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Prevalence and Predictors of Tuberculosis among People Living With Diabetes in Rivers State

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Abstract
This study investigated the prevalence and predictors of tuberculosis among people living with diabetes in Rivers State. The study assessed the level of knowledge of diabetes as a risk factor for tuberculosis among diabetic patients. It also determined the prevalence of tuberculosis among people living with diabetes, predictors of TB in persons living with DM and associations between socio-demographic variables and predictors of TB. The study adopted a descriptive survey research design. The population of the study was estimated at 47,264 patients with diabetes in Port Harcourt and Obio/Akpor LGAs of Rivers State while the sample size was 400 diabetic patients. Inclusion criteria for the study were individuals attending adult diabetes clinics in UPTH and RSUTH (of either gender) who have been confirmed diabetic. Individuals associated with lifestyles associated with TB and DM risk factors are later diagnosed with these diseases later in life. Data were obtained through questionnaires and sputum collection from respondents for TB confirmatory test. The association between selected predictors of TB in persons living with DM an association between socio-demographic variables and predictors were analysed using the chi-square on Statistical Package for Social Sciences (SPSS) version 20 at a 0.05 significant level. The findings of the study showed that the level of knowledge of DM as a risk factor for tuberculosis was poor. DM/TB comorbidity was found to be 7.21%. Socio-demographic variables which are sex, age, the highest level of education, marital status, main occupation, household size and income per month were found to be significantly associated with predictors of TB which are smoking, drinking alcohol, BMI, and physical exercise and duration of diabetes. TB screening among DM patients was also not high. In conclusion, DM patients should take diet, physical exercise, lifestyle and medication serious as well as they should regularly visit their physician for a proper check-up. The study recommended properly planned exercise, proper management of diabetes, diet and regular check-ups amongst others.

Keywords: Tuberculosis, Diabetes, Predictors, Rivers State

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I. Introduction

Tuberculosis (TB) has been noted by the World Health Organisation (WHO) as one of the public health emergencies in Nigeria with an estimated prevalence of 0.62% in the mostly adult population (World Health Organisation, WHO, 2015). The World Health Organisation also estimated that 616 incidences in every 100,000 adults in Nigeria are at risk of contracting TB (World Health Organisation, WHO, 2015). Nigeria is ranked first in Africa, and fourth among the 22 high TB burden nations in the world, with 460,000 cases of TB reported annually in Nigeria (WHO, 2015). Ita and Udofia as cited by Okpokam, Kooffreh-Ada, Okaormhe, and Nna (2016), disclosed that the prevalence rate of TB in Ikot Ekpene was 38.5% and 17.6% in Itu the Local Government Area of Akwa Ibom State; they reported that male subjects had a higher incidence rate of TB (35.6%) compared to 29.6% in female. In the study of Aliyu et al. (2013) results showed a high incidence of PTB cases in Kaduna State with a prevalence rate of *Bovisvis* (1%) and a relatively high prevalence rate of *M. africanum* (13%). Similarly, Nwanta et al. (2011) results showed a slightly higher prevalence rate of 37.9% MTB in Enugu state, Nigeria. This is a relatively high ratio of TB incidence in Nigeria. According to a WHO report in 2017, 10 million cases of PTB were recorded, with a mortality rate of 1.3 million people (WHO, 2018). The major concern on the reduction of TB burden is anchored on controlling the risk factors such as smoking, and drinking alcohol and also calls for prioritization of interventions addressing the key TB risk factors including diabetes mellitus (DM) (WHO, 2016).

According to Jeon and Murray (2008), there has been a suspected association between TB and DM for over a long period but has only recently surfaced as a global concern with increasing incidence of DM in TB endemic regions. On a global scale, an estimated 425 million people are living with DM. according to International Diabetes Federation IDF, (2015), this number is expected to increase to 629 million by 2045. Most of these cases are recorded in Low-and-middle-income countries which are the epicentre of the increasing DM burden. They account for over 80% of the global DM cases (International Diabetes Federation IDF, 2015). There are many studies about the co-existence of TB and DM. But, Al-Rifai, et al. (2017) disclosed that DM appears to increase the risk of TB disease by about three-fold and to have a profound adverse impact on TB-treatment outcomes (e.g., DM appears to increase the risk of TB death by two to four-fold, and TB disease relapse and recurrence by two-fold, among others). DM is suspected to account for a considerable proportion of TB diseases incident cases, highlighting the importance of the joint TB-DM epidemic.

However, mechanisms that favour infection in DM are just starting to emerge (Segura-Cerda et al., 2019). Patients with DM are more susceptible to TB, mainly due to chronic inflammation, which is marked by an increase in proinflammatory cytokines and a decrease in immunomodulatory cytokines (Kumar & Babu, 2017). DM is a common cause of dyslipidaemia, particularly if glycaemia is poorly controlled. The susceptibility to TB among patients with DM may also be caused by dyslipidaemia (Restrepo & Schlesinger, 2013) because host lipids are essential energy sources used by mycobacteria to persist in a latent infection state (Tsai et al., 2017). The continuous combination of these two epidemics may cause an increase in the incidence of TB disease, especially in low- and middle-income countries with increasing numbers of people with DM and prevalent TB disease. Comorbidity of DM and TB had also been discovered to make less effective TB treatments. Despite the well-documented association between DM and TB, the evidence for TB screening among diabetic patients remains limited (Lee et al., 2017).

