Assessing Tuberculosis and Risk Factors: Population Study in Rivers State, Nigeria's Niger Delta Region, Nigeria

Abstract

Mycobacterium tuberculosis (MTB), an infectious airborne bacterium primarily impacting the lungs and instigating a chronic inflammatory response, persists as an enduring menace. This study aims to evaluate the interplay between MTB infection and associated risk factors in Rivers State, Nigeria. The study involved 392 participants from three local government areas (LGAs): Eleme, Obio/Akpor, and PHALGA. Data collection involved a structured questionnaire covering socio-demographics variables and associated risk factors. A stratified random sampling method was employed. Statistical analysis, including descriptive statistics and Spearman's correlation coefficient, was performed using SPSS version 25. Correlation analysis of socio-demographic variables revealed no significant associations with MTB, as indicated by non-significant p-values of (p=0.27), (p=0.83), (p=0.42), (p=0.35), (p=0.49), (p=0.28) for age, sex, education, occupation, marital status and geographical area respectively. However, significant positive weak correlations emerged between MTB infection and cough (p=0.00), hepatitis (p=0.01), coughing blood (p=0.00), and fever (p=0.00). Conversely, family TB history (p=0.93), cough lasting 2 weeks (p=0.84), weight loss (p=0.19), contact with a person who has been coughing for 2 weeks (p=0.93), and alcohol consumption (p=0.55) did not show significant associations.While demographic characteristics alone may not be strong predictors of MTB infection, this study highlights the complex interplay between various risk factors Addressing these risk factors through targeted interventions and raising awareness can contribute to reducing the TB burden in Rivers State and the Niger Delta region.

Keywords: *Associated risk factors, MTB infection, Mycobacterium tuberculosis, Nigeria, public health, Population-based study*

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INTRODUCTION

Tuberculosis (TB) persists as a formidable global health concern, particularly prominent in developing regions, and Nigeria stands as a testament to this challenge [1][2]. Rivers state in the Niger Delta region, situated in the southern part of the country, emerges as one of the most densely populated and economically advantaged areas, boasting an estimated population exceeding 5 million individuals [3]. Recognized for its abundant oil resources, the state bears the brunt of environmental degradation, social turbulence, and armed conflicts [3][4][5][6]. These dynamics significantly compound the hurdles encountered in the prevention and management of *Mycobacterium tuberculosis* (MTB) infection, the causative agent of TB, within the region.

MTB, an infectious airborne bacterium primarily impacting the lungs and instigating a chronic inflammatory response, persists as an enduring menace, notwithstanding significant strides in healthcare [7][8][9][10]. The year 2023 marked the World Health Organization's (WHO) acknowledgment of the substantial tuberculosis burden in Nigeria, with a significant tally of reported cases and associated fatalities [11]. Stark figures underscore an annual toll of approximately 245,000 lives succumbing to TB in Nigeria, accompanied by roughly 590,000

fresh cases emerging each year [11]. Emphasizing the severity of the matter, the TB death rate in Nigeria surged to 53 cases per 100,000 people in 2021 [11].
The distinctive cell wall composition and slow growth rate of MTB pose significant challenges in its diagnosis and treatment [12]. MTB exhibits a spectrum of clinical presentations, spanning from latent infection to active disease [13]. Latent infection denotes the presence of MTB in the body without inducing symptoms or tissue damage [14]. Conversely, active disease manifests when MTB undergoes multiplication, giving rise to symptoms like persistent cough, weight loss, fever, and night sweats [15]. Diagnosing latent infection necessitates either a tuberculin skin test or an interferon-gamma release assay, while active disease diagnosis entails procedures such as sputum smear microscopy, culture, or molecular testing. The management of latent infection entails a preventive therapy course, whereas active disease calls for a combination of anti-TB drugs [16].
The transmission of *Mycobacterium tuberculosis* ensues through respiratory droplets expelled by individuals grappling with active pulmonary TB [17]. The susceptibility to developing active disease hinges on diverse factors, encompassing immune status, genetic predisposition, HIV co-infection, and exposure to various environmental or social stressors [18]. While numerous studies have scrutinized the epidemiology and risk factors of TB in Nigeria, a majority have concentrated on specific states or populations like healthcare workers, prisoners, or children [19][20]. Scarce attention has been directed towards investigating the interplay between TB and its associated risk factors at a regional level, especially in the Niger Delta region, notably in Rivers state. This region's TB burden is likely influenced by the distinctive socio-economic and environmental characteristics it harbours [20][21]. Consequently, a pressing demand exists for a comprehensive study capable of capturing the dynamics and interactions between TB and its risk factors within this region.
The primary aim of this research is to evaluate the Interplay between MTB infection and associated risk factors in a selected population in Rivers State, a region in the Niger Delta. The Objectives includes investigating the correlation between population-based demographic characteristics and risk MTB, exploring the interplay between MTBinfection and some presumably associated risk factors and reviewing the public health implication of the disease burden of MTB. Given the unique socio-economic and environmental characteristics of the Niger Delta region, understanding the relationship between MTB and associated risk factors is imperative for tailoring effective prevention and control strategies. This research will contribute valuable insights that can inform evidence-based interventions, ultimately reducing the burden of TB in this region.

