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Detection of *Mycobacterium tuberculosis* using Acid-Fast Bacilli (AFB) Test among Subjects in Rivers State of Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Tuberculosis (TB), caused by *Mycobacterium tuberculosis* (MTB), is a significant public health concern in Nigeria, with varying prevalence across different regions. This study aimed to assess the prevalence of MTB infection and its association with socio-demographic variables in Rivers State, Nigeria. The study involved 392 participants from three local government areas (LGAs): Eleme, Obio/Akpor, and PHALGA. The Acid Fast Bacilli test was used to detect MTB in sputum samples.

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Socio-demographic data, including age, sex, marital status, education, and occupation, were collected using a structured questionnaire. A stratified random sampling method was employed. Statistical analysis involved descriptive statistics, Mann-Whitney U, and Kruskal-Wallis tests. The overall prevalence of *Mycobacterium tuberculosis* infection was 0.8%. Analysis of socio-demographic variables revealed no significant associations with infection rates, as indicated by non-significant p-values of (p=0.266), (p=0.832), (p=0.730), (p=0.673), (p=0.925) for age, sex, education, occupation, and marital status respectively. The study challenges traditional assumptions about demographic vulnerability. This research provides critical insights into the epidemiology of TB in Rivers State. The low prevalence suggests improved healthcare access and awareness. However, larger, more representative studies with advanced diagnostic methods are recommended for a comprehensive understanding and targeted interventions for TB control in Rivers State.

Keywords: Acid-Fast bacilli test; Mycobacterium tuberculosis; Rivers State; socio-demographic variables; TB prevalence.

1. INTRODUCTION

Tuberculosis (TB), a significant public health concern in Nigeria, with varying prevalence across different regions, emerges as an infectious disorder resulting from a cluster of bacteria identified as *Mycobacterium tuberculosis* complex, inclusive of *Mycobacterium tuberculosis*—the primary instigator of human TB [1]. The impact of TB is predominantly felt in the respiratory system, with the potential to spread to various organs and tissues, including but not limited to the brain, spine, and kidneys [2]. Airborne transmission characterizes TB, as occurring when an individual with active pulmonary TB engages in actions like coughing, sneezing, or speaking, expelling droplets laden with the bacteria [3]. Inhaling these droplets may lead to infection, resulting in latent or active TB development. Latent TB signifies the presence of bacteria in the body without causing observable symptoms or harm. Conversely, active TB involves bacterial proliferation, posing potential fatality if left unaddressed [4].

Symptoms indicative of active pulmonary TB encompass a persistent cough, chest pain, hemoptysis (coughing up blood), fever, night sweats, weight loss, and fatigue [5]. Extrapulmonary TB symptoms hinge on the infection site and may include manifestations such as headaches, back pain, joint pain, abdominal pain, and neurological issues [6]. TB often coexists with other ailments like HIV/AIDS, diabetes, and malnutrition, amplifying the susceptibility to infection, progression, and associated complications [7].

The genesis of TB involves the interplay between bacteria and the host immune system. Upon entry into the lungs, bacteria encounter alveolar macrophages—immune cells designed to engulf and neutralize foreign particles. However, certain bacteria can persist and multiply within these macrophages, creating granulomas, structures designed to contain and isolate the bacteria [8]. Typically, granulomas remain dormant without causing harm. However, they may disintegrate in specific instances, releasing bacteria into the bloodstream or airways, and triggering active TB [7]. This vulnerability arises when the immune system undergoes weakening due to factors like HIV infection, malnutrition, stress, or aging [9].

TB stands as a pervasive global health concern, impacting millions annually. According to the World Health Organization (WHO), the year 2022 witnessed an estimated 2.2 million new cases of TB, with approximately 10.6 million individuals worldwide falling ill due to tuberculosis, comprising 5.8 million men, 3.5 million women, and 1.3 million children [10]. TB holds the grim distinction of being the primary cause of death among individuals living with HIV, contributing to about one-third of AIDS-related fatalities [11]. The weight of TB is disproportionately distributed, with a concentration of cases and deaths in low- and middle-income nations, particularly in Africa and Asia [9]. Nigeria, identified as one of the 30 countries burdened most by TB, contributes significantly, accounting for 87% of global TB cases [12]. In 2020, Nigeria reported an estimated 452,000 TB cases, but only 138,590 were diagnosed and officially reported, potentially explaining the low case detection rate. This discrepancy leaves many TB cases undiagnosed and untreated, posing a substantial threat to public health and fostering disease transmission [13].

