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Examination of the Association Between Poverty, Income, and Education Levels on Tuberculosis Prevalence in Nigeria: Rural Niger Delta Case Study

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Abstract

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MPH, Walden University, 2014

BSC, Iowa State University of Science Technology, 2011

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Public Health

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Abstract

Despite the global decline in tuberculosis (TB) cases, the prevalence of TB in rural populations in Nigeria is rising. To date, poverty and low educational levels continue to affect treatment and other prevention strategies to eradicate the disease. The purpose of this cross-sectional study was to assess the association between poverty, educational levels, household structure and vaccination status on TB prevalence in rural Niger Delta, Nigeria. The theoretical framework for this study was the socio-ecological model. Data were obtained from residents of rural Niger Delta in Nigeria attending a teaching hospital in southern Nigeria. The relationship between the stated demographic factors and TB prevalence was assessed with a binary logistic regression model to evaluate if any of the demographic variables could predict TB prevalence in the studied population. The study findings indicated that educational level was significantly associated with TB prevalence χ^2 (2) = 7.27, (p = 0.026). In addition, respondents with a smaller household size are less likely to develop TB (OR = 0.568, 95% CI = 0.367 – 0.879, p = 0.011). These findings emphasize the need for multi- and cross-sectoral approaches to optimize TB prevention and care. The social change implications of this study include the provision of information to policymakers, local health educators, and community members about the need to modify lifestyles that makes them vulnerable to the disease, thus reducing susceptibility to and the burden of the disease.

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Dedication

I sincerely dedicate this dissertation to my late father, Mr. Emmanuel Banwekalo Zarakpege, who ensured that I had a fair shot at education. To my wife, Patricia Zarakpege, who made it a task that this project is completed, and my son, Barivure Zarakpege, who would not stop giving me the doctoral title as a source of motivation, to encourage me to get to the finish line. These people have a special place in my heart for the incredible roles they played that motivated me to complete this project. God takes first credit for life and imagination made real.

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I appreciate God for making this work possible against all odds. Completing this study had been a combined effort of several people. I sincerely thank Dr. Dandison Ebeh, who worked tirelessly with me during the formative stages of this work, and the physicians at the teaching hospital, who offered their facility as the platform to carry out this study. I also thank Dr. Barry Ikpe, who continuously motivated and inspired me.

This work will be incomplete without the input from my committee chairperson, Dr. Chinaro Kennedy, and committee members Dr. Tolu F. Osoba, and Dr. Jirina Foltysova. They never hesitated to answer all my endless questions and provided critical reviews and clarity to this dissertation. Thank you to everyone who has, one way or the other, made it possible to complete my studies, and thank you to Walden University, who provided me with the knowledge and resources to complete this program at this great institution.

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Chapter 1: Introduction to the Study

Tuberculosis (TB) is a highly infectious disease caused by *Mycobacterium tuberculosis* (Organization for Economic Co-Operation and Development [OECD], 2020). According to health experts, TB is a disease that attacks the lungs and spreads via air when someone coughs or sneezes (Schildknecht et al., 2023). The World Health Organization (WHO) estimated that TB would kill 20% to 70% of infected individuals if left untreated, depending on severity (WHO, 2022). One third of the world's population is estimated to be infected, resulting in about 3 million deaths yearly, with over 95% occurring in developing countries (Kooffreh et al., 2016).

The burden of TB is said to be declining across the world; however, despite the global decline, the cases of TB are rising in Nigeria (Dirlikove et al., 2015). A paucity of quantitative studies examining how illiteracy and low-income/extreme poverty resulted in the high burden of TB in Nigeria is a rising concern for effective treatment at federal, state, and local levels. Furthermore, the reported high TB burden in Nigeria and elsewhere challenges global TB response and eradication (Adebisis et al., 2019). Thus, TB remains a significant public health problem affecting the world's poorest, weak, vulnerable, sick, marginalized, and underserving populace. The challenges of TB are even worse in the face of other chronic comorbidities, such as HIV/AIDs, cancers, and protracted disease outbreaks like Lassa and the COVID-19 pandemic. Other risk factors include smoking, alcohol abuse, malnutrition, and diabetes (Sakamoto et al., 2019). In this study, I addressed the gap in the literature on the associations between poverty caused by malnutrition, income levels, and education levels. A vital relationship, or a

two-way link, is established between malnutrition and poverty, creating a vicious cycle because malnutrition causes conditions that reduce the population's economic potential (Tellez-Navarrete et al., 2021).

Family structure has been identified as an important sociodemographic factor contributing to diseases' prevalence and incidence (Amo-Ajei, 2016). Family structure implies the living arrangement with one person identified as the head of the household, which. include biological, marital, and partnership relationships, such as biological-parent, stepfather, or single-mother families (Beckmeyer & Russell, 2018). Potential household environmental factors can enhance TB's prevalence risk, such as overcrowding and poor living structures (Singh et al., 2018).

As a high-incidence country for TB, Nigeria administers the Bacille Calmette-Guerin (BCG) vaccine to children at birth to prevent incidence (Orogade et al., 2013). Preventive measures such as childhood preinfection vaccination prevent or reduce TB infection risk (Herzmann et al., 2015). Vaccination with BCG given at birth has reduced or decreased the severity of TB (Zahra et al., 2012). However, lack of a potent vaccination due to an inconsistent power supply to maintain the temperatures of the vaccine, the inability to receive vaccination, and other mitigating factors could define the prevalence and incidence of TB in rural Niger Delta, Nigeria.

Background

TB often runs a chronic course primarily involving the lungs (pulmonary TB) and affecting other sites (extrapulmonary TB; Schildknecht et al., 2023). The disease can be present in complex mycobacterium TB (MTB) organisms, including *mycobacterium*

africanum, *mycobacterium bovis*, *mycobacterium canetti*, and *mycobacterium microfti* (Kooffreh et al., 2016). Some factors are associated with the increasing cases of TB, including HIV infection, alcoholism, chronic malabsorption syndromes, immunosuppressive therapy, end-stage renal infection, and smoking (Herchline, 2020). Similarly, in a study on TB transmission, Mathema et al. (2017) reported delayed treatment; environmental factors, such as closed airspaces with limited ventilation and free circulation of air; HIV-related cases; diabetes; smoking; alcohol; and malnutrition as factors that contribute to the rising cases of TB. In addition, Cui et al. (2020) studied long-term TB trends in China, India, and the United States between 1992 to 2017, focusing on joint point and age-period-cohort analysis. After distinguishing the ages in the three countries using the age-period-cohort model, the authors showed that the relative risks of TB in China and India were similar but differed from that in the United States. Their results further indicated that the older the population got, the higher the incidences of TB. The reason for increased TB incidences in old age is a continued decline in the relative immunity of the older population. Consequently, Cui et al. observed that the risk of TB continued to increase in the age group of 35–60-year-olds, with the peak at 75–79 years of age.

TB disease burden and attributable risks have remained and continue to be a major public health issue in low- and middle-income countries and the leading cause of death as a single infectious disease (Ogbo et al., 2018). The WHO global TB report of 2016 increased new infection cases to about 6.3 million, up from 6.1 million in 2015 (WHO, 2018). Ogbo et al. (2018) noted that the WHO had listed Nigeria as a high-burden

country for the last 20 years to stimulate a targeted response, interventions, and advocacy for funds and policies to enhance TB control. Although the WHO and its partners have been implementing intervention strategies in Nigeria, the country lacks practical guidelines to see such programs prosper (Kusimo et al., 2020). Country-specific studies must be conducted to inform policymakers and public health officers about strengthening TB prevention measures.

Vaccination at birth against TB in high-incidence countries such as Nigeria has helped reduce or prevent the disease on various fronts. The benefit of administering a TB vaccine is that it can be administered pre- or postexposure (Kaufman, 2020). In addition, the TB vaccine has proven to protect against severe extrapulmonary TB (Orogade et al., 2013). However, BCG must be improved because it is less protective against infant pulmonary TB because power failures plague Nigeria's cold chain system, resulting in a false sense of vaccine protection. According to Kaufmann (2020), there is a need for vaccines that will serve as the blueprints for rational designs of TB. Vaccines must also be designed to better understand the immune response to *Mycobacterium tuberculosis*.

Family structure is often called a nuclear family arrangement with parents and children living in the same household (Beckmeyer & Russell, 2018). This arrangement could also include extended family members (Amo-Adjei, 2016). According to Rakhmawati et al. (2019), there is a greater risk of disease and death with infectious TB among people living in close or intimate familial contact than those living in the general population. The number of people living together determines how much the infection is transmitted. The family could be a support system to reduce or cut further transmission

by disclosing the infected status of a family member. Singh et al. (2018) agreed that the physical environment that a individual lives in significantly influences the incidence of TB.

Problem Statement

Despite the global decline, the cases of TB are rising in Nigeria (Dirlikove et al., 2015). TB is a major public health problem affecting the world's poorest, weak, vulnerable, sick, marginalized, and underserving populace worldwide (WHO, 2021). TB threatens the lives of over 2 billion people across the globe and is more endemic and deleterious in lower socio-economic nations, such as Nigeria, which bears about 4% of the global TB burden (WHO, 2021). According to Adepoju (2020), a global TB report comparing the disease burden between 2018 and 2019 indicated that the burden of the disease is increasing in Nigeria, in sharp contrast with the international outlook. The disease incidence rate increased from 418,000 in 2017 to 429,000 cases in 2018, while deaths increased from 155,000 to 157,000 within the same period (Adepoju, 2020). Although the number of laboratory-confirmed cases of drug-resistant TB in Nigeria reduced from 2,300 cases in 2017 to 2,275 in 2018, the estimated cases of multidrug resistant TB rose to 21,000 cases in 2018, up from 5,400 cases in 2017 (Adepoju, 2020). Some factors, such as early and improved screening/detection measures, a high index of TB suspicions in patients presenting with cough, multidrug resistance, lack of or incomplete treatment, missing data, and socioeconomic factors, were suggested to account for this high TB prevalence in Nigeria (Adepoju, 2020).

Family structure, defined as nuclear arrangements of only parents and children (McAnally et al., 2022), and poor household living conditions have also been highly prevalent (Erlinger et al., 2019). A growing consensus suggests that TB is more common in urban than rural areas; however, poor living conditions in rural areas and overcrowded households could be breeding grounds for high TB infections (Zhang et al., 2020). According to Singh et al. (2018), a contaminated household environment significantly increases the risk of TB infection. They posited that the number of persons living in the household and sharing toilets and portable water with other members of the same household serves as some of the multiple risk factors strongly associated with TB prevalence.

A few studies, such as Cui et al. (2020) and Dhamnetiya et al. (2019), have investigated the continuous rise in TB cases despite the numerous mitigation strategies in place to curtail its spread by specific countries and other global efforts. Similarly, Herchline (2020) noted that 1 in 3 persons was diagnosed with TB. Onyedum et al. (2017) reported there were 10.4 million TB cases in Nigeria in 2016, accounting for 8% of the cases worldwide. These 10.4 million cases in 2016 equaled 407 cases per 100,000 individuals, which was an increase from the 322 cases per 100,000 people reported in 2015. Additionally, Herchline reported that as of 2010, there were more than 8.8 million cases with more than 1.1 million deaths. Consequently, Nigeria's rising number of TB cases is a significant social problem (Alao et al., 2020; WHO, 2018).

To address the concerns identified, scholars have investigated the reasons for the significant rise in TB cases in Nigeria. For instance, Ogbo et al. (2018) mentioned that

extreme poverty and overcrowding increased TB cases. Haruna et al. (2018) added that drug-resistant TB also increased the rates of TB. Furthermore, Glaziou et al. (2015) observed that low literacy levels, poor economic status, and elevated poverty levels in low- and middle-income countries increased the rates of TB. Adebisi et al. (2018) noted that although countries such as Nigeria have established free TB care, this may also be responsible for the observed iceberg phenomenon of TB burden in the country, causing a temporary high reportage of TB burden in Nigeria.

Even though the aforementioned studies have explored factors contributing to TB prevalence, there is a lack of quantitative studies examining how inaccessibility to health care, low income, and extreme poverty result in increased TB cases in Nigeria. Following the findings of the extant literature, many of these studies, including Ogbubor and Onwujekwe (2019) and Onyeme, (2019), recommended the need to conduct more studies to statistically describe how low-income status and inaccessibility to health care services led to increased incidences of TB.

Purpose of the Study

In this quantitative cross-sectional study, I assessed the association between the sociodemographic factors of poverty, family structure, low educational levels on TB prevalence in rural Niger Delta, Nigeria. I also examined the association between TB vaccination status and prevalence in Nigeria's rural Niger Delta. Given that the available BCG vaccination may have been administered to patients between the ages of 18–64 during the first months following their birth, the vaccine's effectiveness and the prevalence of TB in the region were also assessed in this study.

Research Questions and Hypotheses

The following research questions and hypotheses guided this study:

RQ1: Is there an association between income and TB prevalence in rural Niger Delta, Nigeria, even after controlling for age, gender, occupation, and ethnicity?

$H_0$1: There is no statistically significant association between income level and the prevalence of TB in rural Niger Delta, Nigeria even after controlling for age, gender, occupation, and ethnicity.

H_a1: There is a statistically significant association between income level and the prevalence of TB in rural Niger Delta, Nigeria, and this association remains, even after controlling for age, gender, occupation, and ethnicity.

RQ2: Is there an association between education level and TB prevalence in rural Niger Delta, Nigeria even after controlling for age, gender, occupation, and ethnicity?

$H_0$2*:* There is no statistically significant association between levels of education and TB prevalence in rural Niger Delta, Nigeria even after controlling for age, gender, occupation, and ethnicity.

H_a2: There is a statistically significant association between education level and TB prevalence in rural Niger Delta, Nigeria, and this association remains, even after controlling for age, gender, occupation, and ethnicity.

