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Prevalence of Diabetes Mellitus II and Impaired Fasting Glycemia in Patients Diagnosed with Pulmonary Tuberculosis at the Bamenda Regional Hospital - Cameroon

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Abstract

The rising prevalence of diabetes mellitus (DM) and its association with tuberculosis (TB) and the persistence is a major public health problem worldwide, especially in developing countries,thus emphasizing the importance of investigating this association. This study was aimed at investigating the prevalence of Diabetes mellitus II and impaired fasting glycaemia in patients diagnosed with pulmonary TB at the Bamenda Regional Hospital .An experimental and prospective design, involving 91 patients diagnosed of pulmonary TB and 68 sputum negative patients were used as control. Venous blood was collected from each participant and was analyzed using the CHRONO LAB system chemistry analyzer to screen for impaired fasting glycaemia and Diabetes mellitus. Information to assess the knowledge and perception of both TB and DM of the participants was gotten through questionnaires. This study revealed that the total prevalence of diabetes mellitus was 29.7% while that of IFG was 16.5% amongst TB patients receiving care at the Bamenda Regional hospital compared to the 26.6% DM and 2.9% IFG for the control group. In total, 42(46.2%) of the test population were hyperglycemic (IFG/DM) compared to 16(23.5%) of the control group and this difference was statistically significant ($p<0.05$) More males (28%) in this study were hyperglycemic than females (21%) but the difference was statistically not sgnificant, 26% of alcohol consumers were more hyperglycemic than non alcohol consumers and the difference was statistically significant ($p< 0.05$). The age range of 31 – 40 years had the highest prevalence level (9%) of DM and 7% of IFG and those below 20 years had the lowest glycemic levels. Findings from this study revealed that TB patients had a higher prevalence of DM and IFG compared to the control population (sputum negative patients).

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The screening of diabetes in patients with pulmonary tuberculosis is recommended for successful treatment, control and patient care of the two diseases.

Keywords: Diabetes Mellitus; Impaired Fasting Glycemia; Pulmonary Tuberculosis; Bamenda Regional hospital – Cameroon.

1. Introduction

Diabetes mellitus (DM) is a carbohydrate metabolism disorder in which there is a high blood sugar level or hyperglycemia and it is caused by the absence of insulin or insulin function that allows the body to store glucose[1]. Type 1 DM, type 2 DM, other specific types of diabetes and gestational diabetes mellitus are the 4 major types of diabetes and the other specific types of diabetes include those due to genetic disorders, infections, diseases of the exocrine pancreas, endocrinopathies, and drugs [1]. Persons with diabetes require intensive medical care to manage blood glucose levels and prevent complications due to diabetes such as cardiovascular diseases, retinopathy and neuropathy.[1]. Type 2 diabetes is characterized by insulin resistance and abnormal insulin secretion, either of which may predominate but both of which are usually present. The specific reasons for the development of these abnormalities are largely unknown. Type 2 is the most common type of diabetes. Type 2 diabetes can remain asymptomatic for many years, and the diagnosis is often made from associated complications or incidentally through an abnormal blood or urine glucose test. [1]. For the purpose of this study, type 2 DM will be the area of interest. The global prevalence has risen from 4.7% to 8.5% since the 1980s, and it was estimated that 422 million of adults were living with DM in 2014 [2]. This increase has been due to the accelerated rise of DM in low- and middle-income countries rather than in high-income countries [2]. By 2030, it is estimated that approximately 552 million people will be affected by the disease [2] Diabetes is a large cause of death and disability in Sub-Saharan Africa. The international Diabetes Federation (IDF) has estimated that the prevalence of diabetes in Sub-Saharan Africa as a whole for 2014 was approximately 10.6 [2]. Diabetes poses a large financial burden in countries with limited resources. For example, in Africa, where mean per capita expenditures on health are US$30–800, the mean annual cost for diabetes care ranges between $2144 and $11 430 (direct costs $876–1220) [20]. Tuberculosis (TB) remains a major cause of morbidity and mortality worldwide, with an estimated 10.4 million people newly developing TB and 1.7 million dying from it in 2016 [21]. Over 70% of these new cases occurred in developing countries and the highest rate of death occurred in Africa. Tuberculosis (TB) is an infectious disease caused by the *Mycobacterium* complex, including *M. tuberculosis* (tubercle bacillus), *M. bovis* occurring worldwide and is a major public health problem. Most infections are asymptomatic or non-progressive [3]. The most common site of infection is the lungs (pulmonary TB) and is the main source of infection in the transmission of TB [3]. There is now abundant evidence of high rates of diabetes in people with Tuberculosis, and often diabetes is only discovered if screened for. The same is true for Tuberculosis rates among people with diabetes. The growing burden of TB-DM is changing the landscape of TB care and prevention. Diabetes is a chronic, non-communicable disease that weakens the immune system, making people with diabetes three times more susceptible to active TB [4]. Worldwide, there are an estimated 9.6 million new patients with active TB annually and among them, 1 million have both TB and DM (TB-DM) [4]. In the current scenario, the number of patients with TB-DM comorbidity is higher than the number of patients with TB-HIV co-infection around the world [4]. In Africa, studies investigating the