MATERIALS AND METHOD

Study Area

This study was carried out in Rivers State, nestled within the Niger Delta of Nigeria, renowned for its robust oil and gas production, an industry that has left an indelible mark through environmental degradation and social conflicts. Established in 1967, Rivers State is a made up of diverse ethnic groups, including Ijaw, Ogoni, Ikwerre, Ogba, Ekpeye, Kalabari, and Igbo [22]. The vibrant state capital, Port Harcourt, stands as a bustling metropolis and a pivotal hub in the Nigerian oil industry, boasting an estimated population of 5,198,7161 [22].

Study Population

The study focused on a cohort of 392 randomly selected adults aged 18 years and above, drawn from the socio-culturally diverse landscape of Rivers State. Participants were randomly sampled from three local government areas (LGAs) closely associated with oil and gas facilities, namely Eleme, Obio/Akpor, and Phalga. These LGAs play pivotal roles in shaping the economic, cultural, and social fabric of Rivers State.

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Data Collection

Data were collected between January and December 2023 using a structured questionnaire administered by trained interviewers. The questionnaire featured two sections. The first section gathered socio-demographic information, including age, sex, marital status, education, occupation, and geographical area. The second section focused on the history and symptoms of tuberculosis (TB) and associated risk factors such as cough, hepatitis, HIV, family TB, coughing blood, fever, weight loss, contact with cough in the past 2 weeks, and alcohol consumption. The questionnaire underwent pre-testing on 20 respondents and was modified accordingly.

Data Analysis

Data scrutiny employed SPSS version 25, employing descriptive statistics, including frequency, percentage, mean, and standard deviation, to encapsulate the salient features of the dataset. Spearman's rank correlation coefficient (rho) served as the analytical tool for gauging the strength and direction of the relationship between TB infection and demographic as well as clinical variables. A significance threshold of $p < 0.05$ underscored the statistical rigor applied to discern patterns within the dataset.

Results

Demographic Characteristics

Table 1: Socio-demographic Distribution of Population-based Parameters

Parameter	Number	Percent	Comment
Gender			
Female	238	60.7	Highest
Male	154	39.3	
Prefer not to Say	0	0.0	
Educational Level			
Tertiary	234	59.7	Highest
Secondary	140	35.7	
Primary	8	2.0	
No Formal Education	10	2.6	
Marital State			
Divorced/separated	5	1.3	
widowed/ widower	3	.8	
Married	198	50.5	Highest
Single	186	47.4	
Age Strata			
Less than 30years	121	30.9	
30 – 50years	253	64.5	Highest
Greater than 50years	18	4.6	
Employment Status			
Employed	266	67.9	Highest
Unemployed	19	4.9	
Student	74	18.9	
Others	33	8.4	
Geographical (Residential) Area			
Eleme	8	2.0	
Obio/Akpor	189	48.2	
Phalga	195	49.7	Highest

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Table 1 illustrates the distribution of socio-demographic parameters within the population. The parameters include gender, educational level, marital status, age strata, employment status, and geographical (residential) area. Percentages are rounded, and the "Highest" comment denotes the category with the highest percentage within each parameter

Table 2: Frequency Distribution of MTB Associated Risk Factors

Variables	Response	Frequency (N=392)	Percent
Cough	Yes	3	.8
	No	389	99.2
Hepatitis	Yes	16	4.1
	No	376	95.9
Diagnosed HIV	Yes	0	0.0
	No	392	100.0
family TB	Yes	1	.3
	No	391	99.7
Cough 2 week	Yes	5	1.3
	No	387	98.7
Cough blood	Yes	2	.5
	No	390	99.5
Fever	Yes	33	8.4
	No	359	91.6
Lost weight	Yes	41	10.5
	No	351	89.5
Contact cough 2 weeks	Yes	1	.3
	No	391	99.7
TB treated	Yes	0	0.0
	No	392	100.0
Alcohol	Yes	77	19.6
	No	315	80.4