RQ3: Is there an association between TB vaccination status and TB prevalence in rural Niger Delta, Nigeria even after controlling for age, gender, occupation, and ethnicity?

$H_0$3*:* There is no statistically significant association between vaccination status and TB prevalence in rural Niger Delta, Nigeria even after controlling for age, gender, occupation, and ethnicity.

H_a3: There is a statistically significant association between vaccination status and TB prevalence in rural Niger Delta, Nigeria, and this association remains, even after controlling for age, gender, occupation, and ethnicity.

RQ4: Is there an association between household structure and TB prevalence in rural Niger Delta, Nigeria even after controlling for age, gender, occupation, and ethnicity?

$H_0$4*:* There is no statistically significant association between household structure, defined as a nuclear arrangement (i.e., only parents and children), and TB prevalence in rural Niger Delta, Nigeria even after controlling for age, gender, occupation, and ethnicity.

H_a4: There is a statistically significant association between household structure defined as a nuclear arrangement (i.e., only parents and children) and TB prevalence in rural Niger Delta, Nigeria, and this association remains, even after controlling for age, gender, occupation, and ethnicity.

Theoretical Framework for the Study

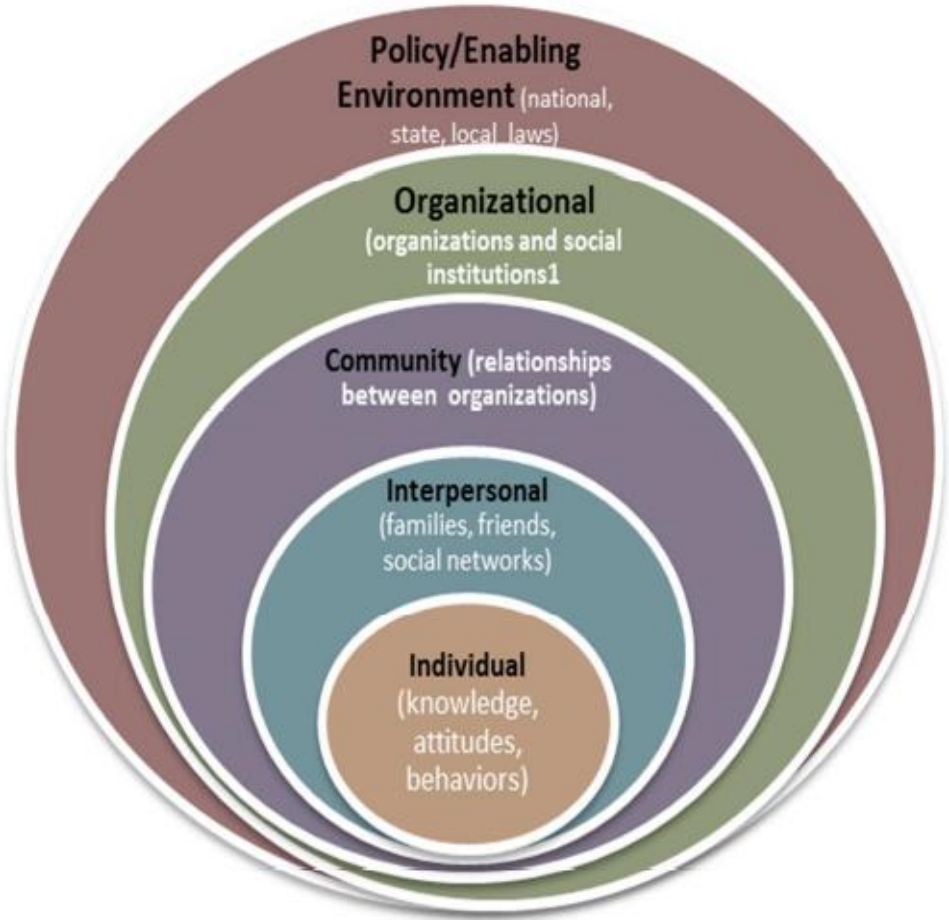
The theoretical framework guiding this study was the socio-ecological model (SEM). This model was introduced in the 1970s as a conceptual model by Urie Bronfenbrenner but was made formal as a theory in the 1980s (Tehrani et al., 2016). According to this framework, the entire ecological system where human birth, residence, and growth occur must be considered to understand human development (McCormack et al., 2017). Furthermore, this model contains a description of individuals' interactive characteristics and the environments that shape their health outcomes (McCormack et al., 2017). According to this theoretical framework, behavior and health are intertwined and cannot be viewed separately (Olaniyan et al., 2021). In addition, the SEM also includes a description of the relationship or interdependence between the individual, which is internal, and the environment, which is the external factors that influence them (Bradshaw et al., 2013). This framework is widely used in public health promotions and interventions (Centers for Disease Control and Prevention [CDC], 2020; Linke et al., 2014).

According to McCormack et al. (2017), health literacy aligns with increased patient engagement supported by the SEM. This model reflects the importance of context, which shows how literacy and patient engagement are inextricably connected and provides insights into how both could be enhanced. The five categories of the SEM are individual/intrapersonal factors, such as gender, age, and race; interpersonal/sociocultural factors, which include family, friends, and social groups; community factors (i.e., relationships between organizations); organizational factors (i.e., organizations and social

institutions); and the policy/enabling environment, which includes national, state, and local law (CDC, 2018). The SEM of health promotion was later advanced on the notion that an individual's health and well-being are also defined by their behaviors, genetic heritage, psychological instincts, and social entanglements (Olaniyan et al., 2021).

Figure 1

The Social-Ecological Model



Adapted from the Socio-ecological model: Framework for prevention, centers for disease control. Available from the Centers for Disease Control and Prevention (CDC; 2020). http://www.cdc.gov/violenceprevention/overview/social-ecologicalmodel.html. 4

Nature of the Study

I used a quantitative cross-sectional study design to examine the research questions in this study. Specifically, I investigated the social determinant of TB burden in Nigeria. Therefore, the cross-sectional design was considered appropriate as it enabled me to measure the extent to which associations exist between the independent variables of poverty and education level and the dependent variable of TB prevalence in Nigeria.

Definitions

Burden: This concept was developed in the 1990s by the Harvard School of Public Health, the World Bank, and the WHO to describe death and the loss of health due to diseases, injuries, and risk factors for all regions of the world (WHO, 2020).

Dependent variable: The values that are influenced by other by independent variables or other values (Andrade, 2021).

Examination: Any investigation or inspection made to make a diagnosis, usually qualifying by the method used (Medical Dictionary, 2021).

Family structure: The diversity of types of family unit composition (Beckmeyer & Russell, 2018).

Illiteracy: The state of being illiterate, especially the inability to read or write (Merriam-Webster, 2021).

Independent variable: Values that influence other variables, such as age, sex, etc. (Andrade, 2021).

Poverty: This concept entails more than the lack of income and productive resources to ensure sustainable livelihoods; its manifestations include hunger and

malnutrition, limited access to education and other basic services, social discrimination and exclusion, and the lack of participation in decision making (United Nations, 2021).

Prevalence: The proportion of a population with a specific characteristic in a given time (NIH, 2021).

Sociodemographic factors: A combination of social and demographic factors, which include gender, age, level of education, employment status, profession, marital status, the total number of persons living in the house, and living arrangements (Gobbens & Remmen, 2019).

Vaccination status: Whether a person is up to date or not with a vaccination (CDC, 2021).

Assumptions

In this study, I utilized the elements of the SEM, which details how environmental factors and other individuals influence and determine the health behavior in people. The framework conceptualizes human development in which individuals are placed into the center of circles surrounding them that reflect the interrelationship of several factors that determine development and interactions at the various levels (i.e., personal, relational, collective, and organizational) all located in the individual's socio-ecological environment (Henderson & Baffour, 2015). Therefore, I assumed that the behavior of the patients or individuals is shaped by many environmental factors while also considering biological components that enable the individual to develop or prevent attitudes and behaviors.

Another assumption was that the data sets collected on the study population would be accurate and reflect the relationship between income levels, educational levels, vaccination status, family structure, and the prevalence of TB, which is the health outcome. For instance, I assumed that being literate or educated translates to having health awareness, which ties into the body of literature on its potential impact in the understanding of the spread of the disease. It was likewise assumed that being uneducated translates to being poor.

Scope and Delimitations

A potential delimitation for this study was the geographic limit of the study on one teaching hospital in 1 out of the 36 states of Nigeria. It would have been impractical to survey all TB cases or treatment centers due to time, logistic, and financial constraints. The population included in this study were patients attending the General Outpatient clinic of the teaching hospital. The participants had to be between 18–64 years old and reside in rural Niger Delta, Nigeria. Individuals who declined consent were also excluded. The convenience sampling strategy was used to collect the sample for this study. This type of sample is drawn from a source that the researcher has easy access to (Andrade, 2021). The sample drawn from this source may not represent the entire population; however, if the findings are trustworthy, they could have high internal validity, but they only be generalized to the population from which the sample was drawn (Andrade, 2021). In addition, although I asserted that individual- and community-level education is critical to combat TB successfully in this study, it was also obvious that more needs to be done in developing countries with an uptick or high incidence rate.

Limitations

Cross-sectional designs are generally limited because they provide a snapshot of an event (in not being able to establish the sequence of events) and only provide limited information. The survey instrument used captured the necessary constructs for this study to address these limitations. The research questions for this study did not require a temporal association to answer them. This type of design is limited because it is prone to biases (i.e., measurement and recall) and low response rate (Di Girolamo & Mans, 2019). To reduce recall and information bias, I developed the questionnaire used to be clearly worded so that the respondents would not have difficulties comprehending what the questions meant. Administering the semi structured questionnaire was also critical in minimizing missing data.

Additionally, the findings of this study cannot be used to draw a valid conclusion about possible causality or association. Temporal biases, another limitation, makes it difficult to establish causality of the disease or its risk factor (Szklo & Nieto, 2014). This is so because when both risk factors and outcomes are present, they must be measured simultaneously (Stangor, 2011). Causation needs to be confirmed through more rigorous studies.

Sample size in studies of this nature need to be large enough to estimate the prevalence of TB with precision. I anticipated collecting a minimum of 204 participants for analysis. The larger the sample size, the less likely the result is due to chance alone. As previously indicated, nonresponse bias is a problem with the quantitative cross-sectional design and can result in measures of the outcome being biased.

Another possible limitation was the use of a convenient sample. Samples for this study were drawn conveniently from attendants who are TB patients of the teaching hospital. According to Andrade (2021), generalization is only possible if the samples were drawn randomly from that population. Other types of validity include content validity, empirical validity, and construct validity Middleton, 2020). Content validity issues were minimized and checked by review of the survey instrument. Empirical validity, also known as instrument validity, was checked by comparing the survey instrument with similar instruments for measuring constructs of the study in the literature (see Bawazir, 2014). I reviewed construct validity statistically through the pilot study after data collection to assess the degree of agreement (Kappa) between responses.

Significance of the Study

Nigeria's health care system is overwhelmed with the challenges of high incidence and prevalence levels of TB (Alao et al., 2020; Oga-Omenka et al., 2021). TB reports from the CDC and WHO for the year 2021 identified Nigeria with high TB burdens despite the global decline in other countries (WHO, 2022). While significant measures have been taken to contain the infection by the health care system in collaboration with the CDC, in this study I further explored the theoretical undergirding of both the impacts of poverty, and literacy levels. In addition, family structure, as defined as one parent and children, and vaccination status suggest measures that could be generalized at the local, state, and federal levels to address this burden.

Social Change Implications

Walden University students strongly adhere to the university's social change mission as part of graduate students' capstone projects. Social change implications have reach beyond the research, extending to the population being studied and, where possible, the entire population (Walden University, 2022). In this study, I examined the association of poverty (measured by income), levels of education, vaccination status, and family structure on the prevalence of TB in rural Niger Delta region of Nigeria. When analyzed, the odds ratio provides significant information on the strength of association between a risk factor and TB prevalence. Finding the prevalence is important in public health for assessing the burden of the disease in rural Niger Delta, Nigeria. The implications of this study are significant because the results may contribute to positive social change through identifying the factors associated with the high TB burden in rural Niger Delta, Nigeria and addressing them. Public health practitioners at the local, state, and federal levels could use the findings of this study to help develop interventions and prevention programs directed to curb the spread of TB among the study population. The study was based on two health improvement models: educating the local population on the prevention of transmission and educating local policymakers on appropriate public health prevention measures. The findings may also align with similar studies that have shown an association with high TB prevalence in Nigeria.

Summary

TB is a global public health issue. Though WHO has been trying to eradicate it via many programs, including the current End TB Strategy, many challenges still affect

TB control, especially in developing countries and underserved areas with poverty and illiteracy (WHO, 2015). Nigeria, being recently described as the world's poverty capital, is grappling with high illiteracy levels and the resultant cumulative effects of the TB burden caused by several factors (WHO, 2021). Despite TB control research efforts, the widening gap between the rich and the poor and lowered education standards have resulted in the high illiteracy rate, especially in Northern Nigeria, which has led to the country being one of the world's drivers of TB burden.

An approach proposed toward addressing inequalities-education and socioeconomic status (SES) is a paradigm shift from the traditional downstream approach to the more innovative upstream approach with a prevention focus (McMahon, 2022). It is hoped that implementing the sustainable development goals (SDGs) will help immensely in the fight against TB globally, particularly in Nigeria. In this study, I examined the possible roles of poverty and education on the TB burden in Nigeria with the hopes of saving lives, especially among the underserved populace. The next chapter contains a review of the relevant literature.