prevalence of TB among persons with DM are limited. The few studies that have been performed show varying prevalence of DM in TB patients, ranging from 3% to 36%, more than 5 folds greater than in the general population [21,22]. Routine screening of TB patients for DM is lacking in most African health facilities, somewhat because of cost, perceived complexities [23] and non-existent treatment infrastructure. The standard diagnostic methods present their own challenges. Patients are required to fast for several hours before fasting blood glucose (FBG), or the the oral glucose tolerance test (OGTT). Use of random blood glucose (RBG) and glycated haemoglobin (HbA1c) with the latter being more expensive, is sensitive, does not require the patient to fast and can be offered at point of care (POC) to minimize the time to diagnosis [24]. In Cameroon, there is very little or no information on the co-infection of TB and diabetes in patients. Thus studies to determine its prevalence is of outmost importance in order to undertake effective preventive measures and to improve on disease management[25]. The purpose of this research was therefore to determine the prevalence of Diabetes mellitus and impaired fasting glycemia in patients diagnosed of pulmonary TB attending the Bamenda Regional Hospital (BRH). This research is to create awareness about TB-DM coinfection and also a call to action to address this threat before it takes a larger toll in death and disability as well as economic impact. It also identifies where knowledge gaps should drive a research agenda, and how evaluation should be used to gauge progress and shape public policies [4].

Main objective

To determine the prevalence of Diabetes mellitus II and impaired fasting glycemia in patients diagnosed with pulmonary TB at the Bamenda Regional Hospital.

Specific objectives

- To determine the prevalence of Diabetes mellitus II and impaired fasting glycemia in TB patients receiving care at the Bamenda Regional hospital and to compare data with those of a control population (people who have a negative test result for TB).

- To assess the prevalence of Diabetes mellitus II and impaired fasting glycemia in relation to age, gender, family history of diabetes and drug regimen.

- To determine the prevalence of DM – TB comorbidity according to sociodemographic factors such as alcohol consumption, smoking, and literacy level.

TB patients are unaware of the co-epidemic of DM-TB. Diabetes rates are skyrocketing worldwide, and having diabetes increases the risk that a person will become sick with TB [5]. A person sick with both diseases is likely to have complications that do not typically exist when either is present on its own. It was therefore the reason for this research, to determine and evaluate the number of TB patients with undiagnosed diabetic status by analyzing their blood sugar levels. The findings from this study could be used to create awareness through health talks and preventive measures to reduce complications which are due to the hyperglycemic environment, exposing the virulence of some pathogens in TB patients.

Hypothesis

Diabetes can be devastating to TB patients by adding more burdens to the chronic disease.

Significance of Study

The results of this study among TB patients will help in future studies which can help create awareness on the risk factors of Diabetes. The findings from this study could also be used for successful treatment, control and care of TB-DM patients.