STATEMENT OF THE PROBLEM

Many studies have disclosed that people diagnosed with DM had approximately three times the risk of developing TB disease than people without diabetes (Baker et al, 2011). Diabetes can worsen the clinical course of TB, and TB can worsen the glycaemic control in people diagnosed with diabetes. Individuals with both conditions thus require careful clinical management. Strategies are needed to ensure that optimal care is provided to patients with both diseases. The global burden of DM is rising; the prevalence is estimated to reach 438 million by 2030, and more than 80% of the adult cases will be in newly developed or developing countries undergoing rapid economic, social and lifestyle changes (International Diabetes Federation, 2015). Further increase in the number of diabetes-associated TB cases can thwart the progress that has been made in the global fight against TB. Therefore, prevention and care of diabetes should be a priority not only for stakeholders involved in the care and control of non-communicable diseases but also for those working on TB care and prevention. This study focused on a broader action on the level of knowledge of diabetes as a risk factor for tuberculosis, prevalence of tuberculosis among people living with diabetes, predictors of TB in persons living with DM and the associations between socio-demographic variables and predictors of TB.

AIM AND OBJECTIVES OF THE STUDY

The main aim of the study was to determine the prevalence and predictors of tuberculosis among people living with diabetes in Rivers State.

The specific objectives of this study were:

1. To assess the level of knowledge of diabetes as a risk factor for tuberculosis
2. To determine the prevalence of tuberculosis among people living with diabetes
3. To determine the predictors of TB in persons living with DM
4. To determine the associations between socio-demographic variables and predictors of TB.

RESEARCH QUESTIONS

The following research questions were formulated to guide the study:

1. What is the level of knowledge of diabetes as a risk factor for tuberculosis?
2. What is the prevalence of tuberculosis among people living with diabetes?
3. What are the predictors of TB in persons living with DM?
4. What are the associations between socio-demographic variables and predictors of TB?

II. Literature Review

The Dual-Process Model

Hofmann and colleagues (2008) came up with the dual-process model (DPM) which suggested that health behaviours are determined by two factors which are reflective and impulsive, and their degree of influence on behaviour is moderated by various boundary conditions. As noted by the authors of DPM (Friese, Hofmann, & Wiers, 2011), there is a high probability of similarity between the constructs proposed by TST and DPM; reflective and impulsive factors map to intention and behavioural pre-potency, respectively. Furthermore, one of the ascertained boundary conditions, executive function, leads to self-regulatory standards.

Health Belief Model

The Health Belief Model (HBM) was initiated or propounded to create an understanding of why people did or did not use preventive care offered by public health services in the 1950s, and has grown over time to address newer concerns in prevention and investigation (e.g., cervical cancer screening, HPV vaccines) as well as lifestyle behaviours such as sexual risk behaviours, self-care, medical check-ups habits, preventive care measures for diseases and injury prevention (Glanz, 2011). The HBM theorizes that what people believe about a particular disease or health challenge and the damage it can cause to them is what makes them take action to avoid it as well as influences their readiness to take positive actions toward preventive behaviour or seek medical help from professionals.

Core areas of the HBM are:
i. Perceived susceptibility and perceived severity
ii. Perceived benefits and perceived barriers
iii. Cues to action
iv. Self-efficacy

The HBM has been most often applied for health concerns that are prevention-related and asymptomatic, such as early diabetes detection and cancer screening – where beliefs are as important as or more important than overt symptoms. The HBM theory is also important in the interventions to reduce risk factors for heart diseases (Glanz, 2011).

Diabetes Miletus (DM)

Diabetes Miletus (DM) is a chronic condition that occurs when the body cannot produce enough insulin or cannot effectively utilise insulin, which results in high levels of glucose in the bloodstream (hyperglycaemia) causing tissue damage over time. There are three common forms of DM that account for the majority of cases: type 1, type 2 and gestational diabetes mellitus (GDM). Recent and up to date estimates of the DM burden worldwide are provided by the International Diabetes Federation (IDF) in their Diabetes Atlas. In 2013, it was estimated that 382 million people worldwide had DM, with 90% or more having Type 2 disease. About 80% of these people live in low- and middle-income countries (LMIC), and if the trends of the past 10–15 years continue with 10 million new cases occurring every year, an estimated 592 million people will have DM by 2035 (Harries et al., 2016).

Symptoms of Diabetes Miletus (DM)

There are various symptoms of diabetes which include:
(a) Frequent urination (polyuria)
(b) Excessive thirst (polydipsia)
(c) Sudden weight loss
(d) Increased hunger (polyphagia)
(e) Unexpected vision changes
(f) Hands or feet numbness
(g) Frequent fatigue
(h) More infections than usual

In some cases, nausea, vomiting, or stomach aches may follow some of the listed symptoms in the case of insulin-dependent diabetes, called Type 1 diabetes (Centre for Disease Control and Prevention, CDC, 2015).

Complications of Diabetes Miletus (DM)

The existing variations of diabetes in a patient over time about 10 – 20 years may cause medical complications, especially for people who have not been diagnosed before that time. The adverse effects of prolonged diabetes include damage to blood vessels, cardiovascular disease, coronary artery disease (which causes about 75% of deaths in diabetic patients) and others such as stroke, and peripheral vascular disease.

Diagnosis of Diabetes Mellitus

Diabetes mellitus can be confirmed by carrying out any one of the following tests:
i. Fasting plasma glucose level test with results ≥ 7.0 mmol/l (126 mg/dl) shows high sugar level.
ii. Plasma glucose ≥ 11.1 mmol/l (200 mg/dl) 2-hours after a 75g oral glucose load as in a glucose tolerance test.
iii. Symptoms of hyperglycaemia and casual plasma glucose ≥ 11.1 mmol/l (200 mg/dl).