Chapter 2: Literature Review

Despite its global decline, TB constitutes a major public health problem affecting the world's poorest, weak, and most vulnerable populations (Dirlikove et al., 2015). TB threatens the lives of over 2 billion people worldwide and has been observed to be more endemic and deleterious in lower socio-economic nations, such as Nigeria, which bears about 4% of the global burden (WHO, 2022). According to Adepoju (2020), a recent global TB report showing a comparison between 2018 and 2019 indicated that the burden of the disease is increasing in Nigeria, in sharp contrast with the increasingly global outlook. This report showed the disease incidence rate increased from 418,000 in 2017 to 429,000 cases in 2018, while deaths also increased from 155,000 to 157,000 within the same period. The report also showed that although the number of laboratory-confirmed cases of drug-resistant TB in Nigeria has reduced from 2,300 cases in 2017 to 2,275 in 2018, the estimated cases of multidrug resistant TB rose to 21,000 cases in 2018, up from 5,400 estimated cases in 2017.

Consequently, Nigeria's high incidence and prevalence rate is a significant social problem that should be addressed. Ogbo et al. (2018) indicated that extreme poverty and overcrowding had increased the incidence rate. In addition, Haruna et al. (2018) suggested that drug-resistant TB also increased the rates of TB, and Glaziou et al. (2015) observed low literacy levels doing the same. Oga-Omenka (2020) and Assefa et al. (2019) have investigated a wide array of other factors, including early and improved screening/detection measures, a high index of TB suspicions in patients presenting with cough, lack or incomplete treatment, missing data, and socioeconomic factors; however,

these studies were both qualitative. There is a lack of quantitative examinations of the impact of poverty and lower literacy levels on the elevated incidence and prevalence rates of TB in Nigeria. In this quantitative study, I assessed the association between sociodemographic factors, namely poverty and low education levels, and TB prevalence in rural Niger Delta, Nigeria.

Literature Search Strategy

I obtained material for the literature review by searching databases, dissertations, and theses available electronically. Electronic databases searched included CINAHL Plus full text, Medline with full text, Dissertations and Thesis at Walden University, and PubMed. I also used the Google search engine to supplement the electronic databases. My searches of databases were limited to peer-reviewed, full text articles published in English between January 1, 2015 and May 12, 2022. Reference sections of identified relevant articles were further checked to retrieve more materials. For those important materials identified from articles and Google whose full text was not available in Walden Library, I sent a request to the Walden Library team for help securing the full-text copies.

I used the following keywords (shown with corresponding results in parentheses) in searches of databases and Google:

- *Tuberculosis* (108,000,000) searched together 729,000 articles
- *Public health* (4,920,000,000; when searched in combination 124,000,000)
- *Examination* (614,000,000; when searched in combination 14,000,000)
- *Nigeria* (2,460,000,000; when searched in combination 850,000)
- *Poverty* (328,000,000; when searched in combination 1,180,000)

- *Illiteracy* (53,400,000; when searched in combination 4,640,000)
- *Income* (1,070,000,000; when searched in combination 16,800,000)

These terms were searched individually and in combination to ascertain relevant articles for consideration.

Health Systems and the TB Burden

Although the global health systems have improved and health expectancy also increased, the COVID-19 pandemic has significantly decimated developed, developing, and under-developed nations (OECD, 2020). Before the pandemic, health systems struggled to contain diseases such as HIV, diabetes, TB, cancer, and cardiovascular diseases, deemed the greatest destroyers of human health and health systems (OECD, 2020). Examining how the coronavirus pandemic has interfered with the health systems, OECD (2020) reported that the treatment and prevention of the diseases mentioned above have taken a deep hit because funds have been directed to counter the effects of the coronavirus pandemic.

Adewole (2020) reported that the effects of the pandemic had been felt in the economy and social life; consequently, the pandemic has disrupted the mitigation strategies and preventive measures for diseases like cancer, TB, and cardiovascular infections. With the virus's rapid spread, most countries diverted their funds into containing it, significantly underfunding other health care programs. Adewole mentioned that the long-term impacts of coronavirus on the gains made in detecting, preventing, and treating TB would be slowed down or even eliminated. Adewole reported that Nigeria had the highest TB burden on the African continent and ranked sixth globally.

Additionally, Adewole identified that the close similarity in the symptoms between coronavirus and TB posed a threat to the screening and detecting both infections. With state machinery targeting the COVID-19 virus, the rate of TB screening dropped significantly, from 34% in 2019 to 13.6% in March 2020. It must also be noted in relation to Adwole's findings that the underlying figures for TB were be higher than the estimated figures.

In the current study, I focused on TB and its upward trajectory on the global health scale and Nigeria. TB is a highly infectious disease caused by the bacteria, *Mycobacterium tuberculosis* (OECD, 2020). According to health experts, TB is a disease that attacks the lungs and spreads via the air when someone coughs or sneezes (Schildknecht et al., 2023). The WHO (2020) has estimated that TB will kill 20% to 70% of the infected individuals if left untreated, depending on severity.

Factors Associated with High TB Prevalence

According to Herchline (2020), some factors associated with the increasing cases of TB include HIV infection, alcoholism, chronic malabsorption syndromes, immunosuppressive therapy, end-stage renal infection, and smoking. Similar results were found by Mathema et al. (2017) in a study of the drivers of TB transmission, with the researchers reporting that delayed treatment; environmental factors, such as closed airspaces with limited ventilation and free circulation of air; HIV-related cases; diabetes; smoking; alcohol; and malnutrition contribute to the rising cases of TB.

Cui et al. (2020) studied a long-term trend in the incidences of TB in China, India, and the United States between 1992 to 2017 with a focus on Joinpoint regression in the

age-standardized incidence rate and age-period-cohort analysis. . The study findings showed that the relative risks of TB in China and India were similar but differed from that of the United States. The results further indicated that the older the population got, the higher the incidences of TB. The main reason for increased TB incidences in old age was a continued decline in the relative immunity in the older population. Consequently, Cui et al. observed that the risk of TB continued to increase in the age group of 35–60-year-olds, with the peak at 75–79 years of age.

Herchline (2020) stated that more than 1 in every 3 people have had TB. According to the WHO, the world recorded more than 8.8 million cases of TB in 2010, with more than 1.1 million deaths in HIV-negative patients and 0.35 million deaths in HIV-positive patients (Herchline, 2020). The data released by OECD (2020) on TB labeled the disease as the leading cause of death in the Asian-Pacific region. For instance, the OECD reports indicated that as of 2018, there were more than 10 million incidences of TB, representing new and relapsed cases. There were 1.2 million deaths among HIV-negative patients recorded in the same year, with India, Pakistan, and Indonesia recording more than 40% of the incidences. The OECD reported that the WHO, as of 2018, designated five countries from the Asian-Pacific regions as countries with the highest incidences of TB; India, China, Indonesia, Pakistan, and the Philippines were estimated to account for 56% of the global cases of TB. Specifically, India had 2.69 million cases, while China recorded 0.86 million. Pakistan, the Philippines, and Indonesia recorded 0.56 million, 0.59 million, and 0.84 million cases, respectively (Herchline, 2020).

Similarly, MacNeil et al. (2018) reported that TB was the leading cause of death when examined from a single infectious agent, especially among patients infected with HIV. Additionally, MacNeil et al. said that the data gathered by the WHO from 194 member states showed that as of 2018, more than 10 million people were infected with TB, with 1.5 million dying from the disease. However, MacNeil et al. asserted that the data presented a significant reduction in TB incidences accounting for between 2% and 5% of infections and deaths reported in 2017 due to the preventive measures.

Even though the WHO has reported a continued drop in the cases of recorded TB as shown above, many scholars have still reported that TB is a challenge, and its incidence is continuously on the rise, especially in low- and middle-income countries. For instance, when studying the rising cases of multidrug resistant TB in Pakistan, Sheikh et al. (2018) reported that an estimated 10.4 million persons were infected with TB, with 47% of the recorded cases coming from India, Pakistan, China, and Russia. Reporting on the findings of previous scholars on the epidemiology of TB, Sheikh et al. mentioned that the younger population was at greater risk of TB infection and that there was higher prevalence among this population, especially among 10- to 25-year-olds, due to poor eating habits and fewer nutrients to strengthen the body's immune system. Moreover, the researchers reported that there have been rising cases of multidrug resistant TB in low- and middle-income nations due to poor follow ups, delays in diagnosis, the unavailability of social support programs for the high-risk population, and inadequate and inappropriate drug regimens.

In another study, Nitu et al. (2017) investigated TB in Romania noting that, since the beginning of the century, the cases of TB have been on an upward trajectory in the country and pose severe economic and health risks in that TB reduces an individual's working capacity and productivity. Consequently, the rising cases of TB in Romania were a result of the rising cases of HIV that significantly compromises an individual's immunity and increase cases of migration.

Additionally, the rising cases of drug-resistant TB due to late diagnosis are exacerbated by the poor economic status of developing countries. According to Nitu et al. (2017), the WHO records 8 to 9 million new cases of TB each year, with an approximated mortality of 2 million. Macneil et al. (2018) and the OECD (2020) reported that a third of the world's population has been infected with TB and 47% of the infected population are from Southeast Asia. According to Nitu et al., the effects of TB on the Romania health system are substantial. Nitu et al. reported that among the countries with high incidences of TB in Europe, Romania is in fifth place after Kazakhstan, Georgia, Kyrgyzstan, and Kazakhstan. Examining the trend of TB since 1985, Nitu et al. reported that Romania experienced growth in the incidence rate of TB from 1992 and peaked in 2002 at 142.2%. Further analysis revealed that starting in 2003, the rates of TB began a downward spiral, with the first level recorded in 2011 (82.5%) and the second and subsequent levels were reported in 2013 (73%) and 2014 (70%). In as much as health systems and programs to combat TB have improved since it was declared a public health concern in 1993, TB continues to wreak havoc. However, the number of deaths resulting from TB is declining with the improved health systems, and the WHO stopped the TB

partnership program (Nitu et al., 2017). Although the 2015 target of the stop TB partnership was not achieved, there were significant strides in reducing the severity of the disease. For instance, compared to 1990, the WHO (2018) reported a significant drop in mortality by 45% from 1990 to 2013.

TB Experience by Country

As reported by the WHO, MacNeil et al. (2018), and the OECD (2020), low- and middle-income countries have experienced and recorded rising cases of TB. MacNeil et al., Nitu et al. (2017), and the WHO reported that Southeast Asia was ranked number one in TB cases, followed by Africa. The reports also indicated that the rising cases of TB in middle- and low-income countries were due to the nation's low economic strength, which translated into misdiagnosis, improper or lack of supervision, inappropriate drug regimen due to misdiagnosis, and generally weakened immunity due to poor feeding habits.

Nigeria has been reported as the country with the highest number of TB cases in Africa (WHO, 2020). Consequently, the global TB report of 2019 ranked Nigeria as the country with the widest gap between its actual TB infection number and estimated value after India (Adepoju, 2020). Accordingly, Adepoju (2020) compared the 2018 and 2019 reports on TB and reported that the cases in Nigeria were on an upward trajectory. Additionally, Adepoju found that TB incidences rose to 429,000 cases in 2018, up from 418,000 in 2017. Similarly, mortality due to TB also rose to 157,000 from 155,000 in the same period, while diagnosis, prevention, and treatment stagnated at 24% within the same period (Adepoju, 2020). Although the number of laboratory-confirmed cases of drug-resistant TB in Nigeria has reduced from 2,300 cases in 2017 to 2,275 in 2018, the

estimated cases of multidrug resistant TB rose to 21,000 cases in 2018, up from 5,400 estimated cases in 2017.

TB Burden in Nigeria

Onyedum et al. (2017), in a systematic and meta-analytic study, investigated the prevalence of multi-drug resistant TB in Nigeria. Preliminary findings of the systematic review conducted by Onyedum et al. reported that multidrug resistant TB has negatively affected the government's effort to combat and eradicate it using the limited available resources. Quoting the report presented by WHO in 2016, Onyedum et al. mentioned that, of the global 10.4 million TB cases, 3.9% were estimated as rifampicin or multidrug resistant TB as of 2015. Similarly, reports released by WHO in 2019 showed an increase in the cases of rifampicin and multidrug TB. According to WHO reports, an estimated 206,030 individuals are infected with rifampicin of multidrug resistant TB- a 10% increase from 2018, with a global total of 186,883.

Onyedum et al. (2017) reported that the rising cases of drug-resistant TB is due to the use of inferior drug regimens, over-exposure to quinolones, high cases of HIV, and nonadherence to anti-TB drugs. Also worth noting is that individuals infected with drug-resistant TB must undergo prolonged and expensive treatment s with a less toxic and effective second-line medication. In Nigeria, Onyedum et al. (2017) alluded that Nigeria was among the 30 countries characterized by WHO as a high burden. WHO estimated that for every 100,000 individuals, there was a possibility that 322 were infected with TB. Even though the study conducted by Onyedum et al. was significant, there were several setbacks. For instance, there were only a few studies to review. In addition, the

researcher's bias and the findings on drug-resistant TB in Nigeria may not effectively represent its prevalence since its magnitude has not yet been investigated in other parts of Nigeria.

Ogbo et al. (2018) in TB disease burden and attributable risks in Nigeria reported that tuberculosis has remained and continues to be a major public issue in low- and middle-income countries and is the leading cause of death as a single infectious disease. According to Ogbo et al., the WHO global TB report of 2016 described an increase in new infection cases to about 6.3 million, up from 6.1 million in 2015. In addition, the 2016 reports on the global burden of diseases, injuries, and risk factors showed more than 9.0 million new TB-HIV negative cases, increasing from 8.8 million in 2015. On a global scale, Ogbo et al. reported that Africa accounted for 25% of the reported incident cases, with Nigeria accounting for 8% or 407 cases per 100,000 individuals in 2016 and an increase from 322 per 100,000 population reported in 2015.

However, the data mentioned above may be lower than the actual number on the ground, given that less than 15% of all TB cases were reported in 2015. Concurring with the findings by Onyedum et al. (2017), Ogbo et al. (2018) reported that for the last 20 years, WHO has listed Nigeria as high burden country with the intent of stimulating targeted response, interventions and advocating for funds and policies to enhance TB control in the country. Although WHO and its partners have begun rolling out intervention strategies in Nigeria, the country lacks practical policies to see such programs prosper. The data used by Ogbo et al. was retrieved from the global TB report, which may not represent a true picture of the situation on the ground. As such, country-

specific studies must be conducted to inform policy makers and public health officers on strengthening TB prevention measures.