2. Materials and methods

2.1 Research design

This was a prospective study conducted on the TB patients attending the Bamenda Regional Hospital (BRH).

2.1.1 Study site

This study was carried out at the Bamenda Regional Hospital (BRH), Northwest Region, and Cameroon. It is one of the 10 regional hospitals in Cameroon that serve as a second level referral hospital to the district hospitals and the polyclinics in the Northwest Region (NWR).

It is situated in the Azire Health Area in the Bamenda Heath District. It serves as a teaching hospital to medical students, student nurses, laboratory science students and other students.

2.1.2 Study population

The study population included all TB patients attending the Bamenda Regional Hospital (BRH) who were willing to participate in the study. A total of 159 patients were sampled in this study

2.1.3 Inclusion criteria

All the TB patients attending the Bamenda Regional Hospital who gave their informed consent to completely answer the questionnaire, and accept for their samples to be collected for analysis

2.1.4 Exclusion criteria

Any TB patients who did not give his/her informed consent was excluded from this study. Pregnant women were also excluded because they were already prone to gestational diabetes due to pregnancy. Those who had eaten before the test were also excluded from the study.

2.1.5 Instruments for data collection

A semi-structured questionnaire was used, which contained both close and open ended questions. The questionnaire was used to collect both demographic and clinical data. It was administered to participants in person and the respondents were expected to fill at their convenience. Those who had difficulties in understanding or answering certain questions were assisted by the researcher. The data was keyed into a laptop and analyzed using Microsoft excel. Names of participant, date of collection, age of participant, sex of participant, and identification numbers were indicated on the Sodium fluoride oxalate tubes for all samples that were collected. In addition, the identification number on each tube for a particular participant was same as that on the respondent's questionnaire sheets.

2.1.6 Materials for data collection

Blood samples were collected from each participant by venipuncture from the antecubital vein of the forearm using disposable syringes from which plasma glucose testing was determined. 2ml of blood was delivered into a clean, dry labeled sodium fluoride tube and taken to the laboratory for analysis.

2.1.7 Sample analysis

2.1.7.1 Biochemical analysis for blood glucose

This was done using the CHRONOLAB SYSTEMS chemistry analyzer.[6]

Test principle

Glucose oxidase (GOD) catalyzes the oxidation of glucose to gluconic acid. The formed hydrogen peroxide is detected by a chromogenic oxygen acceptor, phenol-aminophenazone in the presence of peroxidase (POD). The color intensity formed is proportional to the glucose concentration in the sample.

Procedure

- Adjusted the instrument to zero with distilled water
- Pipetted into cuvettes as follows:
- Mixed and incubated for 10mins at 37 degrees or 20mins at room temperature
- Read the absorbance (A) of the samples and standard, against the blank. The color change was stable for at least 30mins.

Table 1

	Blank	Standard	Sample
WR(ml)	1.0	1.0	1.0
Standard (micro liter)	-	10	-
Sample (micro liter)	-	-	10

Expected results

Normal range for Fasting plasma glucose: 60-110mg/dl ~3.33-6.10 mmol/L [7]

2.1.8 Statistical Analysis

Descriptive statistical packages such as frequency tables, percentages and graphics was used to present research findings. The statistical package used for data analysis is the SPSS (Statistical Package for Social Sciences) Version 21.

2.1.9 Ethical considerations

An authorization to carry out this study was obtained from the North West regional delegation of public health with supporting clearance from the department of medical laboratory science of the University of Bamenda. Only patients who voluntarily accepted to participate were recruited in the study.

3. Results

3.1 Overview of study population

This study consisted of 91 patients and 68 controls. The patient group had more males than females and was more in the age range 31-40 years. About 70% of the patient population was HIV negative; more than 80% were smokers and had a history of alcohol consumption. Almost all patients did not have a family history of diabetes (97%); about 20% had attended at least primary education, and almost 20% of the patient group suffered from multiple drug resistant forms of TB. The control group had more males than females and was more in the age group of 50 years and above; most of them (95%) were nonsmokers but had a history of alcohol consumption and a lot of them had a family history of diabetes (39%). About 16% had attended at least primary education.