TB diagnosis relies on a combination of clinical, radiological, and microbiological criteria. The acid-fast bacilli (AFB) test is the most prevalent and dependable method for microbiological confirmation, capable of detecting mycobacteria in sputum or other specimens [14]. The AFB test entails staining the specimen with a dye that binds to the mycolic acid in the bacteria's cell wall, rendering them red under microscopic examination. Although the AFB test is characterized by simplicity, affordability, and widespread availability, it has limitations, such as low sensitivity, variable quality, and an inability to distinguish between different species of mycobacteria [15].

This research aims to employ the acid-fast bacilli (AFB) test to detect *Mycobacterium tuberculosis* among individuals in Rivers State, Nigeria. The specific objectives of this study are to determine the prevalence of *Mycobacterium tuberculosis* infection within the study population and to assess the rate of MTB infection concerning socio-demographic variables.

The justification for undertaking this study lies in the imperative to enhance the diagnosis and management of Tuberculosis (TB) in Nigeria, particularly in regions characterized by high prevalence and low detection rates. The research intends to–provide crucial insights into the epidemiology and risk factors of TB in Rivers State. Such insights are pivotal for designing and implementing targeted interventions to mitigate this disease's burden. By shedding light on the prevalence and determinants of TB in the region, the study seeks to contribute valuable information that can guide evidence-based strategies for improved TB control.

Moreover, this research will expand the knowledge and evidence base regarding the performance and utility of the AFB test across diverse settings and populations. Understanding the effectiveness of this diagnostic tool in the local context is essential for refining and customizing TB detection methods. Ultimately, the outcomes of this study aspire to facilitate informed decision-making in public health, leading to more effective interventions and a reduction in the overall impact of TB in Rivers State, Nigeria.

2. MATERIALS AND METHODS

2.1 Participants

The study included 392 participants–from three distinct local government areas (LGAs) in Rivers State, Nigeria—Eleme, Obio/Akpor, and PHALGA. Inclusion criteria comprised individuals aged between 18 and 65, representing a diverse spectrum of occupations. Exclusion criteria encompassed those below 18 years, individuals with a history of TB treatment, and those unwilling to participate.

2.2 Sampling

A stratified random sampling method was employed to ensure a comprehensive representation across various age groups, genders, and occupations. Community health centres facilitated participant recruitment, with informed consent obtained from each individual.

2.3 Measures

The acid-fast bacilli (AFB) test was utilized to identify *Mycobacterium tuberculosis* (MTB) in sputum samples collected from the participants. This microscopy-based method employs a special stain to detect bacteria in the sputum [14,5]. Two sputum samples were collected from each participant—one in the morning and one in the afternoon—following the established protocol for collection, processing, staining, and examination [16,17,18,19,20]. A participant was deemed positive for MTB if at least one sample exhibited the presence of AFB. Additionally, socio-demographic data, including age, sex, marital status, education, and occupation, were collected using a structured questionnaire.

2.4 Data Analysis

The data analysis was conducted using SPSS version 25. Descriptive statistics, such as frequency, percentage, mean, and standard deviation, were calculated for both socio-demographic variables and AFB test results. Mann Whitney & Kruskal Wallis tests were employed to compare the prevalence of MTB infection among various categories of socio-demographic variables. A p-value of less than 0.05 was considered statistically significant.

3. RESULTS

Table 1 Presents the Frequency Distribution of socio-demographic variables of study participants according to their age, marital status, education, occupation, and local government area. The majority of the participants were aged between 30 and 39 years (45.9%), married

(50.5%), had tertiary education (59.7%), and lived in either Obio/Akpor or PHALGA (48.2% and 49.7%, respectively). The least represented categories were those aged 51 years and greater (4.6%), divorced (1.3%), had no formal education (2.6%), worked as a housewife (.5%), or lived in Eleme (2.0%).