Dim and Dim (2013) conducted a quantitative study investigating tuberculosis prevalence and treatment trends in the underfunded Enugu State in Southeast Nigeria. Dim and Dim reported that tuberculosis was still a huge burden in Nigeria. Moreover, Dim and Dim claimed that the increasing cases of TB in Nigeria resulted from the failure of the government to publish TB reports for the public. The failure of the government to publish TB reports has contributed significantly to the increased ignorance and poor attitude among Nigerian citizens regarding TB, hence high infection rates (Dim & Dim 2013).

Further, Dim and Dim (2013) noted that Nigeria is characterized by medical pluralism or different health care options ranging from traditional medicine, spiritual healers, and orthodox medicine that operate freely within Nigeria. Even though government facilities dealing with TB control are operational, people have distanced them as most have not regarded such facilities as the first option for TB treatment. The failure of people to adhere to TB treatment or visit TB control facilities for diagnosis has increased the infection prevalence. Similarly, the failure by the government and the ministry to educate and empower its citizens with knowledge on the effects of TB has increased its burden on the people and the economy as a whole. As such, Dim and Dim reported that the ignorance and the poor attitude of Nigerian citizens coupled with the limited resources, will hinder the progress of Stop TB Partnership campaigns. Using the data from the Ministry of Health's TB control program from 2000 to 2009, Dim and Dim

reported that TB incidences in Enugu state were on the rise. The reason for the continually increasing number of TB in Enugu State is ignorance and inconclusive reports on the burden and risks of TB.

Additionally, in the report published by the Guardian Nigeria (2015), Gabriel Akang, the then director of the National Tuberculosis and Leprosy Control Programme asserted that the WHO ranked Nigeria as the third country among the 22 nations with the highest TB prevalence. As of the same year, Guardian Nigeria reported over 600,000 new confirmed cases of TB in the country.

TB Prevalence and BCG Vaccination

BCG is the licensed and commonly used vaccination against tuberculosis globally. BCG is an attenuated strain of *Mycobacterium bovis*. This is the only vaccination given at birth to children to prevent TB (WHO, 2022). BCG was introduced in 1921 (Fritschi et al., 2020). When it was introduced, there were no double-blind placebo-controlled trials before its usage. However, randomized and other trials were later carried out (Katalaris et al., 2020). Although the efficacy against strains such as tuberculosis meningitis and miliary TB in these randomized clinical trials in the meta-analysis was 85% (95% CI: 65%-95%), the effectiveness against pulmonary TB is highly variable at 0%-80%.

A randomized placebo-controlled trial in South India was conducted, and the efficacy was 0%. (Gijsel & Fordham, 2019). The study showed that BCG vaccination with scar is 59% effective and that the prevalence of TB among immigrant children is 17%. Some participants in the study were seen with active TB, thus indicating the need

for an improved TB vaccine. According to Dockrell (2017), the lower level of effectiveness is very common and partly due to the differing effects of BCG vaccine. Despite these, Kumar (2021) noted that as TB continues to be one of the major public health problems, the BCG vaccine is the only tool available that provides significant protection against childhood TB. It emphasizes its effectiveness against childhood TB and the fact that repeated doses are not needed to protect against pulmonary TB as an additional advantage. Gonzalez-Perez et al, (2021) agreed that the accessibility to BCG offers tremendous benefits in addition to the flexibility in its administration. This it argued, is not the case with the coronavirus 2(SARS-COV-2 which takes a longer period and infrastructure to vaccinate a good proportion of the population. Escober et al. (2020) suggest that BCG confers broad protection against other diseases. However, the global connection between BCG vaccination and COVID-19 mortality reflects influences of social, economic, and demographic differences between countries.

TB Prevalence and Family Structure

Family structure has been identified as a driver of high TB infections (Mathema et al., 2017). Family structure, defined as nuclear arrangements of only parents and children, could include extended family members such as grandparents and in-laws living together due to societal and economic shifts. In addition, more people living in small households have an increased risk of TB transmission after prolonged exposure (Mathema et al., 2017). This is especially true for those in familial contact with infectious TB.

According to Sanders et al. (2020), households affected by TB have intense transmission. Singh (2018) in the study that examined the association of household environment with the prevalence of TB, agreed that a contaminated household or family structure increases the risk of TB, with prevalence being highest among older people. Children in multigenerational families are at high risk of TB infection from an infected household adult member (Dodd et al. 2018). According to Jenkins et al. (2017), about half a million deaths from TB among children yearly become undiagnosed because younger children are more likely to develop more severe and severe variants of TB, such as TB meningitis (Chiang et al., 2014).

WHO Response to TB Prevalence

According to Alao et al. (2020), since WHO declared TB a health crisis in 1993, TB has remained a major health concern and global challenge. Consequently, despite the economic burden, it has remained the single most killer disease globally, calling for continuous global research. Furthermore, low- and middle-income countries continue to experience the gruesome impacts of TB due to poor health facilities for diagnosing and supervising TB patients. Equally, Alao et al. reported that multidrug resistant TB is also rising due to overcrowding, increasing TB spread, inadequate nutrition contributing to weak immune systems, extreme poverty, and low-quality health care. Following the mentioned information on the prevalence of TB in previous discussions, Alao et al. conducted a retrospective review of the treatment outcomes of Nigerian patients diagnosed with TB. First, Alao et al. provided that the third WHO's sustainable development goal projected that by 2030 WHO and countries would have cleared the TB

epidemic by 2030. Similarly, Glaziou et al. (2015) reported that, in line with the Millennium Development Goals, WHO had set global targets for reducing TB in 2015 and 2050.

Further, Glaziou et al. (2015) stated that to achieve the set targets, the WHO, in collaboration with the Stop TB Program, stipulated some measures to meet the required target. Some measures reported by Glaziou et al. include promoting innovative research, addressing key epidemiological and system challenges, and adopting best practices for early diagnosis and treatment of TB in its early stages. Correspondingly, Alao et al. (2020) reported that to achieve the targets of the third sustainable development goal, low and middle-income countries needed to establish comprehensive and ongoing reviews of achievements and setbacks of various treatment and mitigation processes. Such ongoing reviews are meant to guide new developments and additional improvements to the programs to achieve the target 85% treatment rate assigned by the WHO. In previous studies, Alao et al. mentioned that the success rates of treatments offered to patients in the past 30 years had varying results that ranged from 34% to 45% in low- and middle-income countries.

The study's findings conducted by Alao et al. (2020) established that the treatment outcomes of TB patients were constant, with the mean successful annual treatment outcome being 75.3 % higher than 34% and 37% of the outcomes in other parts of Nigeria. Further, Alao et al. identified that gender, EPTB, early sputum conversion, and pre-treatment status were major predictors of treatment outcomes. In another study, Haruna et al. (2018) surveyed multidrug resistant TB among patients suspected of TB in

Northern Nigeria. Haruna and colleagues also agree that TB is a major health concern treatment rate both in Nigeria and around the globe. The rising TB cases have been enhanced by the increasing number of multidrug resistant TB and have become an increasing concern in the fight against TB.

Haruna et al. (2018) described multidrug resistant TB as a form of TB that did not respond to anti-TB treatment such as rifampicin and isoniazid. Haruna et al. further acknowledged that the increased cases of multidrug resistant TB reflected the overall increase in TB cases in Nigeria. The increased cases of drug-resistant TB were largely due to inappropriate use of ant-TB drugs, inaccurate treatment, and poor-quality medicines. In this quantitative study, Haruna et al. investigated a sample of 353 participants, among which 192 were male while 161 were female. In their findings, Haruna et al. reported that among the detected drug-resistant cases of TB, 9.5% of the detected samples were rifampicin-resistant, and the majority were among the female population.

Additionally, Haruna et al. (2018) opined that there was a statistical significance that related the rising tuberculosis cases with the availability of health care sectors. As such, Haruna et al. concluded that the rising cases of TB were beyond the expected WHO ratio of 3:1. Consequently, there was a need for the federal state of Nigeria to build more reference labs within Nigeria to address the rising cases of MDR-TB which directly influenced the rising cases of TB.

TB Prevention and Control Outlook

In a quantitative study, Ahmad et al. (2018) sought to analyze some of the policies that have been established to contain and control the spread of tuberculosis. Ahmad et al. agree with fellow scholars such as Haruna et al. (2018), Glaziou et al. (2015), and Alao et al. (2020) that, as of 2018, TB had infected more than 10 million people with over 2 million deaths globally. Ahmad et al. attributed the rising tuberculosis cases to steady but progressive urbanization and increasing poverty levels.

In Nigeria specifically, the rapid growth in population coupled with urbanization and overcrowding has increased the mostly airborne spread of TB. Ahmad et al. (2018) established that the government's failure to account for and control the rising TB cases is attributed to a lack of an effective model that can be used to diagnose, prevent and treat TB effectively. Therefore, as part of the study to examine the rising cases of TB in Nigeria, I will seek to construct a mathematical model to evaluate the burden of TB in Nigeria. Accordingly, Ahmad et al. mentioned that most scholars were able to draw significant conclusions on the dynamics of TB by using models. Examining the work done by scholars such as Okuonghae and Ikhimwin (2016), who developed a model that classified populations by their levels of TB awareness a critical factor in the detection of TB cases.

Using mathematical models, Beeley, (2020) identified individuals with TB. He presented that experts could develop therapeutic strategies to counter TB evasion by understanding resistance mechanisms. In another study, Ahmad et al. (2018) studied the work of Guzzeta et al. who presented three ways in which TB dynamics could be

modeled. First, according to Ahmad et al. Guzzeta et al. presented an ordinary differential equation model that lacked a constant population size and age structure. The second model was modified by the first model and included an age-structures stochastic version and finally, the third model included a sociodemographic individual-based model. In as much the models mentioned are employed in detecting TB, Ahmad et al. presented that none used mathematical presentations to evaluate the TB epidemic in Nigeria.

The mathematical model proposed by Ahmad et al. (2018) showed a dynamic flow of TB, including the susceptible population, the latently infected population and incidences of transmission. The findings of the proposed model under clinical conditions showed that the increased persistence of TB in the Nigerian population was due to an increased number of lately infected populations that continued the transmission.

The rising TB cases result from limited understanding of the factors that enhance transmission and treatment outcomes (Kigozi et al., 2017). To counter the higher rates of TB transmission in Nigeria, it is imperative that a deeper understanding of the factors influencing TB treatment, especially in children, is well understood. Therefore, Ogbudebe et al. (2018) investigated childhood TB in Nigeria, focusing on disease presentation and treatment outcomes. According to Ogbudebe et al., about 1 million TB cases occur annually, with only 359,000 reported cases.

Nonetheless, the presented findings indicated that more than two-thirds of the children with TB were not notified. Ogbudebe et al. (2018) reported that in 2014, 136,000 children below 15 years of age died of TB, with 40,000 of them being HIV related. According to Ogbudebe et al., the increased death rates in children result from delays in

diagnosis, lack of proper treatment, and poor access to health care. The higher number of childhood TB infections clearly indicates the increasing rates of TB in the general population. Ogbudebe et al. showed that TB infections occurred among infants and children below 5 years. Ogbudebe et al. examined 724 childhood cases and reported that the infection rate among children was at 14.9%.

Additionally, Adebisi et al. (2019), in a study to investigate the burden of tuberculosis in West Africa and its eradication, highlighted several factors that stimulate the rising number of tuberculosis cases. To begin with, Adebisi et al. asserted that 95% of TB cases occur in resource-limited nations. Mentioning the data from WHO, Adebisi et al. reported that Africa accounted for 25% of the estimated cases of TB. Specifically, Adebisi et al. observed that Nigeria, Sierra Leone, and Liberia were listed among the 30 countries with high incidence rates. For instance, in 2016, Adebisi et al. reported that Nigeria was estimated to have 219 cases per 100,000 population, accounting for about 4% of TB incidence globally. Equally, the incidence rates of TB in Liberia and Sierra Leone were estimated at 308 and 304 cases per 100,000 population. In their study, Adebisi et al. presented that poverty and undernutrition escalated the cases of TB. Specifically, Adebisi et al. reported that overcrowding, poor ventilation, poor sanitation and malnutrition had elevated TB levels.

The high costs of accessing health services and purchasing medicine have also increased TB rates. For example, Adebisi et al. (2019) asserted that the financial burden experienced by TB patients in low- and middle-income countries has resulted in most of them failing to adhere to treatment procedures increasing the infected population.

Additionally, other factors such as limited and ineffective surveillance systems, increase in drug-resistant TB and inaccessibility to reliable diagnostic kits and late diagnosis have contributed to the rising rates of TB.

TB is a highly infectious disease that affects the lungs, weakens the immune system, and gradually eats away at the infected individual's body (Sheikh et al., 2018). It was declared a global concern in 1993 by the WHO. Scholars such as Alao et al. (2020), Haruna et al. (2018), MacNeil et al. (2020), and reports by OECD indicate that there is a constant rise in the number of TB cases globally. For instance, the discussion above reports that as of 2018, the number of TB infection cases is more than ten million cases, with over two million deaths. Specifically, Adepoju (2020) alluded that the rising cases of TB resulted from poor access to health care, extreme poverty and overcrowding.

Similar results were reported by Herchline (2020), MacNeil et al. (2020), and, Nitu et al. (2017), who mentioned that compared to developed nations, low and middle income reported increased cases of TB. For instance, Nitu et al. and OECD (2020) reported that of the total global population infected with TB, 47% were from Southeast Asia with India, China, Pakistan and Indonesia topping the list. Moreover, similar findings were reported by Onyedum et al. (2017). They presented that the poor economic status of most African countries, extreme poverty, and overcrowding have facilitated increasing tuberculosis cases.