3.1.1 Prevalence of diabetes mellitus and IFG in patients versus control

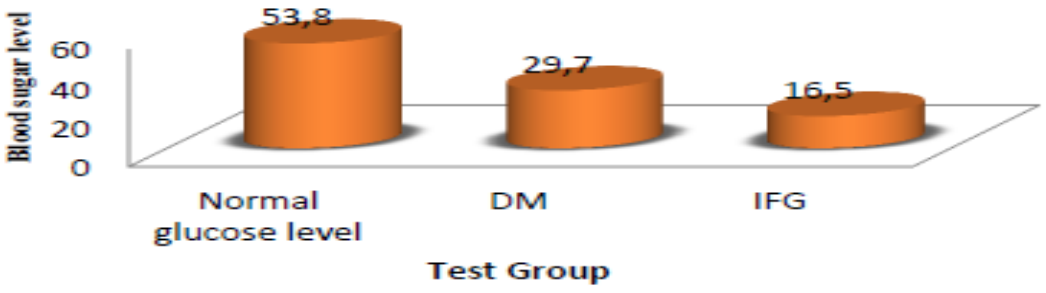

Figure 1: Prevalence of DM and IFG in test group

Considering the 91 TB patients who participated in the study, 49(53.8%) had normal glucose levels, 27(29.7%) were diabetic and 15(16.5%) had IFG. (Fig 1)

3.1.2 Prevalence of DM and IFG in test and control group

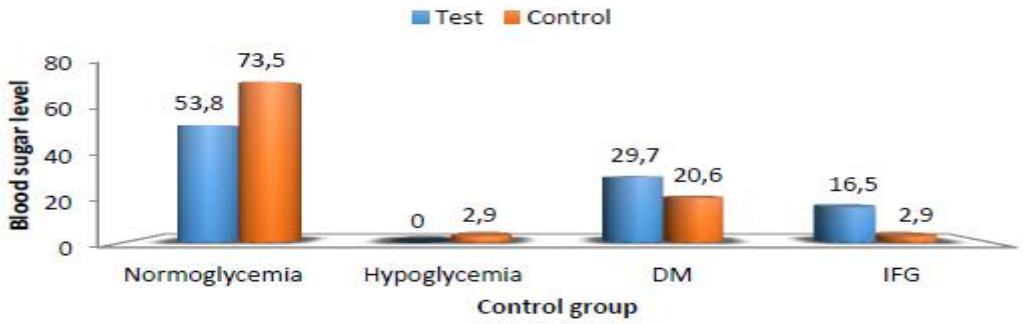

Figure 2: Prevalence of DM and IFG in test and control group

Considering the control group, 50(73.5%) had normal glucose levels, and 14(20.6) were diabetic, 2(2.9%) had IFG and 2(2.9%) were hypoglycemic and the difference was statistically significant (P< 0.05). (Fig 2)

3.1.3 Prevalence of diabetes mellitus according to gender

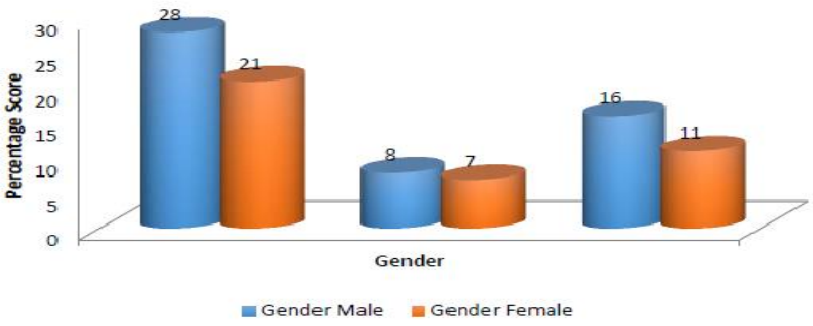

Figure 3: Prevalence of DM and IFG according to gender distribution

The prevalence of DM and IFG was more in males compared to females, (p=0.023) (Fig 3).