Fig. 1 shows bar chart-frequency distribution of study (LGA) with Obio/Akpor and PHALGA LGAs have the most residents.

Table 2 shows the general prevalence of MTB infection among the study participants. Out of 392 participants tested, only 3 (0.8%) were detected with MTB infection.

Table 3 shows the rate of MTB infection among the study participants according to their age, sex, and education. The highest rate of MTB infection was observed among the participants aged 21-29 years (2.9%), followed by those with secondary education (1.4%). The lowest rate of MTB infection was observed among the participants aged less than 20 years, 40-50 years, and 51 years and greater (0.0%), as well as those with no formal education or primary education (0.0%).

Table 4 - Occupational Distribution of Mycobacterium Tuberculosis (MTB) Infection presents the distribution of MTB infection across various occupations. Each occupation is associated with the number of individuals examined, and the frequency and percentage of individuals who tested negative and positive for MTB. The Chi-Square (Kruskal-Wallis) test results (test statistic = 7.548, degrees of freedom = 10, p-value = 0.673) suggest no statistically significant difference in MTB infection rates across the occupations.

Table 5 presents the results of a Mann-Whitney U test comparing the prevalence rate of MTB between males and females. For each sex, the table provides the number of individuals (N), the mean rank, the sum of ranks, and the Mann-Whitney U statistic. The p-value of 0.832 indicates ~~that there is~~ no statistically significant difference in the prevalence rate of MTB between males and females. NS denotes 'Not Significant'.

Table 1. Frequency Distribution of socio-demographic variables of Study Participants

Variable	Classification	Frequency (N=392)	Percent
Age (Years)	<20	51	13.0
	21-29	70	17.9
	30-39	180	45.9
	40-50	73	18.6
	51years and Greater	18	4.6
Marital Status	Single	186	47.4
	Married	198	50.5
	Divorced	5	1.3
	widowed/ widower	3	.8
Education	no formal education	10	2.6
	Primary	8	2.0
	Secondary	140	35.7
	Tertiary	234	59.7
Occupation	Teacher	93	23.7
	civil servant	73	18.6
	self employed	70	17.9
	Driver	7	1.8
	Applicant	19	4.8
	Housewife	2	.5
	Health	13	3.3
	Student	74	18.9
	Cleaner	3	.8
	Security	5	1.3
	Others	33	8.4
Local Government Area	Eleme	8	2.0
	Obio/Akpor	189	48.2
	PHALGA	195	49.7
	Total	392	100.0

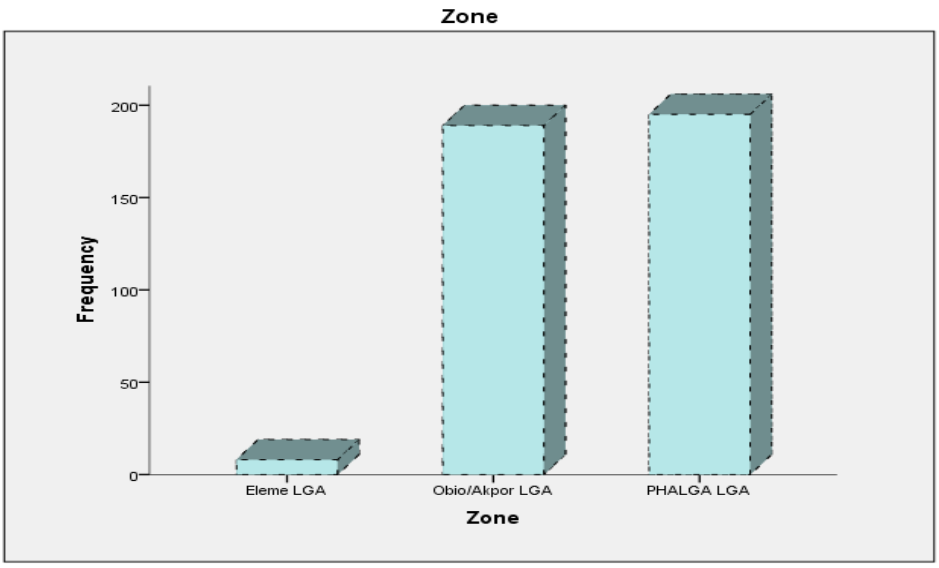

Fig. 1. Bar Chart-Frequency Distribution of Study area (Local Government Areas)