According to WHO, Nigeria is among the nations with high tuberculosis incidence in Africa, with varying positions globally depending on the data used. However, Alao et al. (2020) reported that the WHO ranked Nigeria as sixth in

transmission and incidence rates and the leading in Africa. Dim and Dim (2015), when investigating the rising cases of TB in Enugu State, Nigeria, reported that the rise in TB cases in Enugu was due to ignorance and failure by the government to publish reports on the burden and risk factors leading to increased cases of TB. Consequently, Ahmad et al. (2018) asserted that despite the different mechanisms for controlling the spread of TB, the lack of appropriate models for diagnosing and preventing TB has hindered the progress. Additionally, Ahmad et al. studied the factors that predicted the rising cases of TB. They mentioned that extreme poverty levels and the increased case of multidrug-resistant TB all predicted higher incidences of TB. Furthermore, Ogbudebe et al. (2018), when studying childhood TB in four Nigerian states reported that the increased cases of the reported childhood TB cases were a clear indication of an increased TB population among adults. Therefore, this study sought to quantitatively determine the factors leading to the rising tuberculosis cases in Nigeria.

Theoretical Foundation

The study's theoretical framework was the socioecological model (SEM) developed by Urie Bronfenbrenner, a psychologist in the late 1970s. It demonstrated how an individual’s behavior reflects a complex range of social influences and environmental interactions. The CDC provides detailed and specific guidance based on the assumption that any effort to prevent any health or disease needs multilevel efforts grounded in the SEM (CDC, 2020). According to the framework, there are four levels for organizing risk and protective factors, which subsequently inform prevention strategies. They range from small to larger levels, including individual, relational, community, and societal. At the

individual level, the factors include the person's characteristics such as demographics (age, education, income, substance abuse use etc.), health conditions, attitudes, etc. This level reflects a personal and biological history that makes one susceptible to being infected with TB (CDC, 2020).

The relational factors are those that include direct interactions between person-to-person. These include social support, peers, and family. This close relationship can increase the risk of being infected with the disease. People in one's closest circle influence behaviors that make contracting TB easier. To prevent at this level, one would need parenting or prevention programs focused on the family and promoting healthy relationships (CDC, 2020).

Community-level influences explore the settings that include places of employment, schools, and neighborhoods that establish social relationships and identify these environments as associated with being infected with TB. At this level, prevention strategies are focused on improving the environment, be it physical or social, by creating safe places where people live, learn, work, and play and addressing conditions that gave birth to TB infection (CDC, 2018).

Societal influences reflect broader societal components that create enabling climates that sustain or discourage activities that result in disease conditions. These factors include societal and cultural norms and health, economic, social, and educational policies contributing to social inequalities among groups (CDC, 2020). Prevention methods at this level include creating programs to promote social norms that protect against infection, strengthen financial standing, and provide employment and education

policies that promote good health outcomes. According to McCormack et al. (2017), adopting a multilevel intervention approach is beneficial because of the synergies it could produce, which are far greater than those provided at one level.

Summary and Conclusion

The impact of the various sociodemographic variable on TB prevalence has been examined in different works of literature and conditions. Some studies were conducted to answer questions about the roles of poverty and illiteracy levels on the TB burden. However, these studies were conducted in a location with an appreciable number of TB patients who may be considered poor and illiterate. There is also a lack of literature examining using a quantitative dimension in Nigeria's rural Niger Delta subregion- a country grappling with economic hardship and low educational levels. This research filled these gaps by ascertaining the roles poverty and education can play as drivers of high TB prevalence.

In the face of multiple challenges, the global health systems were already struggling to address several diseases such as TB, cancer, and other cardiovascular diseases, even though some gains were made in improving health and increasing life expectancy of many nations. With the advent of the COVID-19 pandemic, HIV, TB, cancer, and cardiovascular diseases became preexisting conditions, depleting the gains and reducing life expectancy. Many public health programs stalled, and funds were diverted to COVID-19 screenings and treatments. For many people, their quality of life plummeted as they lost income. The attention deficit to many TB and other disease programs may have resulted in a significant drop in screenings for these programs. Social

distances were enforced, and most treatments were delayed. As Cui et al. (2020) envisaged, this could result in a long-term trend. This study will, at the minimum, increase awareness of screening for TB and use available resources.

According to WHO and scholars such as MacNeil et al. (2018), low- and middle-income countries experience the worst hit and rising cases of TB due to misdiagnosis, improper or lack of supervision, lack of funds for programs, and generally weakened immunity due to poor feeding habit. Countries like Nigeria and other developing nations have yet to experience effective intervention strategies that mitigate rising cases. An improvement to the efficacy of the current BCG vaccine may result in significant improvement in reducing the prevalence of TB alongside other programs. Family structure, a driver of high TB prevalence, could benefit from programs that reduce multigenerational populations from clustering in small spaces and improve regular screenings.

In Chapter 3, I will describe the research methodology for this study, highlighting the settings, study population, sample size, instrumentation, data collection, and analytical techniques. Chapter 3 will also discuss ethical considerations for the study and a description of the independent and dependent variables in the study.

Chapter 3: Research Method

In this quantitative study, I assessed the association between sociodemographic factors (i.e., poverty and low education levels) and TB prevalence in Nigeria, using the rural Niger Delta as a case study. Additionally, I examined the association between BCG vaccination prevalence and TB prevalence in this region. Whether the family structure is associated with TB prevalence in this rural community was also assessed. Though some previous studies, such as those of Chang et al. (2015) and Hassan et al. (2020), examined TB prevalence and sociodemographic risk factors in several communities in Nigeria, no study had been conducted in the rural Niger Delta region.

In this chapter, I describe the research design and the operational plan of its execution in the study. The potential threats to internal and external validity and the handling of ethical concerns are also discussed. The chapter ends with a summary of the research methods and a transition to the next chapter.

Research Questions and Hypotheses

The following research questions and corresponding hypotheses guided this study:

RQ1: Is there an association between educational levels and TB prevalence in rural Niger Delta, Nigeria even after controlling for age, gender, occupation, and ethnicity?

$H_0$1: There is no statistically significant association between educational level and the prevalence of TB in rural Niger Delta, Nigeria even after controlling for age, gender, occupation, and ethnicity.

H_a1: There is a statistically significant association between educational levels and the prevalence of TB in rural Niger Delta, Nigeria, even after controlling for age, gender, occupation, and ethnicity.

RQ2: Is there an association between income levels and TB prevalence in rural Niger Delta, Nigeria even after controlling for age, gender, occupation, and ethnicity?

$H_0$2*:* There is no statistically significant association between levels of income and TB prevalence in rural Niger Delta, even after controlling for age, gender, occupation, and ethnicity.

H_a2: There is a statistically significant association between income levels and TB prevalence in rural Niger Delta, Nigeria, even after controlling for age, gender, occupation, and ethnicity.

RQ3: Is there any association between vaccination status and TB prevalence in rural Niger Delta, Nigeria even after controlling for age, gender, occupation, and ethnicity?

$H_0$3*:* There is no statistically significant association between vaccination status and TB prevalence in rural Niger Delta, Nigeria even after controlling for age, gender, occupation, and ethnicity.

H_a3: There is a statistically significant relationship between vaccination status and TB prevalence in rural Niger Delta, Nigeria, even after controlling for age, gender, occupation, and ethnicity.

RQ4: Is there an association between household structure and TB prevalence in rural Niger Delta, Nigeria even after controlling for age, gender, occupation, and ethnicity?

$H_0$4: There is no statistically significant association between household structure, defined as a nuclear arrangement (i.e., only parents and children), and TB prevalence in rural Niger Delta, Nigeria even after controlling for age, gender, occupation, and ethnicity.

H_a4: There is a statistically significant association between household structure, defined as a nuclear arrangement (i.e., only parents and children), and TB prevalence in rural Niger Delta, Nigeria, even after controlling for age, gender, occupation, and ethnicity.

Research Design and Rationale

In this quantitative study, I examined the role poverty, literacy, vaccination status, and family structure play in the prevalence of TB in rural Niger Delta, Nigeria. Given this study's research questions and hypotheses, a nonexperimental research design was suitable for this study; therefore, I employed a cross-sectional design (a type of nonexperimental research design) in this study. A cross-sectional study is an observational study where exposure and outcome are measured simultaneously, usually described as a "snapshot" of the study population per given time (Setia, 2016).

My choice was predicated on the fact that the stated research questions required a single evaluation of the study population: patients attending the TB clinic. These questions could be answered with a single contact with the patients requiring no follow

up. Because the study mainly described the demographics of the TB patients and the relationships between the independent and the dependent variables, it did not require a comparison of two or more groups to assess the effects of an intervention as would have been necessary for an experimental or quasi-experimental design. Cross-sectional study designs are often applied to studies where the surveys are population based and often examine the prevalence of clinic-based diseases (Setia, 2016). The case-control study design would not have been suitable for this study because the case-control study participants are often selected based on the outcome (Setia, 2016). For cohort studies, the criteria for participant selection are often based on exposure status (Wang & Kattan, 2020).

Another advantage of the cross-sectional study design is that it can be conducted in a natural setting, consequently increasing the external validity of findings. Furthermore, the availability of TB patients at the study site teaching hospital eliminated the potential challenges of identifying them, which would have been necessary in the case of a rare condition that would have made the use of a cross-sectional design difficult. Furthermore, the cross-sectional design has the advantage of immediate outcome assessment; hence, there is no attrition or loss in the follow-up situation. The is also ideal for a large population of research subjects, especially those scattered over a wide geographical area (Wang & Cheng, 2020).

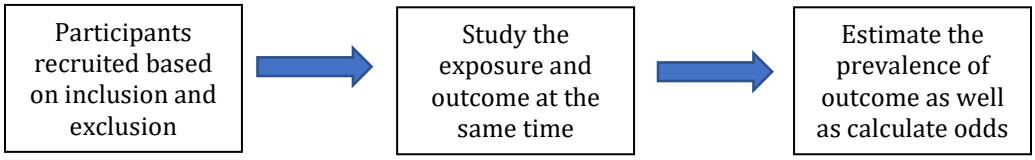
Methodology

Study Design

I used a cross-sectional design to examine the role of poverty and literacy on TB prevalence in rural Niger Delta, Nigeria and whether BCG vaccination status and family structure is associated with TB prevalence While the cross-sectional study design merely provides a snapshot of the health status of a population, information from this study may also be used as a cue to action in the development of TB prevention strategies and was the best study design option because use of the design made it easier to estimate the prevalence of TB.

Figure 2

Cross-Sectional Study



Study Settings

I conducted the study in the Uyo local government area, the state capital of Akwa Ibom State, Rural Niger Delta Region of Nigeria. It is one of the 31 Local Government Areas that constitute Akwa Ibom State, a major, oil-producing state and 1 of the 36 states of the Federal Republic of Nigeria. Akwa Ibom is located along latitude 5.050 North and longitude 80^0 East of the equator. It has a landmass of $115km^2$ (44 sq estimated), and Uyo is bounded by Abak, Itu Uruan, IbesikpoAsutan, and Etinan Local Government Area. The area has a population of 436,606, according to the 2006 census of the Uyo and Itu populations (World Travel Info, 2023).

The name, Uyo, was derived from the local dialect, referring to the abundant wild apple fruits found in the area. The indigenous language spoken is Ibibio, though there are blends of other dialects, such as Annang, Oron, and Eket. Nonindigenes speak other languages, such as English (the Lingua Franca), Yoruba, Igbo, Hausa, Ogoni, Efik, Degema, and Ijaw. The people's unique traditions are expressed in Ekpo, Ekpe Masquerade, and dances.

The people of Uyo are predominately Christian, believing in the existence of one Supreme Being, while others practice traditional worshipping. The Uyo Local Government Area is divided into four clans: Ikono Clan, Etoi Clan, Oku Clan, and Offot Clan. The Uyo Local Government Area is endowed with abundant mineral oil and forest resources, and its people are predominately farmers and traders of food items, such as palm oil and other palm produce, vegetables, banana, yam, and cassava. The Uyo Local Government Area has numerous educational, financial and health institutions, such as commercial banks, primary schools, secondary schools, polytechnic and universities, federal and state parastatals, ministries, churches, water corporations, hospitals, and primary health centers and stadiums. There are over 20 primary schools, 14 government-owned (i.e., public) senior secondary schools, and an estimated 16 private schools in the local government area.

The local government, state government, and some private bodies operate several health facilities in the area. A teaching hospital owned by the federal government, is also in the local government area. A government-owned dental center is also situated within

the premises of the teaching hospital. In addition, there are two private dental clinics within the Local Government Area.

Strategy for Recruitment and Data Collection

I collected data only after receiving approval to do so from the Walden University Institutional Review Board (IRB). Collecting data personally assured a better data collection process and conferred some degree of confidentiality of information. Before collecting data, I administered the informed consent forms to the participants to comply with Walden University's requirements. Data collection occurred at the General Outpatient Department of the UUTH. Some demographic data collected include vaccination information, highest education level, income bracket, and family structure. In addition, I collected clinical information on the participants' TB diagnosis, classification of the type of TB, results from chest x-ray, and laboratory test results.

I used a convenience sampling method to select participants for this study. This is a nonprobability sampling method where information is obtained from respondents who are available and easy to reach at the location of the study (Edgar & Manz, 2017). The convenience sample plan was used because it is the most efficient and least resource-intensive strategy for sampling the patients under study. The benefit of using this sampling method is that it is not challenging to administer, and the results can be applied to the group that shares the same characteristics (Frankfort-Nachomias & Nachmias, 2008).

Participants were recruited into the study as they presented themselves to the hospital. There was no pre-planned pattern in enrolling them because they were recruited

at presentation. I administered a semistructured questionnaire to patients recruited for data collection.