3.1.4 According to age range

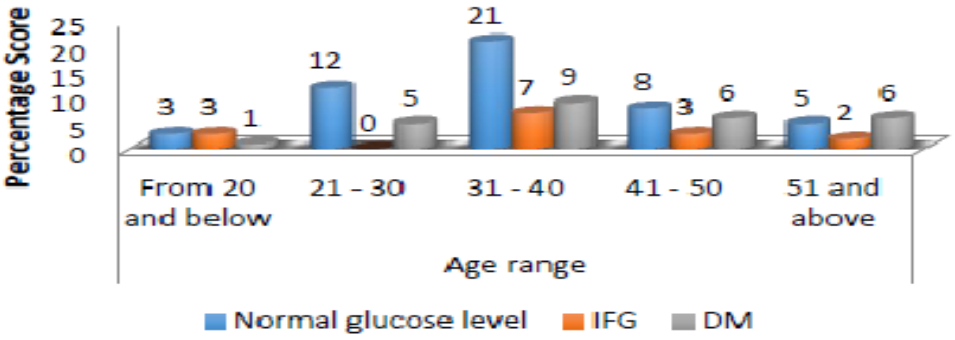

Figure 4: Prevalence of DM and IFG according to age range

The prevalence of DM and IFG did not differ significantly in relation to age (p=0.26, Fig 4)

3.1.5 According to Family history of Diabetes mellitus

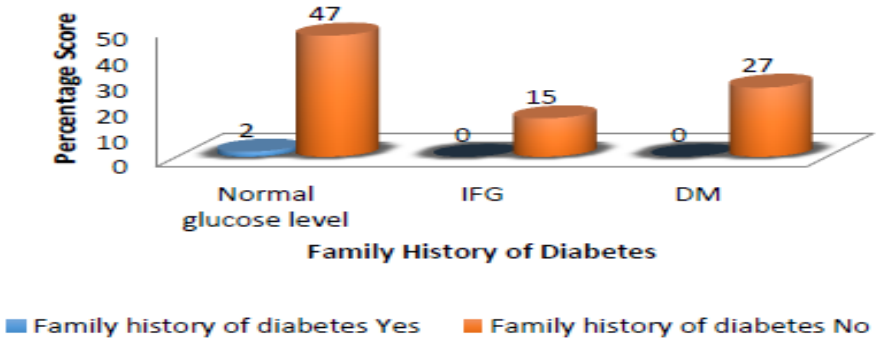

Figure 5: Prevalence of DM and IFG according to family history

The prevalence of DM and IFG did not differ significantly in relation to family history of diabetes, (p=0.416, Fig 5)

3.1.6 Prevalence of hyperglycemia according to alcohol consumption

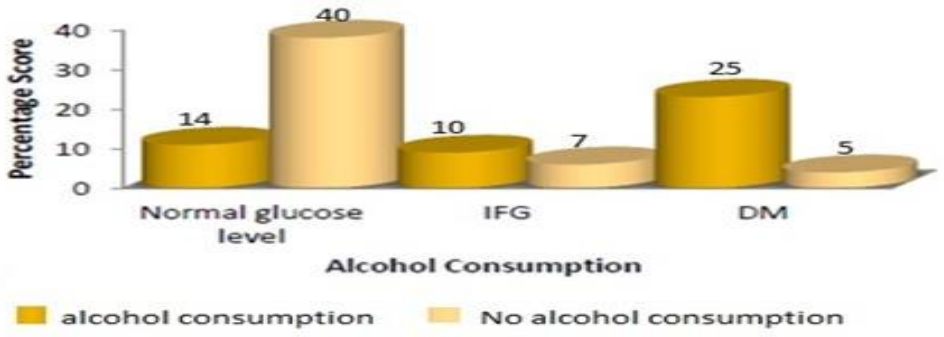

Figure 6: Prevalence of DM and IFG according to alcohol consumption

The prevalence of DM and IFG differed significantly in relation to alcohol consumption, alcohol consumers were more hyperglycemic. (p=0.006, Fig 6)