Table 2. General Prevalence of MTB in the Study

Number Tested	Number Negative	Number Detected	Prevalence Rate
392	389 (99.2%)	3 (0.8%)	0.8%

Table 3. Rate of MTB infection among the study population with respect to the socio-demographic variables

Variables		MTB Detection	Frequency	Percentage (%)
Age	Less than 20 years	Positive	0	0.00
		Negative	51	100.0
	21 - 29 years	Positive	2	2.9
		Negative	68	97.1
		Total	70	100.0
	30 - 39 years	Positive	1	.6
		Negative	179	99.4
		Total	180	100.0
	40 - 50 years	Positive	0	0.00
		Negative	73	100.0
	51 years & Greater	Positive	0	0.00
		Negative	18	100.0
Sex	Male	Positive	1	.6
		Negative	153	99.4
	Female	Positive	2	.8
		Negative	236	99.2
Education				
	no formal education	Positive		
		Negative	10	100.0
	Primary	Positive		
		Negative	8	100.0
	Secondary	Positive	2	1.4
		Negative	138	98.6
	Tertiary	Positive	1	0.4
		Negative	233	99.6

Table 4. Rate of MTB by occupation of subjects

Occupation	Number Examined	Frequency	Percent (%)	Frequency	Percent(%)
		MTB Negative		MTB Positive	
Teacher	93	93	100.0	0	0.0
civil servant	73	73	100.0	0	0.0
self employed	70	69	98.6	1	1.4
Driver	7	7	100.0	0	0.0
Applicant	19	18	94.7	1	5.3
Housewife	2	2	100.0	0	0.0
Health	13	13	100.0	0	0.0
Student	74	73	98.6	1	1.4
Cleaner	3	3	100.0	0	0.0
Security	5	5	100.0	0	0.0
Others	33	33	100.0	0	0.0
Chi-Square (Kruska-wallis)		7.548			
Df		10			
p-value		0.673			
Remark		NS			

Note: p>0.05=NS=Not Significant, p<0.05=Sig=Significant

Table 5. Mann-Whitney U showing difference in the Prevalence Rate of MTB between Male and Female

	Sex	N	Mean Rank	Sum of Ranks	Mann-Whitney U	p-value	Remark
Sex	Male	154	196.73	30296.00	18291.000	.832	NS
	Female	238	196.35	46732.00			
	Total	392					

Note: p>0.05=NS=Not Significant, p<0.05=Sig=Significant

Table 6. Kruskal-Wallis Test showing difference in the prevalence of MTB by socio-demographics (Age, Marital status, Education)

Sociodemo	Group	N	Mean Rank	Chi-Square (Kruska-wallis)	Df	p-value	Remark
Age	<20years	51	198.00	5.219	6	.266	NS
	21-29 years	70	192.40				
	30-39 years	180	196.91				
	40-50 years	73	198.00				
	51years& Greater	18	198.00				
	Total	392					
Marital Status	Single	186	195.89	.472	3	.925	NS
	Married	198	197.01				
	Divorced	5	198.00				
	widowed/ widower	3	198.00				
	Total	392					
Education	No Formal Education	10	198.00	1.298	3	.730	NS
	Primary	8	198.00				
	Secondary	140	195.20				
	Tertiary	234	197.16				
	Total	392					

Note: p>0.05=NS=Not Significant, p<0.05=Sig=Significant

Table 6 displays the results of Kruskal-Wallis tests examining the prevalence of Mycobacterium Tuberculosis (MTB) across various socio-demographic factors, including Age, Marital Status, and Education. Across all three factors, no statistically significant differences were found in MTB prevalence. Age yielded a non-significant p-value of 0.266 (test statistic = 5.219, 6 degrees of freedom). Similarly, Marital Status exhibited a non-significant p-value of 0.925 (test statistic = 0.472, 3 degrees of freedom), and Education showed a non-significant p-value of 0.730 (test statistic = 1.298, 3 degrees of freedom).