Treatments/ Prevention Measures

Treatment, prevention and management measures for DM include:
i. Proper diet control;
ii. physical activities like exercise,

iii. home blood glucose testing, and
iv. oral medication and/or insulin injections.

Tuberculosis (TB)

Tuberculosis (TB) is an airborne transmittable disease caused by an organism of the Mycobacterium tuberculosis complex which was discovered by Robert Koch in 1882. To date, TB continues to be a major cause of the loss of people's lives, primarily in low-income and middle-income countries (World Health Organization, 2021). Principally a pulmonary pathogen, *M. tuberculosis* can cause disease throughout the body. TB can be prevented by changing the range of asymptomatic infection to a life-threatening disease (Esmail et al 2014). From direct observation of health practitioners and public health perspective, patients with TB are realistically arranged into classes, first as having latent TB infection (LTBI), which is an asymptomatic and non-transmissible state, or active TB disease, which is transmissible (inactive pulmonary TB) and for which culture-based or molecular diagnostics can be used (Esmail & Barry, 2014). Patients with active TB disease show symptoms such as fever, fatigue, lack of appetite and weight loss, and those with the pulmonary disease can have a persistent cough and haemoptysis (coughing up blood) in advanced disease. However, Esmail & Barry, (2014) disclosed that some patients with active, the culture-positive disease may be asymptomatic and are best described as having subclinical TB (Esmail & Barry, 2014).

Patterns in TB transmission and control revealed a marked disparity. From 1900 to 1980, TB‑related deaths in Western Europe and the United States fell by >100‑fold (Lienhardt, et al., 2014). As much of this decline occurred before the discovery of effective anti‑TB drugs, it is generally thought that much of this decrease resulted from general improvements in hygiene and socioeconomic conditions. However, progress in most high-burden settings is much slower. The rate of decline in incidence worldwide is currently only about 1.5% per year (WHO, 2015). Faster progress has been observed in some areas; for example, China has halved the prevalence of active TB disease and reduced TB-related deaths by about 80% over the 20 years "1990-to 2010" (WHO, 2014). In contrast, the incidence of active TB increased over the same period in Nigeria and other African countries, mainly due to the effects of the HIV epidemic. Treatment for tuberculosis saved about >43 million lives between 2000 and 2014; however, WHO estimates that more than a third of all individuals who develop active TB disease are never diagnosed or reported to public health authorities, based on the difference between estimated and reported cases: this "3.6 million missing" represents a major challenge in efforts to control tuberculosis (WHO, 2015). The emergence of drug resistance is a major concern and its distribution is very heterogeneous. Globally, the prevalence of MDR-TB is estimated at 5% (3.5% in new cases of active TB disease and 20.5% in previously treated cases), but this prevalence is around 1% in many countries in sub-Saharan Africa, West Europe and North America at >20% in the former Soviet Union (WHO, 2014). Of particular interest in recent years has been the problem of drug-resistant tuberculosis in China (where a quarter of all cases of active tuberculosis disease are resistant to isoniazid or rifampicin) and in India (which has seen the emergence of so-called total resistance drug strains) (Zhao, et al., 2012; Udwadia et al., 2012).

III. Methodology

The study adopted a descriptive cross-sectional study design to conveniently sample diabetic patients in two teaching hospitals in Rivers State (University of Port Harcourt Teaching Hospital, UPTH and Rivers State University Teaching Hospital, RSUTH). The population of this study is estimated at 47,264 patients with diabetes in Port Harcourt and Obio/Akpor LGAs of Rivers State. This value was determined from a 2017 U.N diabetes estimation of 1:17 in the Nigerian adult population (which is 49.8% of the total population) (U.N, 2017; National Population Commission, 2016). Individuals attending adult diabetes clinics in UPTH and RSUTH (of either gender) who have been confirmed diabetic. Individuals associated with lifestyles associated with TB and DM risk factors are later diagnosed with these diseases later in life. Diabetic patients at the emergency unit/ward who cannot assess the questionnaire and whose sputum was not collected for TB confirmation test. This study adopted a multistage sampling method in sample selection. The first stage used purposive sampling to select the two teaching hospitals in Rivers State. The second stage used a stratified sampling method to equally select 200 respondents in each of the teaching hospitals to ensure equal participation. The third stage used purposive sampling to select 400 respondents diagnosed with diabetes mellitus for over five years in the two teaching hospitals. The final stage used a convenient sampling method to select respondents to fill up the study instruments on each diabetes clinic day held once a week. Every clinic day copies of the questionnaire were administered to those that consented until the sample size was completed in the two teaching hospitals in Rivers State. The study depended on primary data collected through copies of questionnaires and laboratory test results from DOTS centres in UPTH and RSUTH. The objectives of be measured tool are to assess the knowledge of DM as a risk factor for TB and to determine the prevalence of TB in DM patients. For this study, data were obtained through questionnaires and sputum collection from respondents for TB confirmatory tests. The questionnaire was a self-structured questionnaire by the researcher to be administered to diabetic patients at the