3.1.7 According to the literacy level

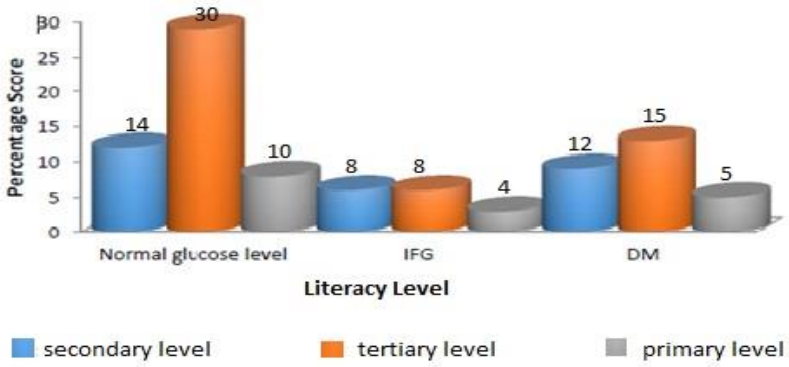

Figure 7: Prevalence of hyperglycemia according to literacy level

Glycemic levels did not differ in relation to literacy levels; however, patients at the university level tended to have better glycemic control when compared to those of lower levels, (p=0.051, Fig 7)

3.1.8 In relation to smoking

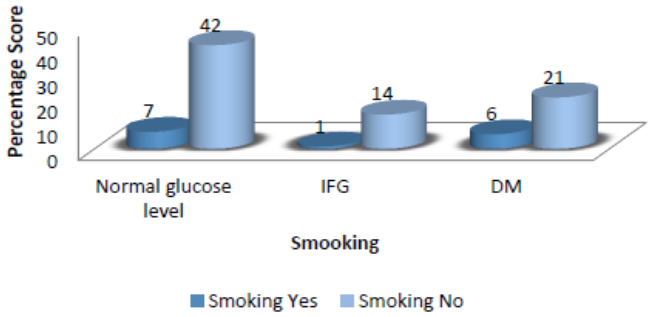

Figure 8: Prevalence of DM and IFG according to smoking

The prevalence of DM and IFG did not differ significantly in relation to smoking, (p=0.389, Fig 8) In total, 42(46.2%) of the test population were hyperglycemic (IFG/DM) compared to 16(23.5%) of the control group and this difference was statistically significant. (p<0.001).