4. DISCUSSION

This study aimed to determine the prevalence of *Mycobacterium tuberculosis* (MTB) infection among subjects from three local government areas (LGAs) in Rivers State, Nigeria, utilizing the acid-fast bacilli (AFB) test. Additionally, the association between MTB infection and socio-demographic variables such as age, sex, education, and occupation was examined.

The overall prevalence of MTB infection among the subjects was 0.8%. This figure is notably lower than the national average of 2.6% reported by the World Health Organization (WHO) in 2022 [21]. Furthermore, it is lower than the 9.79% reported in a similar study in 2020 [22], and higher than the 0.0527% reported by Patrick [23] in Rivers State. Conversely, Alex-Wele et al. [24] reported a markedly higher rate of 61.2% during the pandemic. These findings suggest that the selected LGAs for this study exhibit a relatively low burden of TB. Possible contributing factors include improved access to healthcare, heightened awareness of TB prevention and control, and reduced exposure to risk factors such as malnutrition, and HIV co-infection [25,26].

Furthermore, in agreement with several studies as seen in Tadokera et al [27] and Luba et al [28], the study also found that the rate of MTB infection was not significantly associated with any of the socio-demographic variables, such as age, sex, education, occupation, or marital status at p. This was in contradiction to previous studies as reported by Ogboi et al. [29], Yannabe et al. [30], Choudhary et al. [31], Gisso et al. [32], Gompo et al. [33], Maharani et al. [34] and Zarakpege [35].

The absence of significant associations across socio-demographic categories suggests a remarkable uniformity in the study population's risk of MTB infection. This challenges conventional assumptions about the differential vulnerability of certain demographic groups to tuberculosis [36,37]. It may indicate that factors other than the investigated variables, such as environmental conditions, local healthcare practices, socio-economic factors, or unique cultural practices that were not explicitly investigated in the current study, might play a more influential role in the transmission dynamics of MTB in this region [38]. Tuberculosis transmission is a complex process influenced by various interacting factors. The absence of clear associations with traditional socio-demographic variables highlights the multifaceted nature of MTB transmission in the studied region.

Interestingly, some studies reported a mixed significance for these variables. Haq et al. [37] reported a significant differences in age, sex, and occupation but no significant differences in education and marital status, Diriba et al. [38] reported a significant educational association but not with age.

These findings in the present study should be interpreted with caution, as the sample size was small, and the number of positive cases was very low. A larger and more representative sample could reveal some associations between MTB infection and socio-demographic variables. Some study limitations that should be considered when interpreting the results were identified. First, the AFB test, which is a microscopy-based method that has low sensitivity and specificity, and may not detect all cases of MTB infection, especially those with low bacterial load or extrapulmonary TB, was used [39,40,41]. Second, only two sputum samples from each subject, may not be sufficient to confirm the diagnosis of MTB infection, as the WHO recommends collecting at least three samples for optimal results [42-44]. Third, no molecular or culture tests were performed to confirm the presence of MTB or to identify its drug resistance profile, which may have important implications for treating and controlling TB. Fourth, other variables that may influence the risk of MTB infection, such as smoking, alcohol consumption, diabetes, HIV status, and previous TB exposure or treatment, were not measured [25].

5. CONCLUSION

This study set out to investigate the prevalence of MTB infection using the AFB test among individuals in Rivers State, Nigeria. The research addressed the critical need to enhance the diagnosis and management of TB in regions with high prevalence and low detection rates. The findings revealed an overall MTB prevalence of 0.8%, lower than national and international averages, possibly indicating improved healthcare access and awareness in the selected local government areas. Despite a small sample size, the study observed no significant associations between MTB infection and socio-demographic variables, challenging conventional assumptions about the differential vulnerability of certain demographic groups to tuberculosis. While caution is warranted due to limitations such as the use of the AFB test and a small sample size, this research contributes valuable insights into the epidemiology of TB in the region. The results underscore the multifaceted nature of MTB transmission and suggest that other factors beyond the investigated variables may play a crucial role in TB dynamics in the studied population. Future research with larger, more representative samples and additional diagnostic methods is recommended to further explore these complexities and inform targeted interventions for improved TB control in Rivers State, Nigeria.

