Therefore, this cross-sectional study aimed to determine the prevalence of LTBI in healthy and immunocompromised patients in the Dutsin-Ma metropolis, Katsina State, Nigeria.

MATERIALS & METHODS

Study Area

Dutsin-Ma town serves as the administrative Center for the Dutsin-Ma Local Government Area. It is positioned at the coordinates 12°27'17"N, 7°29'29"E, latitude of 12°27'16.13"N and longitude of 7°29'51.55"E. The Local Government Area covers an expanse of 527 square kilometers and has a population of 169,829 dwellers based on the data from the 2006 census (Gazette, 2009). Dutsin-Ma town is home predominantly to farmers, shepherds, and traders.

Ethical Statement

The Ethical Clearance Committee of the Katsina State Ministry of Health reviewed and authorized the study protocol with the approval number MOH/ADM/SUB/1152/1/768. All participants provided informed consent, and anonymity was preserved throughout data analysis and reporting.

Questionnaire Survey and Data Collection

The participants were administered structured questionnaires that included demographic information, medical history, health status and lifestyle/habits, knowledge about tuberculosis, and willingness to undergo LTBI screening.

Sample Collection

A total of one hundred and seventy (170) blood samples were randomly collected from healthy individuals (n=50), pregnant women (n=65) attending the antenatal clinics, diabetic patients (n=25), and HIV-positive patients (n=30) attending routine follow-ups in September 2023 at the Federal University Dutsin-Ma Clinic, Comprehensive Health Care Centre, Dutsin-Ma, and the General Hospital Dutsin-Ma. The samples were immediately transported to the Microbiology Laboratory at the Federal University Dutsin-Ma under standard laboratory protocol and were tested for anti-TB antibodies using the Rapid Tuberculosis Test Card (RTTC).

Statistical Analysis

Descriptive statistics and a Chi-square test at 95% CI were used to measure the strength of association between variables. Values were considered statistically significant at 95% CI and a P-value of ≤ 0.05.

RESULTS & FINDINGS

In this survey, a total of 170 participants were included. The healthy individuals had the highest prevalence (24%; 12/50) of anti-TB antibodies, followed by the Diabetic patients (20.0%; 5/25), and the pregnant women had the lowest prevalence (11.1%; 5/65) of anti-TB antibodies in this study (Table 1).

Table 1
Prevalence of latent tuberculosis infection among the studied groups

Variables	Number tested	Number positive	Percentage prevalence
Pregnant women	65	5	11.1
Diabetic Patients	25	5	20.0
HIV Patients	30	0	0.00
Healthy individuals	50	12	24.0
Total	170	22	12.94

It was found that a higher percentage of females (18%; 22/122) tested positive for anti-TB antibodies than males (4.17%; 2/48). This suggests that the female gender is likely to be more susceptible to LTBI than males (Table 2).

Table 2
Prevalence of Latent Tuberculosis in the Gender of Participants

Gender Distribution	Number Tested	Number positive	Percentage Prevalence
Female	122	20	18.0
Male	48	2	4.17
Total	170	22	12.94

From the demographic data analysed in this survey, the age group of 25-34 years had the highest prevalence of LTBI, which was recorded at 35.9%. On the other hand, the lowest prevalence of LTBI, which was 6.0%, was found in the age group of 18-24 years. These findings suggest that LTBI is more prevalent in individuals aged 25-34 years as compared to other age groups (Figure 1).

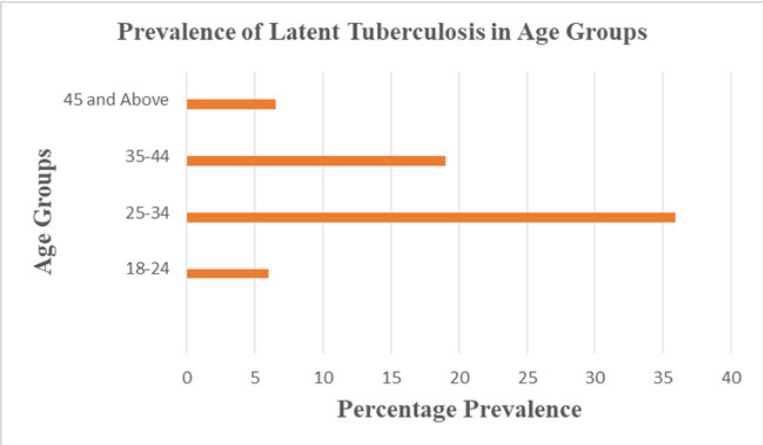

Fig. 1. Prevalence of Latent Tuberculosis among Age Groups

Several risk factors associated with LTBI were deduced from the administered questionnaire in this survey. The risk factors include having a family history of MTB infection, urban exposure, immune suppression, lifestyle factors (such as smoking and malnutrition), and occupation. Participants who worked as cleaners in healthcare facilities and smokers had a 25% and 13.3% prevalence rate respectively. Those who had a family history of MTB infection or suffered from malnutrition had prevalence rates of 11.1% and 18.2%, respectively. At the same time, the participants who lived in urban areas had a 12.0% prevalence rate of LTBI. In addition, the study found a higher prevalence of anti-TB antibodies in non-diabetic patients (12.0%) than in diabetic patients (8.0%).