Table 2 summarizes the frequency distribution of Mycobacterium tuberculosis (MTB) associated risk factors among 392 participants. Key findings include high percentages of participants without diagnosed HIV (100.0%), no family history of TB (99.7%), and no TB treatment history (100.0%). Conversely, 19.6% reported alcohol consumption. These insights provide a concise overview of MTB-related risk factors in the study population.

Table 3: Spearman Correlation between Mycobacterium Tuberculosis (MTB) and demographic Characteristics

Socio-demographic (N=392)	Coefficient of Correlation rho	p-value	Remark
Age	0.056	0.27	Not Significant
Sex	-0.011	0.83	Not Significant

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Marital Status	0.035	0.49	Not Significant
Education	0.041	0.42	Not Significant
Occupation	-0.047	0.35	Not Significant
Geographical (Residential) Area	0.055	0.28	Not Significant

Table 3 presents the Spearman correlation coefficients between Mycobacterium Tuberculosis (MTB) infection and various demographic characteristics. The table shows that none of the demographic variables (age, sex, marital status, education, occupation, geographical area) have a significant correlation with MTB infection, as indicated by the p-values greater than 0.05.

Table 4: Correlation Analysis showing Interplay between Demographic Characteristics

Demographics	Statistics	Age	Sex	Marital Status	Education	Occupation	Geographical (Residential) Area
Age	Correlation	1.000	-.211	.638	.177	-.427	.022
	p-value	.	.000	.000	.000	.000	.663
	Remark		**Sig**	**Sig**	**Sig**	**Sig**	**NS**
Sex	Correlation	-.211	1.000	-.005	.019	-.038	.062
	p-value	.000	.	.917	.706	.453	.224
	Remark	**Sig**		**NS**	**NS**	**NS**	**NS**
Marital Status	Correlation	.638	-.005	1.000	.091	-.294	.065
	p-value	.000	.917	.	.073	.000	.201
	Remark		**NS**		**NS**		**NS**
Education	Correlation	.177	.019	.091	1.000	-.406	-.128
	p-value	.000	.706	.073	.	.000	.011
	Remark	**Sig**	**NS**	**NS**		**Sig**	**Sig**
Occupation	Correlation	-.427	-.038	-.294	-.406	1.000	-.042
	p-value	.000	.453	.000	.000	.	.412
	Remark	**Sig**	**NS**	**Sig**	**Sig**		**NS**
Geographical (Residential) Area	Correlation	.022	.062	.065	-.128	-.042	1.000
	p-value	.663	.224	.201	.011	.412	.
	Remark	**NS**	**NS**	**NS**	**Sig**	**NS**	392

Table 4 displays the correlation analysis of demographic characteristics such as age, sex, marital status, education, occupation, and geographical area. It provides correlation coefficients, p-values, and significance remarks. The table reveals significant and non-significant correlations between the variables, highlighting the complex interplay of demographic factors in Mycobacterium tuberculosis infection.

Table: 5: Correlation between MTB and Some Associated Risk Factors

Risk Factors-History	Correlation	p-value	**Remark**
Cough	0.328	0.00	Significant positive weak correlation
Hepatitis	0.130	0.01	Significant positive weak correlation
Family TB	-0.004	0.93	Insignificant negative, no correlation
Cough 2 Week	-0.010	0.84	Insignificant negative, no correlation
Cough Blood	0.405	0.00	Significant positive moderate correlation

Fever	0.184	0.00	Significant positive weak correlation
Lost Weight	0.066	0.19	Insignificant positive weak correlation
Contact Cough 2 Weeks	-0.004	0.93	Insignificant negative no correlation
Alcohol	.030	0.55	Insignificant positive weak correlation

Table 5 presents the correlation between Mycobacterium Tuberculosis (MTB) infection and associated risk factors. The table provides correlation coefficients, p-values, and remarks for each risk factor. It reveals significant positive correlations between MTB infection and cough, hepatitis, coughing blood, and fever. However, family TB history, cough lasting 2 weeks, weight loss, contact with a person who has been coughing for 2 weeks, and alcohol consumption show no significant correlation with MTB infection.