Included in the study population were patients attending the Clinic at the teaching hospital who consented to participate. To be eligible for inclusion, patients had to be between the ages of 18–64 years old, residing in the rural Niger Delta region, and receiving services at the teaching hospital. This population also included pregnant and nonpregnant patients as well as incarcerated and nonincarcerated individuals. Because this study was for patients in rural Niger Delta, Nigeria, any patient residing in that region was considered. Patients who refused to be part of this study were excluded. Each participant provided informed consent before being included in the study.

Study Population

The study population were residents of rural Niger Delta in Nigeria attending the General Outpatient Clinic at the teaching hospital. These patients were heterogenous because they attended the clinic for different complaints. Therefore, I selected this population based on inclusion and exclusion criteria.

Sample Size Determination

I used statistical power in determining the sample size. Statistical power is the probability of having a large null so that the null hypothesis can be rejected when false. Scientists use four interrelated components to conduct power analysis: sample size (i.e., the number of participants in a study), effect size (i.e., the magnitude of the effect of the experiment), alpha level (i.e., the probability that the test result or finding observed is as a result of chance), and power (i.e., the chances or likelihood that test finding being

observed by the researcher is one that exists; Johnston et al., 2019). When an appropriate sample size is determined, it improves the study's power (Johnston et al., 2019). I determined the minimum sample size of 184 by using Taro Yamane's formula:

$$n = \frac{Z^2 pq}{d^2}$$

Where:

n = minimum sample size

z = number of standard deviations, usually 1.96

p = prevalence of TB in Nigeria (Kooffreh et al., 2016) = 44.6% ≈ 0.446

q = prevalence of TB free level in Nigeria = 55.4% ≈ 0.554

d = degree of precision = 5% = 0.05

$$n = \frac{(1.96)^2 \; x \; 0.446 \; x \; 0.554}{(0.05)^2}$$

$$n = \frac{0.45975885}{0.0025}$$

$$n = 183.9$$

To allow for non- response rate of 10 % was chosen.

183.9/.9 = 204

Therefore, the estimated sample was calculated to be 204. However, this was adjusted to allow for the detection of about 10 TB cases for the sake of data analysis.

Case Definition of TB

This study defined a case as a person diagnosed with TB, confirmed by pathology, bacteriology, radiology, or a regular clinical response to treatment from the TB clinic in the teaching hospital. Cases were grouped using the following inclusion criteria:

1. Confirmed: This is *Mycobacterium* TB (MTB) from a clinical specimen isolated in the laboratory.
2. Probable: Proof of acid-fast bacilli result that is consistent with TB diagnosis
3. Possible: Clinical signs and symptoms of TB from an abnormal x-ray.

The diagnosis of TB was made based on the guidelines laid down by the WHO, which include the following.

1. Interferon-gamma release assay (IGRAs) and Mantoux or Tuberculin skin test should not be used in low- and middle-income countries for the diagnosis of either pulmonary TB or extrapulmonary TB to avoid the consequences of unneeded treatment or high false-positives due to the specificity of IGRAs (and the Tuberculin skin test in these areas).
2. IGRAs should not be used in health care worker screening programs in low- and middle-income countries. Since health care providers carry out the interview or conduct the screening, this was not used.
3. For adults in the general population exhibiting signs or symptoms of TB, the Gene Xpert mycobacterium TB / rinfampicin (MTB/RIF) or Xpert Ultra could be used in place of culture as the initial test for pulmonary TB.

4. Using gene Xpert MTB/RIF as an initial diagnostic test for TB and rifampicin-resistance detection in sputum in adults with signs and symptoms of pulmonary TB. Nigeria does not have the Xpert MTB/RIF in all medical centers. However, the teaching hospital has this facility.

Types of Variables and Measurement

The variables of interest in this study include dependent, independent, and potential confounding variables.

Independent Variables

1. Poverty will be defined by income level.
2. Education levels will be determined by years of school attendance.
3. Vaccination status. This will be determined by prior immunization status. I asked for a BCG vaccination history and looked for a round scar of about 4-8mm diameter on the deltoid area of the participant's arms. It was coded as "Yes" or "No."
4. Family structure was measured the number of persons sharing the participant's sleeping area or room.

Dependent Variable

Presence of TB

Covariates

1. Age: 18-64 years
2. Gender: male or female
3. Occupation

4. Level of Education

Table 1 shows the variables of interest and their operationalization.

Table 1.

Variables and Operationalization

Variable type	Measured by	Measurement scale
Independent variable		
Poverty	Household income N0 – 15, 000 (low-low); N16, 000 – 30,000 (middle low); 31 -50, 000 (middle-middle); 51,000 – 66,000 (middle-high); 67,000 and above (high)	Ordinal
Literacy	Not attended primary, secondary, and tertiary levels of education	Nominal
Vaccination status	Vaccinated (present of scars) or record, not vaccinated, and unknown	Nominal
Family structure	Alone, couple, nuclear family or extended family	Nominal
Dependent variable		
TB Presence	See case definition above	Nominal
Covariates		
Age	Number in years	Ratio
Gender	Male or female	Nominal
Comorbidity HIV, diabetes, etc.	One or more	Dichotomous
Occupation	Unemployed, self-employed, employed	Nominal
Knowledge	Awareness, unawareness	Dichotomous
Access to TB clinic	Distant in km to Hospital	Ratio

Data Analysis

The data was analyzed using IBM SPSS Statistics for Windows, version 26 (IBM Corp., Armonk, N.Y., USA). I used descriptive statistics to summarize the quantitative data and organize the qualitative data via charts and Tables. All the research hypotheses for RQ1 to RQ4 were tested using a chi-squared test for categorical variables and binary logistic analysis. Chi-square was also computed to determine significant differences between my test and outcome variables. Binary logistic regression was used to check for the impact of the independent variables on a dichotomous outcome categorical variable. Binary logistic regression was used to model the dependent variable's response using the independent variables stated in RQs. Binary logistic regression allowed me to check for the effects of covariates. Adjusted and unadjusted odds ratios with confidence intervals of 95% was calculated to assess associations of variables having p-values of less than 0.05.

Possible Types and Sources of Data

Data was collected through semi-structured questionnaires administered to patients who attended the General Out-Patient clinic at a teaching hospital in Niger Delta, Nigeria during the course of the study.

Threats to External and Internal Validity

External validity describes to what extent the conclusions arrived in a study could be replicated or hold true for other researchers in different locations and periods beyond the immediate study (Patino & Ferreira 2018). External validity is important in a study because it shows that if a causal relationship could be established, it could be generalized in different settings and at different times for different people (Patino & Ferreira, 2018).

For this study, a threat to external validity arises when eligible study participants relocate to different regions during the study period. This could undermine the result or findings.

Threats to internal validity can reduce confidence in saying that a relationship exists between the independent and dependent variables. This can be measurement errors arising from varied sources, such as measuring the wrong attributes, duplicate data entry, differences in a study setting, dissimilar administration of study instruments, lack of uniformity in coding, and varied interpretations of the measuring instrument by people. For example, a copy of my research instrument was pilot tested on a sample of patients to see if it could get the information needed for my study and check for areas needing revision.

Also, the same questionnaire was administered to all the respondents to address other possible threats that may arise from measurement errors. I personally administered the questionnaire to the patients, simultaneously addressing the dissimilar administration of the survey instrument. This also reduced attrition or missing data.

Another potential threat to the internal validity of the study is information bias. This study's potential sources of information bias may include defective definitions of study variables or faulty data collection methods. This can lead to outcome identification bias, an example of which is respondent bias due to the inability to obtain objective confirmation of some of the responses and recall bias, where the research participant may not adequately recall information, especially those in the past. In addition, there was an assumption that responses would be as truthful as possible.

Ethical Consideration

Clearance was obtained from the hospital's ethics committee selected for the study and submitted to Walden University Institutional Review Board (IRB) as part of my IRB application. Walden University's IRB ethics and review approval was met before any process at the hospital or partner organization, before participant recruitment and data collection. Walden IRB approval number is 11-08-22-0352139. To ensure privacy and confidentiality, participants consented before participating in the study. They were not required to provide a full name or a house address number. This also includes that my research questions, planned analysis and data collection align, assuring that IRB materials reflect the final set of research questions and procedures, and assuring a familiarity with the local custom to reflect my understanding of privacy, confidentiality and data protection. Raw data will be stored and destroyed 5 years after the completion of the research. This will be carried out safely and securely during and after the research in compliance with privacy data protection protocol.

Summary

Cross sectional study was utilized for this study. The population for this study were patients who attended the General Out-Patient Department of a teaching hospital in southern Nigeria. All the patients who fulfilled the inclusion criteria were included in this study during the data collection period. Data collection was by survey method using a paper based, survey instrument. I personally collected the data, after obtaining informed consent, which addressed some threats to study validity. Collected data were analyzed using SPSS software Version 26. Descriptive statistics was used to present the

demographic characteristics while for the inferential questions, Pearson's Chi Square and binary logistic regression were used. The chapter concluded with how ethical issues likely with the conduct of the study were addressed. The next chapter will describe the findings from the study.

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Chapter 4: Results

The purpose of this quantitative cross-sectional study was to assess the association between sociodemographic factors of poverty, family structure and low educational levels on TB prevalence in rural Niger Delta, Nigeria. I also examined the association between TB vaccination status and prevalence in Nigeria's rural Niger Delta. TB prevalence was the dependent variable. I investigated four associations between the independent and dependent variables as stated in the following research questions and hypotheses:

RQ1: Is there an association between educational levels and TB prevalence in rural Niger Delta, Nigeria even after controlling for age, gender, occupation, and ethnicity?

$H_0$1: There is no statistically significant association between educational levels and the prevalence of TB in rural Niger Delta, Nigeria even after controlling for age, gender, occupation, and ethnicity.

H_a1: There is a statistically significant association between educational levels and the prevalence of TB in rural Niger Delta, Nigeria even after controlling for age, gender, occupation, and ethnicity.

RQ2: Is there an association between income levels and TB prevalence in rural Niger Delta, Nigeria even after controlling for age, gender, occupation, and ethnicity?

$H_0$2*:* There is no statistically significant association between income levels and TB prevalence in rural Niger Delta, Nigeria even after controlling for age, gender, occupation, and ethnicity.

H_a2: There is a statistically significant association between income levels and TB prevalence in rural Niger Delta, Nigeria even after controlling for age, gender, occupation, and ethnicity.

RQ3: Is there an association between TB vaccination status and TB prevalence in rural Niger Delta, Nigeria even after controlling for age, gender, occupation, and ethnicity?

$H_0$3*:* There is no statistically significant association between vaccination status and TB prevalence in rural Niger Delta, Nigeria even after controlling for age, gender, occupation, and ethnicity.

H_a3: There is a statistically significant relationship between vaccination status and TB prevalence in rural Niger Delta, Nigeria even after controlling for age, gender, occupation, and ethnicity.

RQ4: Is there an association between household structure and TB prevalence in rural Niger Delta, Nigeria even after controlling for age, gender, occupation, and ethnicity?

$H_0$4*:* There is no statistically significant association between household structure, defined as a nuclear arrangement (i.e., only parents and children), and TB prevalence in rural Niger Delta, Nigeria even after controlling for age, gender, occupation, and ethnicity.

H_a4: There is a statistically significant association between household structure, defined as a nuclear arrangement (i.e., only parents and children), and TB prevalence in rural Niger Delta, Nigeria even after controlling for age, gender, occupation, and ethnicity.

Results

Demographic Characteristics of Study Participants

Table 2 shows the different age groups included in the analysis. Most of the participants were females (74.1%), married (67.3%), and self-employed (65.0%). The Ibibio tribe (72.2%) was represented more in the population.

Table 2

Demographic Characteristics of Residents of Rural Niger Delta in Nigeria (N = 266)

Demographic characteristics	Frequency	Percentage
Age group		
≤ 30	54	20.3
31–40	68	25.6
41–50	64	24.1
> 50	80	30.1
Gender		
Male	69	25.9
Female	197	74.1
Marital status		
Single	59	22.2
Married	179	67.3
Divorced	18	6.8
Widowed	10	3.8
Occupation		
Employed	81	30.5
Self-employed	173	65.0

Unemployed	12	4.5
Tribe		
Ibibio	192	72.2
Annang	58	21.8
Oro	16	6.0

Figure 3 shows the different residence in the Niger Delta region of the participants included in the study.

Figure 3

Residence of Study Participants

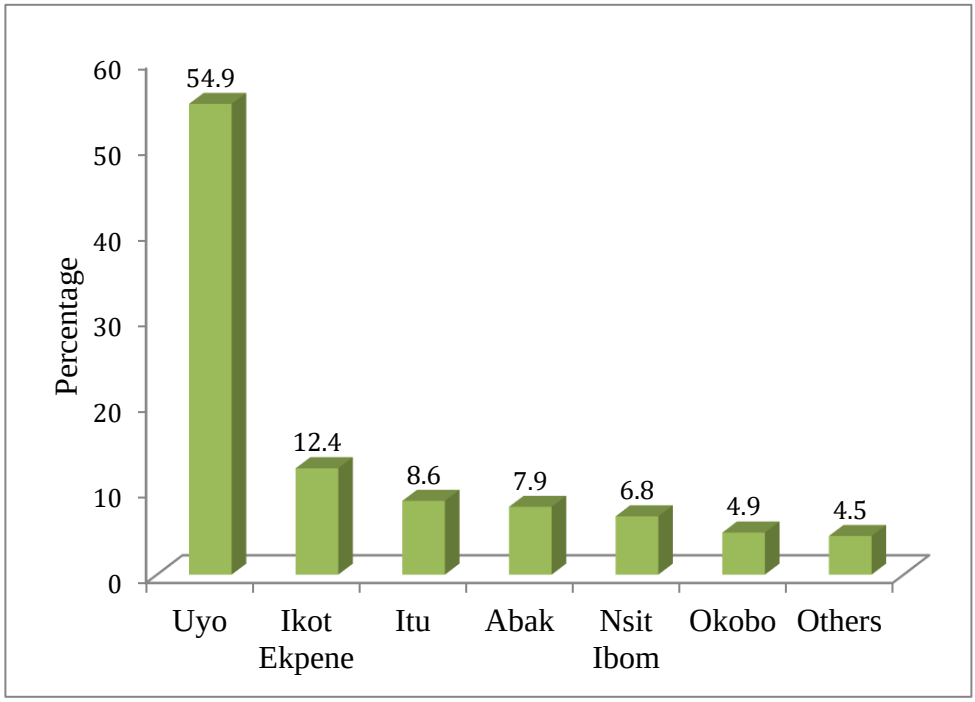


Table 3 is a frequency distribution of the different independent variables included in the study. More of the participants had only a primary level of education (41.4%). Most of them earn less than a dollar per day (69.9%) and greater than half (58.6%) had

been vaccinated for TB with BCG. The household structure of most of the participants was three or more people (i.e., nuclear or extended families), accounting for 74.8% of the sample of the study. Nine patients had TB out of the 266 patients, resulting in a prevalence of 3.38% (see Figure 4).