University of Port Harcourt Teaching Hospital (UPTH) and Rivers State University Teaching Hospital (RSUTH) to elicit information about the prevalence and predictors of tuberculosis in people living with diabetes mellitus (DM). The questionnaire contains questions divided into different sections covering each research variable. Section A contains items to elicit socio-demographic data of the respondents while Sections B, C and D have items representing the variables of the study. The responses to the instruction were structured with open-ended and multi-choice questions statements. The instrument for data collection was administered and retrieved immediately from the selected respondents. For the TB confirmatory test, clinical services in the DOTS centres from the two teaching hospitals were accessed. The DOTS centres provided the opportunity and necessary materials to collect sputum samples from the DM patients. The data collected by questionnaire and TB tests were sorted and collated. The questionnaire administered was validated via face and content validity by the project supervisor. The reliability coefficient of the instrument was established using the Kuder Richardson (K-R 20) correlation co-efficient. Twenty copies of the instrument were administered to twenty (20) randomly selected respondents from the sample. The responses were analysed using the Pearson Product Moment Correlation method which yielded a reliability coefficient of 0.87 which was considered reliable enough. The sputum collection process followed the same procedure used by National Tuberculosis and Leprosy Control Programme (NTBLCP) guidelines; respondents were advised to rinse their mouths at least twice with water before producing the specimen to remove food particles and reduce contaminating bacteria load from their mouth. They were instructed to take two breaths, and then cough deeply and expectorate the sputum into the provided 50ml screw-capped translucent bottles, holding the sample container close to their mouth. Confirmation of the presence of *M. tuberculosis* was x-rayed using the GeneXpert machine at the laboratory. The tests were run following the manufacturer's instructions.

IV. Results

Level of knowledge of DM as a risk factor for tuberculosis

Table 1 Level of knowledge of DM as a risk factor for tuberculosis **(n=379)**

f-frequency, %-percentage.

Table 1 shows the level of knowledge of DM patients as a risk factor for tuberculosis.

The level of knowledge was 18.8%, wrong knowledge (7.21%) and 74.0% of DM patients do not have any idea about DM as a risk factor for tuberculosis. The results are presented as shown in Figure 1 below.

Items	**Responses**		
	Good Knowledge (f / %)	**Average Knowledge (f / %)**	**No/Poor Knowledge (f / %)**
Do you know that diabetic patients are at risk of tuberculosis?	67 (18.0%)	45 (12.0%)	267 (70.0%)
Can diabetes cause tuberculosis?	37 (9.80%)	67 (18.0%)	275 (72.2%)
DM increases the susceptibility to TB infection	109 (28.8%)	23 (6.10%)	247 (65.1%)
DM increases the proportion of TB infections entering the latent-fast state as opposed to a latent-slow state	41 (10.8%)	9 (2.40%)	329 (86.8%)
DM increases the rate of developing TB disease among those with latent TB infection.	102 (30.0%)	7 (1.80%)	270 (68.2%)
DM causes the reactivation of TB infection.	58 (15.3%)	11 (3.00%)	310 (81.7%)
Total Level of Knowledge	**18.8%**	**7.21%**	**74.0%**

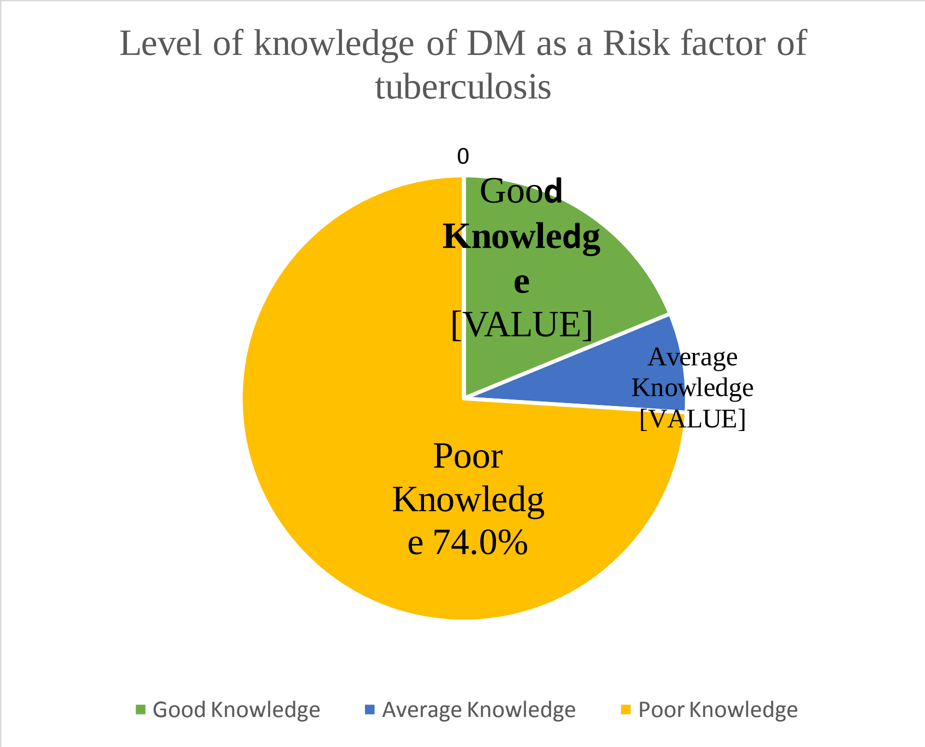

Figure 1 Pie Chart showing the Level of Knowledge of DM as a risk factor for tuberculosis

Prevalence of Tuberculosis among Diabetes Patients
Table 2 Prevalence of Tuberculosis among Diabetes Patients **(n=379)**

Table 2 shows that 108 (28.5%) patients with DM show symptoms of coughing with 89 (23.5%) having persistent cough. The majority 271 (71.5%) and 290 (76.5%) were not coughing therefore do not cough persistently. From the test conducted for TB 31 (8.2%) DM patients tested positive, 343 (90.5%) tested negative

Items	Responses	Frequency (%)
Are you coughing presently?	Yes No	108 (28.5%) 271 (71.5%)
Do you have a cough On and Off?	Yes No	89 (23.5%) 290 (76.5%)
Has your sputum been tested before?	Yes No	379 (100%) 0 (0.00)
TB Test Outcome	Positive Negative No Results **Total**	31 (8.2%) 343 (90.5%) 5 (1.3%) **379 (100.0%)**

and 5 (1.3%) have no results. Compared to the total number of DM patients in the study the prevalence of TB in DM patients was 31 out of 379 which represents 8.20% of the total sample. The results are shown in Figure 2 below.