Table: 6: Correlation Analysis showing Interplay of MTB Associated Risk Factors

		cough	hepatitis	Family TB	cough2 week	Cough blood	fever	Lost weight	Contact cough 2 weeks	Alcohol
Cough	Correlation	1.000	.278	-.004	-.010	.405	.184	.161	-.004	.030
	p-value	.	.000	.930	.844	.000	.000	.001	.930	.550
Hepatitis	Correlation	.278	1.000	-.010	-.023	.166	.309	.351	-.010	.060
	p-value	.000	.	.837	.643	.001	.000	.000	.837	.234
Family TB	Correlation	-.004	-.010	1.000	-.006	-.004	-.015	-.017	-.003	-.025
	p-value	.930	.837	.	.910	.943	.762	.733	.960	.622
Cough 2 week	Correlation	-.010	-.023	-.006	1.000	$.311^{**}$	$.211^{**}$	-.039	-.006	.058
	p-value	.844	.643	.910	.	.000	.000	.443	.910	.250
Cough blood	Correlation	$.405^{**}$	$.166^{**}$	-.004	.311	1.000	.107	.093	-.004	$.145^{**}$
	p-value	.000	.001	.943	.000	.	.034	.067	.943	.004
Fever	Correlation	$.184^{**}$	.309	-.015	.211	.107	1.000	.497	-.015	.081
	p-value	.000	.000	.762	.000	.034	.	.000	.762	.108
Lost weight	Correlation	.161	.351	-.017	-.039	.093	$.497^{**}$	1.000	-.017	$.146^{**}$
	p-value	.001	.000	.733	.443	.067	.000	.	.733	.004
Contact cough 2 weeks	Correlation	-.004	-.010	-.003	-.006	-.004	-.015	-.017	1.000	-.025
	p-value	.930	.837	.960	.910	.943	.762	.733	.	.622
Alcohol	Correlation	.030	.060	-.025	.058	.145	.081	$.146^{**}$	-.025	1.000

p-value	.550	.234	.622	.250	.004	.108	.004	.622	.

Table 6 presents the correlation analysis showing the interplay of Mycobacterium Tuberculosis (MTB) associated risk factors. The table provides correlation coefficients, p-values, and remarks for each pair of risk factors. It reveals significant positive correlations between cough, hepatitis, coughing blood, fever, and lost weight. However, family TB history, cough lasting 2 weeks, contact with a person who has been coughing for 2 weeks, and alcohol consumption show no significant correlation with each other. This table forms a crucial part of the study's findings, highlighting the complex interrelationships between the risk factors associated with MTB infection.

DISCUSSION

This study aims to evaluate the interplay between MTB infection and associated risk factors in Rivers State, a 'Niger Delta' region. The investigation explores the correlation between population-based demographic characteristics and the risk of MTB infection while reviewing the public health implications of the disease burden.

The demographic breakdown reveals that the majority of participants are female (60.7%), with the highest educational attainment being tertiary level (59.7%). The most prevalent age group ranges from 30 to 50 years (64.5%), and a substantial proportion of the population is employed (67.9%). PHALGA emerges as the LGA with the highest residential representation (49.7%). This demographic distribution provides insight into the profile of the studied population, allowing for a targeted approach in understanding the MTB prevalence within specific groups.

Furthermore, majority of the participants did not exhibit common symptoms or risk factors associated with MTB infection. For instance, only 0.8% of the participants reported having a cough, and 4.1% reported having hepatitis. None of the participants had been diagnosed with HIV or had been treated for TB, which are known risk factors for MTB infection [23]. Interestingly, the table shows that 19.6% of the participants reported alcohol consumption, which is a known risk factor for TB [24]. Also, a small percentage of participants reported having a fever (8.4%) or having lost weight (10.5%), which are common symptoms of TB [15]. These findings provide valuable insights into the distribution of MTB associated risk factors in the studied population. They highlight the need for targeted interventions to address these risk factors, particularly alcohol consumption, to control the spread of MTB infection in Rivers State, Nigeria.