CONSENT AND ETHICAL CONSIDERATION

The study adhered to ethical guidelines and obtained approval from the Ethics committee, Rivers State Ministry of Health. All participants were provided detailed information about the study's purpose, and procedures. Written consent was obtained from each participant, ensuring their voluntary participation and right to withdraw without repercussions.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. World Health Organization. Tuberculosis in the WHO African Region: 2023 progress update. Brazzaville: WHO African Region; 2023. License: CC BY-NC-SA 3.0 IGO. Available:https://www.afro.who.int/sites/default/files/202309/Tuberculosis%20in%20the%20African%20Region_2023%20report.pdf
2. Nigeria TB Dashboard. (n.d.). Available:https://www.stoptb.org/static_pages/NGA_Dashboard.html Accessed on:January 16, 2024
3. Onyechege D, Mohamed Nor N, Wan A, Naseem N. Tuberculosis and its socioeconomic determinants in Nigeria: An empirical investigation using ARDL approach. Eur J Environ Public Health. 2023;7:em0126. Available:https://doi.org/10.29333/ejeph/12449 Accessed January 16, 2024.
4. Schluger NW. The Acid-Fast Bacilli Smear: Hail and Farewell. Am J Respir Crit Care Med. 2019;199(6):691-692. Available:https://doi.org/10.1164/rccm.201809-1772ed Accessed on:January 16, 2024.
5. Riello FN, Brígido RTS, Araújo S, Moreira TA, Goulart LR, Goulart IMB. Diagnosis of mycobacterial infections based on acid-fast bacilli test and bacterial growth time and implications on treatment and disease outcome. BMC Infect Dis. 2016;16(1). Available:https://doi.org/10.1186/s12879-016-1474-6 Accessed on:January 16, 2024.
6. Yi Ling Lai, Emily Ricotta, Kenneth Olivier, Sameer S Kadri, D Rebecca Prevots. Acid-Fast Bacilli Testing Trends at 43 In- and Outpatient Facilities and Nontuberculous Mycobacterial Pulmonary Isolation Rate, United States, 2009–2015. Open Forum Infect Dis. 2019;6(Supplement_2): S502. Available:https://doi.org/10.1093/ofid/ofz360.1246. Accessed January 16, 2024
7. Salina EG. Mycobacterium tuberculosis Infection: Control and Treatment. Microorganisms. 2023;11(4):1057. Available:https://doi.org/10.3390/microorganisms11041057 Accessed on: January 16, 2024.
8. Lee A, Xie YL, Barry CE, Chen RY. Current and future treatments for tuberculosis. BMJ. 2020;368. Available:https://doi.org/10.1136/bmj.m216 Accessed on: January 16, 2024.
9. 9.Moule MG, Cirillo JD. Mycobacterium tuberculosis dissemination plays a critical role in pathogenesis. Frontiers in Cellular and Infection Microbiology. 2020; 10(65). Available:https://doi.org/10.3389/fcimb.2020.00065