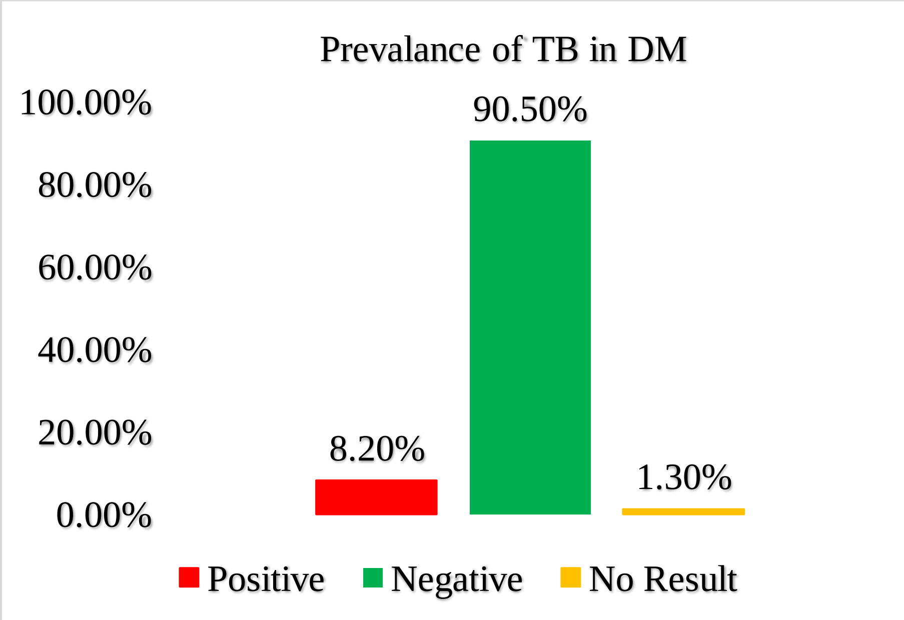

Figure 2 Column chart showing the prevalence of TB in DM in the patients

Table 3 Chi-square test result on the cross-tabulation between the type of DM and TB status

	TB status	(χ^2)	df	Exact Sig. (2-sided)
Type of DM				
Type 1	12	139.	1	0.0000
Type 2	19	114		
Total	31			

From Table 3 the Pearson Chi-square value (χ^2) = 139.114 and a p-value = 0.0000 significant at 1% which shows that status of diabetes is significantly associated with TB infection or reactivation.

Predictors of TB in persons living with DM

Items	Responses	Frequency (%)	p-value
Type of diabetes diagnosed of:	Type 1 Type 2	12 (3.20%) 367 (96.8%)	0.023
Are you a current smoker?	Yes No	89 (23.5%) 290 (76.5%)	0.033
Are you currently drinking Alcohol?	Yes No	23 (1.60%) 356 (98.4%)	0.002
Are you currently smoking & drinking Alcohol?	Yes No **Total**	23 (3.80%) 133 (96.2%) **156 (41.2%)**	0.041
BMI (Kg/m2)	<18.5 18.5 – 24.9 25.0 – 29.9 ≥ 30.0	156 (41.2%) 223 (58.8%)	0.243
How long have you been diabetic?	1 – 5 years 6 – 10 years 11 – 15 years 16– 20 years ≥ 21	67 (17.7%) 121 (31.9%) 109 (28.8%) 47 (12.4%) 35 (9.20%)	0.017
Are you involved in planned physical exercise?	Yes No	200 (52.8%) 179 (47.2%)	0.456
If yes, what type?	Jogging Weight Lifting Football Aerobic exercise Swimming	143 (37.7%)* 65 (17.2%)* 43 (11.3%)* 101 (26.6%)* 78 (20.5%)*	

	Long Walk Bicycles Riding Gym Workout	156 (41.2%)* 43 (11.3%)* 120 (31.7%)*	

Table 4 Predictors of TB in persons living with DM
*Multiple responses recorded.

From Table 4 there were 89 (23.5%) diabetic patients who smoke currently, 6.00% who drink alcohol and 23 (3.80%) smoke and drink among those who smoke or drink. From the table above 156 (41.2%) had BMI below 18.5 while 223 (58.8%) patients had BMI (Kg/m^2). The duration of diabetes among respondents shows that the majority (31.9%) had it for about 6 – 10 years, followed by 109 (28.8%) for about 11 – 15 years, 67 (17.7%) had it for about 1 – 5 years, 47 (12.4%) for 16– 20 years and 35 (9.20%) have been diagnosed for diabetes for over 21 years. The majority of 200 (52.8%) diabetic patients were involved in planned physical exercise while 179 (47.2%) were not involved in planned physical exercise. The types of planned exercise engaged by diabetic patients were 143 (37.7%) were involved in jogging, 65 (17.2%) in weight lifting, 43 (11.3%) plays football, 101 (26.6%) participate in aerobic exercise, 78 (20.5%) involve in swimming, 156 (41.2%) long walk, 43 (11.3%) * bicycles riding and 120 (31.7%) gym workout.