4. Discussion of findings

The prevalence of DM and IFG in our study was 29.7% and 16.5% respectively compared to 26.6% and 2.9% for the control group.The results in this study were similar to that of Balakrishnan and his colleagues of Southern India [9]. Reference [13] had emphasized that there is substantial evidence to support the fact that diabetes is an important risk factor for TB. They had a prevalence of 25.3% and 24.5% respectively for DM and IFG among TB patients in South India. The Chandigarh Urban Diabetes Survey (CUDS) through Ravikumar and his colleagues (2011) instead reported a lower prevalence of diabetes (11.1%) and IFG (13.2%) in North India and Barik and his colleagues (2016) reported a much lower prevalence in Bengal of 2.95% and 3.34% respectively.. The high prevalence of DM and IFG obtained in this study is evidence that insulin dependence, and poor glycemic control predicts increased TB risk. Leung and his colleagues [10]. Reference [5] in studies carried out in Hong Kong, China, 2008 and in John Hopkins University, school of medicine,USA, 2009, on their part reported that the association between diabetes and TB is bidirectional because diabetes exerts a negative effect on the clinical course of TB with increased risk of treatment failure, relapse and death, while (Jeon and his colleagues [8] in a systematic review in India, 2010, revealed that, TB exacerbates poor glycemic control in people with diabetes . Males in this study, had higher DM (8%) than females (7%), and higher IFG, 16% and 11% respectively although the difference was statistically insignificant (P=0.023). This could be because men are more consumers of alcohol and tobacco which are risk factors of this disease. Balakrishnan and his colleagues [9] had similar findings stating that higher prevalence of DM among men than women might be an accumulative effect of other risk factors such as smoking, tobacco use and alcohol consumption, which impact both TB and DM. This study also revealed that patient within the age range 31 - 40 years had higher FBS values although the difference was not significant. This could be attributed to unhealthy diets, sedentary lifestyles and childhood and adult obesity. Corbett and his colleagues [15] and Raviglione and his colleagues (1992) [17] in studies carried out in western Europe, 2003, had similar results stating that older age group from 40 years and above have an increased risk of DM and TB.and maximum cases are in the age group of 60 years and above which they postulated that the older age group are likely to develop diabetes due to depressed immune activity. Alcohol consumers were more hyperglycemic, ($\boldsymbol{p}$= 0.006),showing that alcohol consumption was a significant factor in increasing FBS levels in the TB patients. This study has therefore revealed that gender, age, alcohol consumption and smoking had an accumulative effect on co-morbidity of DM and TB. Balakrishnan and his colleagues in a study , they carried out in Kerala, India,2012 presented similar results stating strongly that the higher prevalence of DM among men than women might be an accumulative effect of other risk factors such as smoking, tobacco use and alcohol consumption, which impact both TB and DM. , [9] This study did not record any significant relationship between family history of diabetes and hyperglycemia in TB positive patients. Similarly,in a study carried out by Silvera and his colleagues 2006,in Brazil, showed no association with family history [16]. Unlike a study carried out by Alfredo and his colleagues 2004, in Southern Mexico which showed an association of family history with DM/TB comorbidity. TB patients at the university level tended to have lower glycemic levels compared to those at primary or secondary levels. This could be

explained by the fact that at lower education levels, respondents were not educated on the dangers of developing DM in TB for prevention through lifestyle modification. The studies by [2014] in India and Silveira and his colleagues in Southern Brazil [19] also obtained similar results which found no significant association between level of education and frequency of DM/TM comorbidity.

5. Limitations of the study

Anthropometric measurements to calculate Body Mass Index (BMI) to screen for obesity which is a predisposing factor for diabetes was not done. Sample size was reduced because TB patients who had eaten were excluded from carrying out the diabetes tests which were Fasting Blood Sugar(FBS) and Impaired Fasting glucose (IMG). Random Blood Sugar(RBS) was not done. The impact of this study was record based and the impact on treatment outcome of the co-morbidity was not done.

6. Conclusion

This study revealed that the prevalence of diabetes in pulmonary tuberculosis patients was higher than expected and the high proportion of DM patients among our study participants indicates low diabetes screening coverage in TB clinics. Also . the study revealed that the diseases had mainly affected the age group from 31 years and above thus reducing the productive work force in this region of our Country, Cameroon. so it is important that there should prevention of DM through attention to unhealthy diets, sedentary lifestyles and childhood and adult obesity must be included in broad non-communicable disease prevention strategies.

7. Recommendations

These findings suggest that it is important for Cameroon Health Policy Makers to implement an integrated health service approach to address the burden of the two diseases. Our finding of a positive relationship between DM and TB thence highlights the need to screening TB patients for DM and vice versa, particularly in this North-Wes Region where there is lack of data on the occurrence of DM in TB. Appropriate and reliable prediabetes and diabetes screening methods and more screening Health centers should be put in place in order to reduce the risk of developing these diseases and manage them at early stages. More studies are needed to further understand the relationships and treatment outcome approaches of TM- DM co-morbidity.

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8. Corrections done on manuscript

1. Added limitations of this study
2. Discussion on the results clarified
3. Improved the discussions of previous studies