In the study,correlation between Population-Based Demographic Characteristics and Risk of *Mycobacterium Tuberculosis* Infection, no statistically significant correlations were observed between any of the listed demographic characteristics (age, sex, marital status, education, occupation, and geographical area) and MTB risk (all p-values > 0.05). These findings suggest that, at the individual level, these demographic factors alone may not be robust predictors of MTB infection. This aligns with previous studies conducted in Saudi Arabia, Northwestern Ethiopia and New York-Newark-Jersey City [25][26][27], which also reported a lack of significant association. This was in contradiction to other studies [28][29][30]**.** Studies indicating that these factors do not influence MTB infection are lacking. Thus, degrees of influence can vary and is a subject of ongoing research.

However, the study further paints a more nuanced picture. While individual associations remain weak, a network of tangled relationships emerges. Age exhibits a significant negative

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correlation with occupation (ρ=-0.427, p<0.001), implying that younger individuals might be more likely to engage in occupations carrying higher TB risk. Education displays a significant negative correlation with both occupation (ρ=-0.406, p<0.001) and age (ρ=-0.177, p<0.001), potentially indicating that higher education levels are associated with lower-risk occupations and younger age groups. Interestingly, marital status shows a significant positive correlation with age (ρ=0.638, p<0.001), suggesting that older individuals are more likely to be married. These interwoven relationships emphasize the importance of considering demographic factors not in isolation, but rather as a complex network influencing TB risk.

On the Interplay between *Mycobacterium tuberculosis* infection and some specific and presumably associated risk factors, the study indicated significant positive weak correlations between MTB infection and factors such as cough, hepatitis, cough blood, and fever. This implies that while these factors are associated with MTB infection, they are not strong predictors. This is in line with a study by Narasimhan *et al* [31] Therefore, these symptoms may not be sufficient to diagnose MTB infection, but they could be considered as potential indicators that warrant further investigation. Additionally, family TB, cough 2 weeks, lost weight, contact cough 2 weeks, and alcohol showed insignificant correlations with MTB infection. A finding in sync as reported byWijayamti [32], Gebrecherkos*et al* [33] and Melsew*et al* [34] but in contrast to Kan *et al* [35] , Jethan *et al* [36] and Reechaipichitkul*et al* [30]. This shows that these factors may not be reliable indicators of MTB infection. However, it's important to acknowledge that this doesn't necessarily mean these factors have no impact on MTB infection. They might still play a role, but their effects could be influenced by other variables not considered in this study. Notably, cough blood exhibited the highest correlation with MTB infection, followed by fever and hepatitis.This could demonstrate that these symptoms could be strong indicators of MTB infection. They could potentially be used as key symptoms to look out for in early detection and diagnosis of the disease. Family TB, cough 2 weeks, and contact cough 2 weeks demonstrated negative correlation with MTB infection. This is somewhat counterintuitive as one might expect these factors to increase the risk of MTB infection. However, this could be due to a variety of reasons such as effective preventive measures in families with a history of TB, or other factors not considered in the study. It's also possible that these factors do increase the risk, but their effects are overshadowed by other, stronger factors.

These results have significant implications for public health in Niger Delta region and Rivers state in particular. The evaluation of the interplay between associated risk factors with MTB infection can inform effective prevention and control strategies, including screening, diagnosis, treatment, and education. These results can also contribute to global efforts to eliminate MTB infection as a public health threat by 2035, as set by the World Health Organization [37].

Acknowledging limitations, including the reliance on self-reported data, and the absence of certain potential confounding variables not captured in this study, such as Socioeconomic factors; (income, housing conditions, and access to healthcare), might play a more significant role. Additionally, environmental factors specific to the Niger Delta, such as oil pollution and industrial emissions, warrant exploration as potential contributors to TB vulnerability is crucial. To address these limitations, future studies should employ the use larger and more diverse samples, and consider additional factors like genetic variables and immune status. Recommendations for future research include using more accurate methods of detection, and implementing more comprehensive surveys.

CONCLUSION

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This study emphasizes the lack of association between MTB infection and socio-demographic characteristics but highlights varying degrees of significant and insignificant correlations with clinical and additional risk factors. These findings contribute valuable insights for public health strategies in Rivers state and by extension, the Niger Delta region and beyond, aiding in the global efforts to eliminate MTB infection. However, caution is warranted due to study limitations, and future research should address these limitations and explore other influencing factors in the complex interplay between MTB infection and associated risks.

Ethical Approval and Consent

The study adhered to ethical guidelines and obtained approval from the Ethics committee, Rivers State Ministry of Health. All participants were provided with detailed information about the study's purpose, procedures. Written consent was obtained from each participant, ensuring their voluntary participation.

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