Logistic regression was performed to ascertain the predictors of TB age of diabetes, smoking, drinking and smoking, drinking alcohol and BMI in diabetic patients. The logistic regression model was statistically significant $\chi^2(4) = 147$, the result shows that type of diabetes is statistically significant with TB status at p-value = 0.023, so also are smokers p-value = 0.033, alcohol drinkers p-value = 0.002, drinkers and smokers p-value = 0.041, years of diabetes p-value = 0.017 while physical exercise p-value = 0.456, and MBI p-value = 0.243 were not statistically significant.

Associations between socio-demographic variables and predictors of TB

Table 5 Chi-square test result on Gender versus Predictors of TB

Associations between smoking and TB-Outcome

Table 4.7 Chi-Square Tests between smoking and TB-Outcome

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability	Odd ratio	Confidence interval
Pearson Chi-Square	.350[a]	1	.554	.626	.361		1.6	(0.6, 4.28)
Continuity Correction[b]	.119	1	.730					
Likelihood Ratio	.346	1	.557	.626	.361			
Fisher's Exact Test				.626	.361			
Linear-by-Linear Association	.346[d]	1	.556	.626	.361	.161		
N of Valid Cases	89							

a. 0 cells (.0%) have an expected count of less than 5. The minimum expected count is 8.80.
b. Computed only for a 2x2 table
c. For 2x2 cross-tabulation, exact results are provided instead of Monte Carlo results.
d. The standardized statistic is -.588.

From Table 5 the chi-square test showed a Pearson Chi-Square $\boldsymbol{\chi(1)} = 0.350$, degree of freedom (df) =1, p-value = 0.554, with odd ratio = 1.6 and confidence of interval (C.I) = (0.6, 4.28) which showed that there is no significant association between smoking and TB-Outcome from the study sample. The odds ratio indicates the level of association between the presence and absence of TB among diabetic patients who are smokers or non-smokers. From the odd ratio of 1.6, diabetic patients who smoke are likely to have TB 1.6 times more than those who do not smoke. The 95% confidence interval for the odds ratio is between 0.6 and 4.28. This interval is close because the number of non-smokers is large compared to the number of smokers.

Table 6 Chi-Square Tests between alcohol drinking and TB-Outcome

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Probability	Odd ratio	Confidence interval
Pearson Chi-Square	.144[a]	1	.704	1.000	.602		0.39	(0.11, 1.41)
Continuity Correction[b]	.000	1	1.000					
Likelihood Ratio	.148	1	.701	1.000	.602			
Fisher's Exact Test				1.000	.602			

Linear-by-Linear Association	.138[d]	1	.710	1.000	.602	.440		
N of Valid Cases	23							

a. 2 cells (50.0%) have an expected count of less than 5. The minimum expected count is 1.30.
b. Computed only for a 2x2 table
c. For 2x2 crosstabulation, exact results are provided instead of Monte Carlo results.
d. The standardized statistic is -.372.

From Table 6 the chi-square test showed a Pearson Chi-Square $\chi(1)$ = 0.444, degree of freedom (df) =1, p-value = 0.704 which showed that there is no significant association between smoking and TB-Outcome from the study sample. The odd ratio = 0.39 and confidence of interval (C.I) = (0.11, 1.41). The odd ratio of 0.39 indicates that diabetic patients who do not drink alcohol are associated with a decrease in contracting TB. The 95% confidence interval for the odds ratio is between 0.11 and 1.41. This interval is close because the number of diabetic patients who do not drink alcohol is large compared to the number of those who drink alcohol.

Table 7 Chi-Square Tests between smoking & alcohol drinking and TB-Outcome

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Odd ratio	Confidence interval
Pearson Chi-Square	.726[a]	1	.394			3.8	(10.49, 29.62)
Continuity Corrections	.001	1	.972				
Likelihood Ratio	1.238	1	.266				
Fisher's Exact Test				1.000	.547		
Linear-by-Linear Association	.695	1	.405				
N of Valid Cases	23						

a. 3 cells (75.0%) have an expected count of less than 5. The minimum expected count is .52.
b. Computed only for a 2x2 table

From Table 7 the chi-square test showed a Pearson Chi-Square $\chi(1)$ = 0.726, degree of freedom (df) =1, p-value = 0.394 which showed that there is no significant association between smoking and TB-Outcome from the study sample. The odd ratio = 3.8 and confidence of interval (C.I) = (10.49, 29.62). The odd ratio of 3.8 indicates that diabetic patients who drink alcohol and smoke tobacco are more likely to contract TB infection 3.8 times than non-smokers and alcohol drinkers. The 95% confidence interval for the odds ratio is between 10.49 and 29.60. This interval is close because the number of diabetic patients who do not drink alcohol and smoke is large compared to the number of those who drink alcohol.

Table 10 Chi-Square Tests between BMI and TB-Outcome

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	**Odd ratio**	**Confidence interval**
Pearson Chi-Square	6.907[a]	1	.009			0.97	(0.47, 1.99)
Continuity Corrections	5.459	1	.019				
Likelihood Ratio	11.178	1	.001				
Fisher's Exact Test				.006	.004		
Linear-by-Linear Association	6.876	1	.009				
N of Valid Cases	223						

a. 1 cell (25.0%) has an expected count of less than 5. The minimum expected count is 4.51.

b. Computed only for a 2x2 table

From Table 10 the chi-square test showed a Pearson Chi-Square $\chi(1)$ = 6.907, degree of freedom (df) =1, p-value = 0.009 which showed that there is no significant association between smoking and TB-Outcome from the study sample. The odd ratio = 0.97 and confidence of interval (C.I) = (0.47, 1.99). The odd ratio of 0.97 indicates that diabetic patients' BMI is less than 18.5 and are likely to contract TB infection 0.97 times more than diabetic patients who have BMI greater than 18.5. The 95% confidence interval for the odds ratio is between 0.47 and 1.99. This interval is close because the number of diabetic patients with a BMI greater than 18.5 is large compared to those with BMI less than 18.5.