10. World Health Organization. Tuberculosis. World Health Organization; 2023. Available:https://www.who.int/news-room/fact-sheets/detail/tuberculosis Accessed on: January 16, 2024.
11. WHO | Regional Office for Africa. HIV/AIDS; 2024. Available:https://www.afro.who.int/health-topics/hivaids#:~:text=Tuberculosis%20(TB)% 20remains%20the%20leading. Accessed on: January 16, 2024.
12. Nigeria. Nigeria Background. n.d. Available:https://tbassessment.stoptb.org/assets/docs/Digital%20TB%20Surveillance%20System%20Assessment%20All%20Country%20Reports/Nigeria%20Digital%20TB%20Surveillance%20System%20Assessment%20Report.pdf Accessed on: January 16, 2024.
13. Rosapep LA, Faye S, Johns B, Olusola-Faleye B, Baruwa EM, Sorum MK, Nwagagbo F, Adamu AA, Kwan A, Obanubi C, Atobatele AO. Tuberculosis care quality in urban Nigeria: A cross-sectional study of adherence to screening and treatment initiation guidelines in multi-cadre networks of private health service providers. PLOS Global Public Health. 2022;2(1):e0000150. Available:https://doi.org/10.1371/journal.pgph.0000150 Accessed on:January 16, 2024.
14. CDC. Fact Sheets; 2019. Available:https://www.cdc.gov/tb/publications/factsheets/testing/diagnosis.htm Accessed on:January 16, 2024.
15. LTG. Sputum for AFB Test Purpose, Procedure, Result and more. Lab Tests Guide; 2021. Available:https://www.labtestsguide.com/sputum-for-afb Accessed on: January 16, 2024.
16. Acid Fast Bacilli (AFB) Smear and Culture Testing. n.d.Health.ucdavis.edu. Available:https://health.ucdavis.edu/blog/lab-best-practice/acid-fast-bacilli-afb-smear-and-culture-testing/2021/03. Accessed on:January 16, 2024.
17. AFB Smear Microscopy. n.d. Available:https://www.aphl.org/programs/infectious_disease/tuberculosis/TBCore/TB_AFB_Smear_Microscopy_TrainerNotes.pdf. Accessed January 16, 2024.
18. Sputum Specimen Collection. n.d. Available:https://www.albertahealthservices.ca/assets/healthinfo/ipc/if-hp-ipc-bpg-sputum- collection.pdf Accessed January 16, 2024.
19. Component 1: Laboratory Evaluation-Acid-Fast Bacilli Microbiology (AFB) Tool Why the laboratory component of tool? n.d. [Internet]. Available:https://www.cdc.gov/globalhealth/healthprotection/errb/pdf/researchandsurvey/tb_too l_c1.pdf. Accessed on: January 16, 2024.
20. SOP for Collection and Transport of Sputum Sample for AFB Stain. n.d. [Internet]. Available:https://aiimsrajkot.edu.in/sites/default/files/inline-files/DMC% 20AIIMS% 20 rajkot.pdf Accessed on: January 16, 2024.
21. World Health Organization. Global Tuberculosis Report; 2021. Available:https://www.who.int/teams/global-tuberculosis-programme/tb-reports Accessed on:January 16, 2024.
22. Duabo MG, Bibiye AAS, Tamunoibitem J. Prevalence of Tuberculosis and Compliance to Treatment from 2010-2020 In Rivers State, Southsouth Nigeria. Int J Environ Pollut Res. 2022;10(3):1-11. Available:https://doi.org/10.37745/ijepr.13/vol10n3111 Accessed on: January 16, 2024
23. Patrick F. Prevalence and Treatment Outcome of Tuberculosis before and during COVID-19 Pandemic in Rivers State, Nigeria. [Abstract presentation]. J Epidemiol Soc Nigeria. 2022;1:62–63. Available:https://doi.org/10.5281/zenodo.6015395
24. Alex-Wele MA, Obunge OK. Molecular Characterization of Drug-Resistant Mycobacterium tuberculosis Isolated from HIV-Positive Patients in Rivers State, Nigeria. Asian J Res Infect Dis. 2021;6:44-51. Available:https://doi.org/10.9734/ajrid/2021/v6i430204
25. CDC. TB Risk Factors. Centers for Disease Control and Prevention; 2016. Available:https://www.cdc.gov/tb/topic/basics/risk.htm. Accessed on: January 16, 2024
26. World Health Organization. 6.3 TB determinants; 2021. Available:https://www.who.int/publications/digital/global-tuberculosis-report-2021/uhc-tb-determinants/determinants Accessed on:January 16, 2024.
27. Tadokera R, Bekker L-G, Kreiswirth B, Mathema B, Middelkoop K. TB

transmission is associated with prolonged stay in a low socio-economic, high burdened TB and HIV community in Cape Town, South Africa. BMC Infectious Diseases. 2020;20(1):120.
Available:https://doi.org/10.1186/s12879-020-4828-z