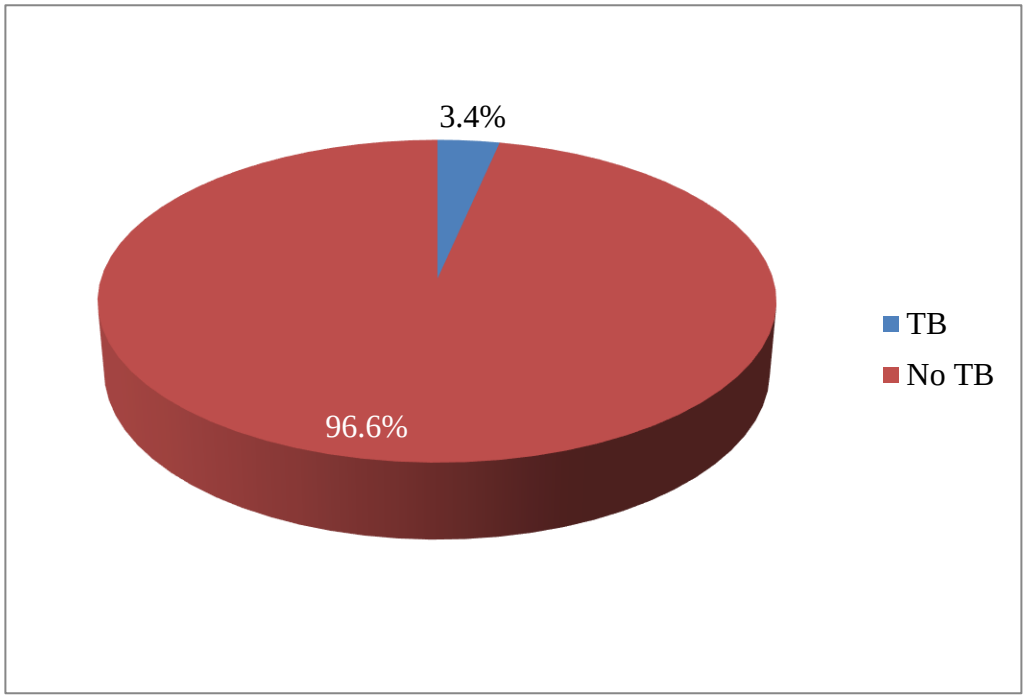
Table 3

Distribution of Independent Variables of the Study

Variables	Frequency (*N* = 266)	Percentage
Educational levels		
Primary	110	41.4
Secondary	77	28.9
Tertiary	79	29.7
Income/day		
< 1 dollar	186	69.9
≥ 1 dollar	80	30.1
TB vaccination status		
Yes	156	58.6
No	73	27.4
Not sure	37	13.9
Household structure		
Alone	25	9.4
Couple	42	15.8
Nuclear or extended family	199	74.8

Figure 4

Prevalence of TB



Association between the different demographic factors and TB prevalence shows that occupation was significantly associated with TB prevalence, χ^2 (2) = 31.7, (p = 0.001). All the participants who were unemployed (n = 6) and three (1.7%) of those that were self-employed had TB. All the age groups were represented in the presence of TB. Likewise, both genders were also represented. No patient from the Oro tribe had TB. However, there was no statistically significant relationship between the age group, gender, marital status, and tribe and TB prevalence (p > 0.05). Table 4 shows the details of this analysis.

Table 4

*Association Between Demographic Variable and TB Prevalence Among Residents of Rural Niger Delta in Nigeria (*N *= 266)*

Demographic variables	Status of TB		χ^2	*p* value
	Yes	No		
Age group				
≤ 30	4 (7.4%)	50 (92.6%)	3.198	0.362
31–40	1 (1.5%)	67 (98.5%)		
41–50	2 (3.1%)	62 (96.9%)		
> 50	2 (2.5%)	78 (97.5%)		
Gender				
Male	4 (5.8%)	65 (94.2%)	1.660	0.244[f]
Female	5 (2.5%)	192 (97.5%)		
Marital status				
Single	4 (6.8%)	55 (93.2%)	4.685	0.196
Married	3 (1.7%)	176 (98.3%)		
Divorced	1 (5.6%)	17 (94.4%)		
Widowed	1 (10.0%)	9 (90.0%)		
Occupation				
Employed	0 (0.0%)	81 (100.0%)	31.734	0.001*
Self-employed	3 (1.7%)	170 (98.3%)		
Unemployed	6 (50.0%)	6 (50.0%)		
Tribe				
Ibibio	7 (3.6%)	185 (96.4%)	1.142	0.565
Annang	2 (3.4%)	56 (96.6%)		
Oro	0 (0.0%)	16 (100.0%)		

*Statistically significant *at* $p < 0.05$.

RQ1

This question addressed the association between educational levels and TB prevalence. These were two nominal variables, and I used the Pearson chi-square statistic to test the relationships between these categorical variables. Table 5 shows the result of the analysis. I found a statistically significant relationship between the educational levels of the participant and TB prevalence, χ^2 (2) = 7.27, (p = 0.026). None of the participants with a tertiary educational level had TB; however, four (3.6%) participants with a primary level education and five (6.5%) with a secondary level education had TB. In view of the result of the analysis, the null hypothesis was rejected.

Table 5

Association Between Educational Levels and TB Prevalence in Rural Niger Delta, Nigeria

Educational level	Status of TB		χ^2	p value
	Yes	No		
Primary	4 (3.6%)	106 (96.4%)	7.267	0.026*
Secondary	5 (6.5%)	72 (93.5%)		
Tertiary	0 (0.0%)	79 (100.0%)		

*Statistically significant at $p < 0.05$.

RQ2

This question addressed the association between income levels and TB prevalence. These were two nominal (i.e., dichotomous) variables, and I used Fisher's exact statistic to test the relationships between these categorical variables. Table 6 shows

the result of the analysis. I found that there is no statistically significant relationship between the income levels of the participant and TB prevalence, χ^2 (1) = 4.01, (p = 0.061). However, none of the participants with an average income of ≥ $1 per day had TB. In view of the result of the analysis, I failed to reject the null hypothesis.

Table 6

Association Between Income Levels and TB Prevalence in Rural Niger Delta, Nigeria

Income/day	Status of TB		χ^2	p value
	Yes	No		
<1 dollar	9 (4.8%)	177 (95.2%)	4.007	0.061[f]
≥1 dollar	0 (0.0%)	80 (100.0%)		

[f] Fisher's exact test.

RQ3

This question addressed the association between vaccination status and TB prevalence. These were two nominal variables, and I used the Pearson chi-square statistic to test the relationships between these categorical variables. Table 7 shows the result of the analysis. I found that there is no statistically significant relationship between the vaccination status of the participants and TB prevalence, χ^2 (2) = 1.65, (p = 0.437). All the different categories under the vaccination status among the patients had cases of TB. In view of the result of the analysis, I failed to reject the null hypothesis.

Table 7

Association Between TB Vaccination Status and TB Prevalence in Rural Niger Delta, Nigeria

TB vaccination status	Status of TB		χ^2	*p* value
	Yes	No		
Vaccinated	6 (3.8%)	150 (96.2%)	1.653	0.437
Not vaccinated	1 (1.4%)	72 (98.6%)		
Not sure	2 (5.4%)	35 (94.6%)		

RQ4

This question addressed the association between household structure and TB prevalence. These were two nominal variables, and I used the Pearson chi-square statistic to test the relationships between these categorical variables. Table 8 shows the result of the analysis. I found that there is no statistically significant relationship between the household structure of the participants and TB prevalence, χ^2 (2) = 3.15, (p = 0.418). Those who had a household structure of couples did not have any case of TB. In view of the result of the analysis, I failed to reject the null hypothesis.

Table 8

Association Between Household Structure and TB Prevalence in Rural Niger Delta, Nigeria

Family structure	Status of TB		χ^2	*p* value
	Yes	No		
Alone	1 (4.0%)	24 (96.0%)	3.152	0.418
Couple	0 (0.0%)	42 (100.0%)		
Nuclear or extended family	8 (4.0%)	191 (96.0%)		

A logistic regression analysis was done to check the odds of predicting TB prevalence by the different independent variables included in the analysis. Generally, logistic regression is used to identify independent (predictor) variable(s) that influence (predict) the dependent (outcome) variable. Looking at the influence of the independent variables individually (crude *OR*), as in Table 9, family structure significantly influences (predict) the dependent variable (TB prevalence). In this case, the respondents with fewer household size are less likely to develop TB (*OR* = 0.568, 95%CI = 0.367 – 0.879, *p* = 0.011). However, educational level and vaccination status do not significantly influence or predict TB occurrence.

In adjusted *OR*, all the independent variables are taken together simultaneously in the analysis to find out their combined effect (influence) on the dependent variable. In Table 9, none of the independent variables significantly influence (predict) the dependent variable (TB). The variables considered for the adjusted *OR* were the independent variables. Although it is supposed to be independent variables that were significantly

associated with the dependent variable. In this case, because of the small frequency of the TB cases, I decided to use all the independent variables in the logistic regression even though only educational level was significantly associated with TB. Note that in binary logistic regression analysis, the dependent variable is always dichotomized and SPSS consider the last group as the reference group.

Table 9

Binary Logistic Regression of Independent Variables on TB Prevalence Among Residents of Rural Niger Delta, Nigeria

Independent variables	Crude OR (95% CI)	*p* value	Adjusted *OR* (95% CI)	*p* value
Educational level	1.704(0.698-4.159)	0.242	1.741(0.707-4.287)	0.228
Vaccination status	0.994(0.398-2.483)	0.990	1.130(0.442-2.891)	0.799
Family structure	0.568(0.367-0.879)	0.011*	0.674(0.194-2.345)	0.535

Summary

In this chapter, I addressed the findings involving the research questions. A total of 266 participants were included in the data analysis. Most of the participants were females (74.1%), married (67.3%) and self-employed (65.0%). The Ibibio tribe (72.2%) were represented more in the population. The prevalence of TB was 3.4%. Only the educational levels of the participants had a statistically significant relationship with TB prevalence, χ^2 (2) = 7.27, (p = 0.026). However, family structure significantly predicts the TB prevalence. This implies that respondents with fewer household size are less likely to develop TB (*OR* = 0.568; 95CI% = 0.367 - 0.879; *p* value = 0.011). Chapter 5 will

discuss the results of the study, limitation of the study, and recommendation on what can be done to address the situation. I will also discuss the positive social change implication that this study brings to policy makers in addressing the spread of TB.

Chapter 5: Discussion, Conclusions, and Recommendations

TB is a major public health problem negatively affecting the world's poorest, weak, vulnerable, sick, marginalized, and underserving populace (WHO, 2021). TB threatens the lives of over 2 billion people across the globe and is more endemic and deleterious in lower socio-economic nations, such as Nigeria, which bears about 4% of the global TB burden (WHO, 2021). Notwithstanding the global decline, the cases of TB are rising in Nigeria (Dirlikove et al., 2015). The purpose of this quantitative cross-sectional study was to assess the association between the sociodemographic factors of poverty, family structure, and low educational levels, and TB prevalence in rural Niger Delta, Nigeria. I also examined the association between TB vaccination status and TB prevalence in Nigeria's rural Niger Delta.

The prevalence of TB in this study was 3.4%. Only the educational levels of the participants had a statistically significant relationship with TB prevalence. There was no association between income levels, household structure, and vaccination status with TB prevalence; however, when assessing the predictive capabilities of the independent variables on TB occurrence, I found only family structure significantly predicts TB prevalence. This finding implies that respondents with smaller household sizes are less likely to develop TB. Educational level and vaccination status do not significantly influence or predict TB occurrence.

Interpretation of Findings

Association Between Educational Levels and TB Prevalence

According to Rusnoto et al. (2020), education and economic status are risk factors that influence the incidence of pulmonary TB. The results of the current study showed a statistically significant relationship between the educational levels of the participant and TB prevalence. None of the participants with a tertiary educational level in this study had TB; however, four (3.6%) participants with a primary level education and five (6.5%) with a secondary level education had TB. This finding is similar to those of Alemayehu et al. (2017) in Ethiopia who also reported that low educational levels were associated with the development of TB. The authors cited that as educational level increases, the prevalence of TB decreases. Increasing TB prevalence among those with low educational levels may be due to low awareness about the ways TB is transmitted and spread (Alemayehu et al., 2017). Therefore, an individual's education level influences their knowledge of factors related to pulmonary TB (Rusnoto et al., 2020).