Table 11 Logistic regression output for predictors vs adjusted ratio

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	Smoking_Outcome	.281	1.023	.075	1	.784	1.324	.178	9.823
	Drinking_Outcome	-.146	1.464	.010	1	.921	.864	.049	15.244
	Bmi_Outcome	1.539	.941	2.675	1	.102	4.662	.737	29.493
	Constant	-2.069	2.499	.686	1	.408	.126		

a. Variable(s) entered on step 1: Adjusted ratio of SMOKING_outcome, BMI_outcome.

Table 11 above shows a logistic regression was performed to ascertain the effect of smoking, drinking and BMI on the TB-reactivation or incidence in people living with diabetes. From this result smoking (p=0.784), drinking (p=0.921) and BMI (p=0.102) did not significantly to the model/ prediction. The model explained 16.2% (Nagelkerke R^2) of the variance of TB outcome.

V. Discussion of Findings

Level of Knowledge of Diabetes as a Risk Factor of Tuberculosis

The findings from the results showed that the level of knowledge of DM as a risk factor for tuberculosis was poor. The level of knowledge was found to be 18.8% good knowledge from respondents in the study area, average knowledge about DM/TB comorbidity was found to be 7.21% among the participants of the study and 74.0% of DM patients who participate in the study have poor knowledge about DM as a risk factor of tuberculosis. This might be because of disagreement among scholars in the establishment of a statistical association between DM/TB. This is supported by Wu et al. (2015) who disclosed that the impacts of DM on the risk of active TB disease and the details surrounding this association have not been well established. According to Chukwu et al., (2019), there is no definite pathophysiological mechanism of the effect of DM as a predisposing risk factor for TB is unknown. Nonetheless, some hypotheses are suggested including depressed cellular immunity, dysfunction of alveolar macrophages, low levels of interferon-gamma, pulmonary microangiopathy, and micronutrient deficiency (Ottmani et al., 2010).

Prevalence of tuberculosis among people living with diabetes

From the study results 108 (28.5%) DM patients were coughing with 89 (23.5%) having persistent coughs. These are some signs and symptoms of TB. The majority 271 (71.5%) and 290 (76.5%) were not coughing therefore do not cough persistently. It has been disclosed that 50% of all people with culture-positive active TB disease do not have a prolonged productive (phlegm or mucus-producing) cough, and at least 25% have no symptoms whatsoever (Andrews, et al. 2012). Thus, the progression from LTBI to active TB disease can be clinically subtle, even though individuals with subclinical TB can transmit the organism to others (Dowdy, Basu, & Andrews, 2013). From the test conducted for TB 31 (8.2%) DM patients tested positive, 343 (90.5%) tested negative and 5 (1.3%) have no results. Compared to the total number of DM patients in the study the prevalence of TB in DM patients was 31 out of 379 which represents 8.20% of the total sample. Chi-square test result on the cross-tabulation between the type of DM and TB showed a Pearson Chi-square value (χ^2) = 139.114 and a p-value = 0.0000 significant at 1% which shows that status of diabetes is significantly associated with TB infection or reactivation. The study of McMurry et al., (2019) which investigated diabetes mellitus and tuberculosis comorbidity in most low- and middle-income countries (LMICs) varies from 1.8% to 45%, with the majority found between 10% and 30%. The prevalence in this study is 1.8% lower than that of McMurry et al., (2019). Other studies were of similar results Usmani et al (2014) in their study found (5.69%) in Pakistan, Dave et al., (2013) in India was (6.5%), Ekeke et al., (2017) in Nigeria was (5.5%) and Lusaka in Zambia (5%) by Fwoloshi and Hachaambwa (2018). Wagnew et al., (2018) opined that the global number of patients with diabetes mellitus comorbidity is higher than the number of patients with tuberculosis and human immunodeficiency virus comorbidity. Several studies indicated that diabetes mellitus and tuberculosis comorbidity results in treatment failure, prolonged sputum positivity, relapse and risk of developing multi-drug resistant tuberculosis and a high risk of death (Shariff & Safian, 2015).

Predictors of TB in persons living with DM

From Table 4.6 there were 89 (23.5%) diabetic patients who smoke currently, 6.00% who drink alcohol and 23 (3.80%) smoke and drink among those who smoke or drink. From the table above 156 (41.2%) had BMI below 18.5 while 223 (58.8%) patients had BMI (Kg/m^2). The duration of diabetes among respondents show that the majority (31.9%) had it for about 6 – 10 years, followed by 109 (28.8%) for about 11 – 15 year, 67 (17.7%) had it for about 1 – 5 years, 47 (12.4%) for 16– 20 years and 35 (9.20%) have been diagnosed for diabetes for over 21 years. The majority of 200 (52.8%) diabetic patients were involved in planned physical exercise while 179 (47.2%) were not involved in planned physical exercise. The types of planned exercise engaged by diabetic patients were 143 (37.7%) were involved in jogging, 65 (17.2%) in weight lifting, 43 (11.3%) plays football, 101 (26.6%) participate in aerobic exercise, 78 (20.5%) involve in swimming, 156 (41.2%)* long walk, 43 (11.3%)* bicycles riding and 120 (31.7%)*gym workout.