Discussion

In the current study, we reported an overall prevalence of 12.94% among the participants. A high risk of activation of LTBI in individuals with significant immunosuppression, such as pregnant women, people living with HIV, and diabetics has been previously reported (Corbett et al., 2006; Churchyard et al., 2007). The concurrent presence of HIV and TB in pregnant women can result in severe outcomes, as it is a major contributor to maternal morbidity and mortality (Orazulike et al., 2017).

The high frequency of anti-TB antibodies observed in this study may be attributed to several factors. Firstly, individuals with little or no educational background and lower social status may be at higher risk for LTBI and active TB infections due to various risk factors or lifestyles that predispose them to these conditions. Secondly, poor living conditions, such as overcrowding, inadequate and poor ventilation, poor personal hygiene, and poor nutrition, may also contribute to the high prevalence of LTBI. These factors could potentially lead to increased exposure to *Mycobacterium tuberculosis* and can potentially cause higher rates of LTBI and MTB infection (Chukwudi et al., 2020).

In comparison, females had a higher percentage of participants that tested positive for LTBI (18%; 22/122), than males (4.17%; 2/48) in this survey. The higher proportion of LTBI observed in females may be because many participants in this study (122/170) are women of reproductive age between 18 and 44 years old. Pregnancy is associated with immunosuppression, which can exacerbate the LTBI and potentially result in the reactivation of tuberculosis or the emergence of active disease during pregnancy. A previous study reported that the coexistence of HIV infection in this age group contributes to the highest burden of tuberculosis infection (Alene et al., 2019). In addition, the coexistence of diabetes mellitus (DM) with TB infections has a substantial impact on global health. As the frequency of both diseases rises, particularly in LMICs, where they are both prevalent. This emerging public health issue presents a significant health challenge (Al-Rifai et al., 2017; Firă nescu et al., 2016).

In terms of age groups, the study found that participants between the ages of 25-34 years had the highest prevalence rate of LTBI at 35.9%, while those aged 18-24 years had the lowest prevalence rate at 6.0%. The high occurrence of LTBI in this age group may be linked to various risk factors, such as lack of vaccination with BCG in their childhood, certain occupations, diabetes, poor nutrition, and lifestyle. Interestingly, no anti-TB antibodies were detected among vaccinated participants in this study. Hino et al. (2022) reported that there was a significant increase in LTBI in children in Japan because of changing the recommended age for routine infant BCG vaccination which was initially at 3-6 months old, but in 2013, it was adjusted to be under 1 year old.

The transmission of MTB from an infectious source to other individuals through shared air is influenced by various factors, including the proximity to the infectious source and duration of exposure. Studies have consistently demonstrated a correlation between the level of transmission and the degree of contact with the infectious source. Household contacts are particularly susceptible to both LTBI and active MTB infections due to their proximity to the infected individual. Therefore, assessing individuals who are likely to have recently acquired MTB infection is crucial because they have a higher risk of developing active tuberculosis after exposure, typically within 1-2 years (Morrison et al., 2008).

The risk factors associated with LTBI in this survey include; working as a cleaner in healthcare facilities (25%;1/4), malnutrition (25%;1/9), having a family history of the MTB infection (18.2%; 2/11), smoking (13.3%; 2/15), and living in urban areas (12.0%;3/25). The high prevalence of LTBI among cleaners of healthcare facilities and those with a family history of MTB infection may be due to their closeness to infectious sources. This is consistent with the report of Akinshipe et al. (2019) who reported that certain factors increase the likelihood of having LTBI and pre-diabetes. These risk factors include not receiving the BCG vaccine, having a family history of diabetes and MTB infection, smoking, living in a particular location, and aging. This information can help in

identifying individuals who may be at higher risk for these conditions and can be used in implementing preventive measures accordingly (Morrison et al., 2008; Akinshipe et al., 2019).

CONCLUSION

The study highlighted the importance of routine testing and identifying risk factors related to LTBI. This survey involved the screening for anti-TB antibodies in 170 participants; the results may not be representative of the entire population and may limit the generalizability of our findings. Therefore, further research is required to establish the prevalence of LTBI in the study locality. Nonetheless, it is crucial to implement urgent measures to prevent the dissemination of this disease considering the study's findings.

Data Availability Statement

The data supporting the findings of this survey are available from the corresponding author upon request.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Author Contributions

IM conceptualized and designed the study; EDA and VVT carried out the laboratory analysis; EDA wrote the first draft and the final manuscript of the article; IM revised the final copy of the manuscript. All authors read and approved the final manuscript.

Acknowledgements

The authors would like to thank the management and staff members of the Katsina State Ministry of Health for granting us the approval to conduct this study and the entire staff members of the hospital and clinics where samples were collected. The authors would like to express their gratitude to the individuals who willingly consented to participate in this study, their cooperation is greatly appreciated.

Competing Interest

The authors had no competing interests.

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