28. Luba TR, Tadesse S, Beyen TK, Mohammed A, Admasu M, Mohammed S, et al. Knowledge, attitude and associated factors towards tuberculosis in Lesotho: A population based study. BMC Infectious Diseases. 2019;19(1):96.
29. Ogboi SJ, Idris SH, Olayinka AT, Junaid I. Socio-demographic characteristics of patients presenting pulmonary tuberculosis in a primary health centre, Zaria, Nigeria. J Med Lab Diagn. 2010;1(2):11-14.
Available:http://www.academicjournals.org/JMLD
30. Yannabe MM, Abdul-Rahman H, Hayati KS, Hammangabd A. Socio-demographic risk factors of pulmonary tuberculosis: A case-control study in Yobe State, Nigeria. Int J Public Health Clin Sci. 2015;2(2):35.e-ISSN:2289-7577.
Available:https://publichealthmy.org/ejournal/ojs2/index.php/ijphcs/article/download/172/150
31. Choudhary P, Singh TS, Adhikari L, Nandy P. Occurrence of pulmonary tuberculosis: Associated socio-demographic factors and the role of knowledge and awareness. Int J Innov Res Adv Stud. 2017;4(9).
Available:https://www.ijiras.com/2017/Vol_4-Issue_9/paper_14.pdf
32. Gisso BT, Hordofa MW, Ormago MD. Prevalence of pulmonary tuberculosis and associated factors among adults living with HIV/AIDS attending public hospitals in Shashamene Town, Oromia Region, South Ethiopia. SAGE Open Med. 2022;10.
DOI:10.1177/20503121221122437.
33. Gompo TR, et al. Risk factors of tuberculosis in humans and its association with cattle TB in Nepal: A One Health approach. One Health. 2020;10:100156.
Available:https://doi.org/10.1016/j.onehlt.2020.100156.
34. Maharani R, Karima UQ, Kamilia K. Socio-demographic and behavioral factors relationship with pulmonary tuberculosis: A case-control study. Open Access Maced J Med Sci. 2022;10(E):130–135.
Available:https://doi.org/10.3889/oamjms.2022.8157
35. Zarakpege NG. Examination of the Association Between Poverty, Income, and Education Levels on Tuberculosis Prevalence in Nigeria: Rural Niger Delta Case Study. [Dissertation]. Walden University; ProQuest Dissertations Publishing, 30572372; 2023.
36. World Health Organization. Tuberculosis and vulnerable populations; 2017.
Available:https://www.who.int/europe/news-room/fact-sheets/item/tuberculosis-and-vulnerable-populations.
37. Centers for Disease Control and Prevention (CDC). TB in Specific Populations; 2019.
Available:https://www.cdc.gov/tb/topic/populations/default.htm.
38. Coleman M, et al. Mycobacterium tuberculosis Transmission in High-Incidence Settings—New Paradigms and Insights. Pathogens. 2022;11(11):1228.
Available:https://doi.org/10.3390/pathogens11111228.
39. Haq MU, et al. Are patients with pulmonary tuberculosis identified by active and by passive case detection different? A cross-sectional study in Pakistan. Int J Infect Dis. 2022;121:39–46.
Available:https://doi.org/10.1016/j.ijid.2022.04.055
40. Diriba K, Awulachew E. Associated risk factor of tuberculosis infection among adult patientsin Gedeo Zone, Southern Ethiopia. SAGE Open Med. 2022;10.
DOI: 10.1177/20503121221086725.
41. National Library of Medicine. Acid-Fast Bacillus (AFB)Tests: MedlinePlus Lab Test Information. 2021.
Availablehttps://medlineplus.gov/labtests/acid-fast-bacillus-afb-tests/
Accessed on:January 16, 2024
42. Jwatch.org; 2024.
Available:https://www.jwatch.org/na48799/2019/03/25/diagnosing-tb-with-xpert-assay-vs-afb-smear-microscopy
Accessed on:January 16, 2024
43. Extrapulmonary tuberculosis - Symptoms, diagnosis and treatment | BMJ Best Practice US. n.d.
Available:https://bestpractice.bmj.com/topics/en-us/166
Accessed on: January 16, 2024.

44. WHO announces updates to its guidelines on tests for the diagnosis of TB infection. n.d. Available:https://www.who.int/news/item/30-09-2022-who-announces-updates-to-its-guidelines-on-tests-for-the-diagnosis-of-tb-infection. Accessed on:January 16.

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