Associations between smoking and TB-Outcome

The chi-square test showed a Pearson Chi-Square $\chi(1)$ = 0.350, degree of freedom (df) =1, p-value = 0.554, with odd ratio = 1.6 and confidence of interval (C.I) = (0.6, 4.28) which showed that there is no significant association between smoking and TB-Outcome from the study sample. The odds ratio indicates the level of association between the presence and absence of TB among diabetic patients who are smokers or non-smokers. From the odd ratio of 1.6, diabetic patients who smoke are likely to have TB 1.6 times more than those who do not smoke. The 95% confidence interval for the odds ratio is between 0.6 and 4.28. This interval is close because the number of non-smokers is large compared to the number of smokers.

Association between alcohol drinking and TB-Outcome

The chi-square test showed a Pearson Chi-Square $\chi(1)$ = 0.444, degree of freedom (df) =1, p-value = 0.704 which showed that there is no significant association between smoking and TB-Outcome from the study sample. The odd ratio = 0.39 and confidence of interval (C.I) = (0.11, 1.41). The odd ratio of 0.39 indicates that diabetic patients who do not drink alcohol are associated with a decrease in contracting TB. The 95% confidence interval for the odds ratio is between 0.11 and 1.41. This interval is close because the number of diabetic patients who do not drink alcohol is large compared to the number of those who drink alcohol.

Association between smoking & alcohol drinking and TB-Outcome

The chi-square test showed a Pearson Chi-Square $\chi(1)$ = 0.726, degree of freedom (df) =1, p-value = 0.394 which showed that there is no significant association between smoking and TB-Outcome from the study sample. The odd ratio = 3.8 and confidence of interval (C.I) = (10.49, 29.62). The odd ratio of 3.8 indicates that diabetic patients who drink alcohol and smoke tobacco are likely to contract TB infection 3.8 times more than non-smokers and alcohol drinkers. The 95% confidence interval for the odds ratio is between 10.49 and 29.60. This interval is close because the number of diabetic patients who do not drink alcohol and smoke is large compared to the number of those who drink alcohol.

Association between BMI and TB-Outcome

The chi-square test showed a Pearson Chi-Square $\chi(1)$ = 6.907, degree of freedom (df) =1, p-value = 0.009 which showed that there is no significant association between smoking and TB-Outcome from the study sample. The odd ratio = 0.97 and confidence of interval (C.I) = (0.47, 1.99). The odd ratio of 0.97 indicates that diabetic patients' BMI is less than 18.5 and are likely to contract TB infection 0.97 times more than diabetic patients who have BMI greater than 18.5. The 95% confidence interval for the odds ratio is between 0.47 and 1.99. This interval is close because the number of diabetic patients with a BMI greater than 18.5 is large compared to those with BMI is less than 18.5.

Associations between socio-demographic variables and predictors of TB

From the findings socio-demographic: variables which are sex, age, the highest level of education, marital status, main occupation, household size and income per month were found not to be significantly associated with predictors of TB which are smoking, drinking alcohol, BMI, physical exercise and duration of diabetes. In the study of Gezahegn et al., (2021) factors found to be associated with diabetes mellitus and tuberculosis co-morbidity in binary logistic regressions and multiple regressions were being female (gender), age equal to or older than 50 years (age), and having extrapulmonary tuberculosis (history of TB). The role gender plays was reported by Amare, Gelaw, Anagaw and Gelaw (2013) to be about 52% of males and 48% of females were infected just like a study done in Ethiopia in which smear-positive pulmonary TB among diabetic patients was 52% for males and 48% for females. Females were about 1.3 times more likely to have TB than males in the current study. However, the difference was not marginal or statistically significant. Accordingly, the odds of being diabetes mellitus and tuberculosis co-morbidity were about four times more likely among tuberculosis patients with an age of equal to or older than 50 years patients compared to those with the age of fewer than 50 years old tuberculosis patients (AOR=3.98, CI: 1.11–14.3). The possible reason might be due to a lack of physical activity during the age of old age (Gezahegn et al., 2021). The study of Gedfew et al., (2021) found some factors significantly linked with increased risk of tuberculosis in diabetes mellitus patients which are the history of alcohol consumption, history of tuberculosis, and low body-mass index. Gedfew et al., (2021) also disclosed a relatively higher proportion of TB patients (53.6%) aged 18–35 years. In addition, the incidence was higher among rural residents (16, 61.5%) and those that had 1–3 years (14, (53.8%) follow-up. More than half 19 (73.1%) TB + DM patients had type 1 DM.

Logistic regression was performed to ascertain the effect of smoking, drinking and BMI on the TB-reactivation or incidence in people living with diabetes. From this result smoking (p=0.784), drinking (p=0.921) and BMI (p=0.102) are not significant to the model/ prediction. The model explained 16.2% (Nagelkerke R2) of the variance of TB outcome.

VI. Conclusion

The level of knowledge of DM as a risk factor for tuberculosis was poor. DM/TB comorbidity was found to be 7.21%. Socio-demographic variables which are sex, age, the highest level of education, marital status, main occupation, household size and income per month were found to be significantly associated with predictors of TB which are smoking, drinking alcohol, BMI, and physical exercise and duration of diabetes. TB screening among DM patients was also not high. In conclusion, DM patients should take diet, physical exercise, lifestyle and medication serious as well as they should regularly visit their physician for proper check-ups.

VII. Recommendations

From the findings the following recommendations were made:
1. TB screening among DM patients should be encouraged by healthcare providers.
2. More awareness should be created among the general public about the comorbidity of DM/TB.
3. There should be a robust preventive programme.

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