On the contrary, in a study conducted in India, Imam et al. (2021) found an increased incidence of TB in patients who had finished high school compared to other educational levels. A similar study in Indonesia also showed a higher occurrence of TB among those who had a high school education (Subkhan et al., 2021). Imam et al. study also stated that most of the TB patients were poor or with low-income levels and possibly benefited from scholarship schemes to attend schools. This may explain the variation with my finding that TB was more common among patients with low educational levels. Educated patients generally have more knowledge and awareness of TB and, therefore,

have less chance to acquire the disease, and unskilled workers have a higher probability of acquiring a TB infection (Imam et al., 2021). Subkhan et al. (2021) summarized the relationship between educational level with TB prevalence by saying that individuals with different educational levels have different knowledge and perceptions regarding TB. However, Subkhan et al, cited a study in Indonesia that reported that TB cases were mostly found in patients with low educational levels, which is similar to the findings of the current study.

Association Between Income Levels and TB Prevalence

In this study, I grouped the participants to those who earn < $1 per day and those who earn ≥ $1 per day. The results of the study showed no statistically significant relationship between the income levels of the participant and TB prevalence. Socio-economic status has been shown to be a risk factor for the occurrence of active TB (Alemayehu et al., 2017) because the economic status of an individual is closely related to their family income, which has an impact on daily living patterns, such as food consumption and health care (Rusnoto et al., 2020). Globally, more than 90% of TB patients are located in low- and middle-income countries, and the TB cases are mainly clustered among economically and socially disadvantaged groups **(**Nidoi et al., 2021).

None of the participants in the current study with an average income of ≥ $1 per day had TB; however, half of those who were unemployed had TB, supporting the assertion that there is increasing incidence of TB with low socio-economic status. Other studies reported increasing TB prevalence with low-income levels. For instance, Ogbo et al. (2018) mentioned that extreme poverty and overcrowding increased TB cases in

Nigeria. Glaziou et al. (2015) also observed increased TB rates in low- and middle-income countries among patients with low literacy levels, poor economic status, and elevated poverty levels. Different classifications for income levels in these studies for assessing its association with TB prevalence may explain the variations among findings.

Alemayehu et al. (2017) found that the average monthly income of the patient was associated with the development of TB. Patients who had low monthly income were more prone to the development of TB. Possibly, people with low monthly income do not eat well, which makes their immune system suppressed and more prone to TB (Rusnoto et al., 2020). Patients with low-income levels are also less likely to seek medical help, get appropriate investigations for TB, and have good TB treatment outcomes (Nidoi et al., 2021). Generally, the "social status and daily living conditions of patients modify several risk factors over time and influence access to resources leading to differential exposure, differential vulnerability to disease-causing and/or modifying agents and differential consequences of ill health" (Nidoi et al., 2021, p. 2).

Association Between Vaccination Status and TB Prevalence

The results of this study did not show any statistically significant relationship between the vaccination status of the participants and TB prevalence even though above half (58.6%) of the participants were sure of their vaccination status. In this study, TB was recorded in both the vaccinated and unvaccinated groups. As a high-incidence country for TB, Nigeria administers the BCG vaccine to children at birth to prevent incidence of TB. The low vaccination rate reported in the current study could possibly be explained by families with low levels of income having less or limited access to health

services (see Aboubacar et al., 2022). According to Zahra et al. (2012), vaccination with BCG given at birth has reduced or decreased the severity of TB. The level of protection afforded children who received BCG vaccination was estimated to be 80%; however, the vaccine can be less effective against TB affecting the lungs in adults, and the protection from the BCG vaccine can last up to 15 years (National Health Service, 2022). The age range of the population included in the current study was from 18 to 64 years old.

The lack of association between the vaccination status and TB prevalence, apart from the number of those vaccinated, could also be attributed to the expiration of the effects of the vaccine after 15 years. According to Dockrell (2017), the lower level of effectiveness of the vaccine can also be partly due to the differing effects of the BCG vaccine. The duration of the effectiveness of the BCG vaccine may also explain the paucity of studies comparing the association between vaccination status and TB prevalence. Available literature comparing the prevalence of TB infection in BCG vaccinated versus nonvaccinated children in a TB endemic region have conflicting findings. Pulickal and Fernandez (2007) claimed that BCG vaccination is associated with significant protection against the acquisition of TB infection in childhood, while Aboubacar et al. (2022) found that BCG vaccination did not protect children in Niger from TB. Nonetheless, TB continues to be a major public health problem, and the BCG vaccine is the only tool available that provides significant protection against childhood TB (Kumar, 2021).

Association Between Household Structure and TB Prevalence

Family structure has been identified as an important sociodemographic factor contributing to the prevalence and incidence of diseases because diseases like TB spread by droplets of the infection, such as sneezing and coughing (Amo-Ajei, 2016). The number of people living together determines how much the infection is transmitted (OECD, 2020). I found no statistically significant relationship between the household structure of the participants and TB prevalence in the current study; however, the logistic regression analysis shows that family structure significantly predicts TB prevalence. A study in New Zealand showed that TB incidence is associated with household crowding (Baker et al., 2008). The authors recommended that reducing or eliminating household crowding could decrease TB incidence in New Zealand and globally (Baker et al., 2008). According to Rakhmawati et al. (2019), there is a greater risk of disease and death with infectious TB among people living in close or intimate familial contact than those living in the general population. This is similar to the findings in the current study showing the predictive nature of family structure on TB prevalence. The family could be a support system to reduce or cut further transmission by disclosing the infected status of a family member. In a Chinese study, Zhang et al. (2020) also found a higher TB incidence to be associated with urbanization, population density, poor economic conditions, and household crowding. According to Singh et al. (2018), a contaminated household environment significantly increases the risk of TB infection. Household crowding increases the shared space among household members and the possibility of contact between infected TB patients and susceptible persons (Daniel et al., 2022). The number

of persons living in the household and sharing toilets and portable water with other members of the same household serves as some of the multiple risk factors strongly associated with TB prevalence. In a study in South Africa, Obaromi et al. (2019) identified household size as the most important factor in determining risk of TB, noting that each additional person in the house increased the risk of TB. In addition to being an indicator of poverty and population density, household size was also found as an important covariate in the household transmission of TB (Obaromi et al., 2019). Although household crowding has been identified as a risk factor for the development of TB in some studies, other studies did not find a significant association between household crowding and TB (Daniel et al., 2022). The use of different methodologies and measurement scales for household structure could account for the conflicting findings (Ross et al., 2021).

Limitations of the Study

The current study seems to have been limited by some research biases. Reflected in this study are recall bias and information bias as well as other unknown confounders that call for caution when interpreting the results of the study. Although this study addressed the roles of some potential predictor variables on the prevalence of TB in rural Niger Delta of Nigeria, it is noteworthy that the contribution of some confounders that may have influenced or impacted the predictor-outcome relationship was not examined in the study. Some of these confounders include undernutrition, homelessness, smoking, alcohol use disorders, HIV, and lack of access to health care. These variables (that were not examined in the current study) could confound the relationships between poverty,

educational level, and TB prevalence because most of these variables are found among poor people and those with low educational status. However, according to the WHO (2023a, 2023b), the variables are documented determinants of TB.

Some of the participants in this study appear to have faded memory of events of the past or at least could not accurately account for some of their responses when reporting information in the survey used. Age, disease status, education, socio-economic status, and the length of time since the event could be responsible for reported information that might be wrong or incorrect. For example, in this study I asked for simple demographic information, such as age and educational level, but some of the participants were not certain of their actual age because their birth year was only a guess.

The results obtained in this study are based on those patients attending a tertiary health institution and were not based on the general population. Being a referral center, the hospital could have attracted all manner of patients leading to a misclassification bias. The target population included patients aged 18–64 years old. Because the study did not include the general population, the ability to infer conclusions about the prevalence of TB in the general population of the rural Niger Delta population is limited. In addition, this research involved self-reporting, which makes it necessary to be aware that information provided by the participants may not have been accurate and was based on individual or personal experiences, not arbitrary inferences.

Recommendations

Further analysis of the risk factors of TB transmission is needed to break the transmission chain, regarding the prevalence of TB cases, their complications, and the

burden towards the population. One of the factors that might contribute towards TB transmission is knowledge and perception about the disease. The population's level of education should be considered as a valuable factor affecting program outcomes when targeting the level of knowledge and perceptions of TB in the community. According to Idris et al. (2020), an educational program was effective in reducing stigma about TB, and health education could be used as one of many strategies in preventing and controlling TB. Therefore, I recommend that TB education should be included as part of public health intervention programs, with an emphasis on behavioral lifestyles. Furthermore, investigating the impact of improved education on and about TB and TB prevalence can help reinforce the role of education to mitigate TB infection.

Improving access to health care for the screening and early detection of TB can also help curtail the spread of TB. This will require governmental intervention because there are presently very few medical centers where TB testing can be done, which means that some such centers will be far from some areas of the country. Establishing or equipping more health facilities with TB screening kits will address this challenge.

Implications for Social change

The social change implication for this study implies that there is a crucial need for education and awareness which is the most important agent to bridge the gap that is driving the level of TB high in rural Niger Delta. Without education, there cannot be any social change or any effective population level programs reforms. Education transforms the thought processes of individuals and communities, as well as altering the behaviors, lifestyles, and old superstitious beliefs of the people. For policy makers, it triggers policy

deliberations and generates knowledge-based decisions for creating programs that are more effective and enduring. Education provides the needed knowledge, skills, and training needed to obtain new ideas to solve problems. Low-income levels, poor family structure, and lack of vaccination are predominantly due to lack of enlightenment and ignorance. Education provides us with a road map to understanding the risk factors and adopting measures that are aimed at mitigating them. Results obtained from this study could provide important information that could form the basis of preventing and controlling the prevalence of the disease among the Niger Delta, Nigerian population. For policy makers to draft programs that will adequately address this public health concern by providing appropriate preventive measures. It could also educate the local population and create awareness on the transmission of the disease in the region. This finding aligns with several studies that have shown association of literacy or educational levels, and vaccination status with the prevalence of TB (Inoue & Kashima, 2021; Singh et al, 2018).

Conclusions

TB continues to be one of the major public health problems in the Niger Delta region of Nigeria. This quantitative cross-sectional study examined the associations between educational levels, income levels, vaccination status, and household structure on TB prevalence. Educational levels of the patients were found to be significantly associated with TB prevalence in the region. TB is commoner with patients with low educational levels (Subkhan et al., 2021). More so, educated patients generally have more concepts of TB and therefore have less chance to acquire the disease (Imam et al., 2021). This indicates that the level of education should be considered as a valuable factor affecting

outcome program which targets increasing the level of knowledge and perception in the community.

The household structure was also found to be predictive of TB occurrence in the studied population. The number of people living together determines how much the infection is transmitted (OECD, 2020). There is a greater risk of disease and death with TB among people living in close or intimate familial contact than those living in the general population (Rakhmawati et al., 2019). The income levels and vaccination status of the studied population, though very important independent variables were not significantly associated with TB prevalence in the studied population. This result has significant public health implications for educating both policy makers as well as the populations on the need to modify lifestyles that makes them too vulnerable to this disease.

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Appendix: Questionnaire

Dear Respondent, my name is *Nwinmene George Zarakpege* carrying out a Doctoral research work at the Walden on the *"Relationship between Poverty, income and Lower Educational Levels on Tuberculosis (TB) Prevalence in Nigeria: Rural Niger Delta Case Study".* Please kindly enter your answers as instructed. Information supplied will be treated confidentially and it is purely for research purposes.

Thanks for participating,
Researcher

SECTION A

1. How old are you? ……...
2. What is your sex, male or female? ……..
3. Are you employed Yes, No or others?.....
4. What is your occupation? ……
5. What is your marital status, Single/Married/Divorce/Widowed/others?
6. What is your level of Education Primary/Secondary/Tertiary?.....
7. What village, city or local government area do you reside in?.....
8. What is your religion? ……
9. What is your Tribe? .....

SECTION B

Tick "Yes" or "No" in the space provided against each question.

10. Presence of tuberculosis from a TB Yes ☐ No ☐
11. Have you ever been a health care worker, volunteer, or employee of a nursing home, prison or other residential institution? Yes No ☐ ☐
12. Have you ever been in close contact with someone known to have active TB? Yes ☐ No ☐
13. Did you have health information about TB prior to been diagnosed? Yes ☐ No ☐ NA ☐
14. Do you visit the hospital regularly for routine health checkups? Yes ☐ No ☐
15. If yes why? Other disease ☐ Routine checkup ☐ Others ☐
16. Do you think that you must go for a routine health care checkup? Yes No ☐
17. Do you think that not having preventive health information will cause disease? Yes ☐ No ☐ ☐
18. Do you know what TB infection does to your health? Yes ☐ ☐
19. What is the most important thing about TB disease that you know? Kills ☐ Does not kill Don't know. ☐ ☐
20. Do you know of anyone that has TB or died of the disease in your community?
21. Does Tb have a cure? Yes ☐ No ☐

22. What treatment is available? ……
23. Did you receive a TB vaccination? Yes ☐ No ☐
24. Do you live in the same household with other persons? Yes ☐ No
25. If yes how many people live in the household with you? ☐

SECTION C

26. Can you read and write? Yes ☐ No ☐
27. If yes, what language? English ☐ others ☐
28. Do you have any spoken language? Yes ☐ No ☐
29. Do you have any communication disability? Yes ☐ No ☐
30. Did you go to school? Yes ☐ No ☐
31. What is your highest level of Education? Primary ☐ Secondary ☐ Tertiary ☐

SECTION D

32. Have you ever worked in your stated occupation? Yes ☐ ☐
33. Do you currently work? Yes ☐ No ☐
32. How much do you currently earn a day on average? < # 500($1) ☐ > #500 ($1)
34. Do you pay for your TB treatment? Yes ☐ No ☐ ☐
35. If yes what method? Insurance ☐ Out of pocket ☐ Others
36. Do you need transportation to access treatment? Yes ☐ No ☐ ☐
37. If yes how much does that cost?.....
38. Does this affect your hospital visitation? Yes ☐ No ☐
39. Do you agree that poverty and lower educational level has an impact on your TB condition and treatment? Yes ☐ No ☐

Thank you for your time