Association Between Socioeconomic Factors And Tuberculosis Infection Among Diabetic Patients Attending JM Kariuki County Referral Hospital, Nyandarua County, Kenya

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Abstract

Introduction: Approximately 1.2 million individuals die of TB-associated health complications annually. Diabetes coexistence with TB accelerates TB disease, complicates treatment, hence aggregating the possibility of poor TB outcome.
Methods: The study was carried out at JM Kariuki County Referral Hospital, Nyandarua County, Kenya. A sample size of 139 study participants was used for the study. Data was collected through carrying out diagnostics tests which included: Fluorescent TB smear microscopy, Gene-Xpert test, Chest X-ray, blood sugar test and face to face interviews which was recorded in a structured interviewer checklist and the clinical data uploaded in various ministry of health laboratory tools. SPSS version 22 was used to analyze the data.
Results: TB infection and age was found to be statistically significant (p=0.001). Study subject's occupation and TB infection was statistically significant (p=0.003). There was no significant difference between gender and diabetes mellitus (p=0.613). The study showed significant difference between smoking and alcoholism and TB infection (p=0.001).
Conclusion: There is a need to implement active TB case finding programs in diabetes management initiatives in Nyandarua and countrywide.

Key words: *Socioeconomic Factors, Tuberculosis infection, Diabetic Patients & Diabetes Mellitus*

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1. Introduction

Notwithstanding global determination to eradicate tuberculosis (TB) by 2035 (being ultimate objective of End TB Strategy 2035), TB is still among the primary healthcare problems worldwide. In 2016 an international report by the World Health Organization (WHO) highlighted the increasing prevalence of TB, citing that nearly 10.3 million new TB infections in yearly rates, and that approximately 1.2 million individuals die of TB-associated health complications annually. The report also indicated that amongst the 10 million new incidences of TB reported in that year, 1.9 million cases were linked to factors including undernourishment, 0.8 million were associated with smoking, 1.0 million were linked to HIV/AIDS, and 0.8 million incidences were attributable to diabetes (World Health Organization, 2017).

The prevalence of DM has increased globally, and studies link the upsurge with contemporary trends of urbanization, increasing aging population, reduction in physical activity (adoption of a dormant lifestyle), transformation in diet habits, and increasing prevalence of obesity (Webb *et al*., 2009). Well above three quarters (84%) of the accumulative global DM cases (it is estimated that 415 million people have DM globally) are in developing economies. The prevalence of DM is expected to experience a steady increase in areas with high TB incidence rates over the coming 30 years (Hu, 2011).

When compared with general TB patients, DM-TB patients are typically found to be older, and most of them have additional characteristics such as HIV-AIDS, consumption of illicit substances, incarceration, a high body weight index (obesity), and alcohol abuse (Martinez & Kornfel, 2014). As such, there is a need to consider the evolving nature of TB contagion and apply non-traditional approaches that incorporate the socio-demographic characteristics of patients when examining individuals exhibiting signs of pulmonary diseases to enable accelerated TB detection (Havlir *et al.*, 2008).

An estimated 1 million (15%) of the TB cases are attributed to DM (Firănescu *et al*., 2017). There are also higher chances for DM-TB patients (in comparison with those diagnosed with TB only) to have higher levels of unemployment and lower educational attainments; both of which indirectly complicates DM and TB management because of the association between these socio-demographic characteristics with poor glucose control and lower access to healthcare (Sun *et al.*, 2012).

WHO's worldwide TB control policy vouches for the DOTS (directly observed treatment short course strategy); an incidence identification strategy that depends on the readiness individuals who exhibit TB-suggestive symptoms to seek health care services (Sanghani & Udwadia, 2013). Although passive health care seeking behavior of TB patients upon which the DOTS strategy is established has proven to be operative in identifying TB incidences in DM-prevalent nations such as Peru, Ethiopia and Vietnam (Shargie & Lindtjorn, 2005), uncertainties of its efficacy emerges because of the existence of other equally important risk factors for TB, such as diabetes mellitus (DM) and HIV/AIDS (Havlir, *et al*., 2008)

In recent years, the ability to detect TB has stagnated; an outcome that has been used to indicate weaknesses and gaps in the current TB eradication initiatives (World Health Organization, 2017). While World Health Organization (2017) reports on the effectiveness of passive TB case findings in

identification of symptomatic TB cases, passive case-finding, which typically involves when people with experiencing symptoms that are suggestive of TB voluntarily go for medical examination and treatment, has been identified to be particularly efficient in identifying and managing of TB mostly when patients reach the symptomatic stages (Harries *et al*., 2016). Among the major drawbacks of passive TB case-finding, which typically relies on bacteriologic examination to detect TB, are the various factors that affect the ability and decision of patients to seek diagnostic and treatment services. For example, in developing countries, individuals seeking TB care especially those who passively presents at health facilities encounter healthcare services accessibility challenges due to distance, socioeconomic factors (inability to afford TB screening and treatment because of the related financial costs), lack of TB symptoms awareness, and lack of trained healthcare personnel to offer TB screening and treatment to the ever-increasing TB population (Harries *et al*., 2016). All these challenges have been found to set off delays in the delivery of health care services, which increases the duration between TB infection and treatment, and heighten the chances of adverse health outcomes and therapeutic failures (Storla, *et al.* 2008).

Kenya experiences a TB occurrence ratio of about 558 per 100,000 and the dominance of diabetes is evaluated to be at 4.56%. TB accounts for 750,000 deaths yearly whereas DM is estimated to cause about 20,000 mortalities annually (International Diabetes Federation, 2015). As cited in WHO (2016), the Republic of Kenya has already attained the 2015 target of the Millennium Development Goal (MDG) with regards to reducing TB mortalities among patients of different age groups (Enos *et al*, 2018). This state of the scenario is associated in part with the country's rigorous TB eradication strategy as articulated in the National Strategic Plan for tuberculosis, leprosy and lung health (2019). As articulated in the National Strategic Plan (2019-2023), among other things, the Government of Kenya offers is free TB treatment at all public hospitals. This has been reinforced by the relentlessness of the Ministry of Health (MoH) in bringing TB screening and treatment services close to the people in all counties (Suleiman *et al* ., 2018). Regardless of the positive efforts, the rising occurrence of diabetes has proven being a major challenge to the national anti-TB initiatives (Harries *et al*., 2016).

Increasing rates of TB infections have been reported among people living with DM since diabetes worldwide. DM is said to affect patients' immune mechanism, hence predisposing them to tuberculosis infection (Harries, 2015). The findings of systematic analyses of studies published concerning the association between TB and DM suggest the existence of a direct correlation between the two diseases (Jeon & Murray, 2008). Even so, the dynamics of this association on TB eradication initiatives have not been confirmed in Nyandarua County. Nonetheless, while the WHO indorses the screening of TB on newly diagnosed DM cases, this recommendation has not been implemented in various parts of Kenya, including Nyandarua County, which is majorly served by JM Kariuki Memorial County Referral Hospital. The state of the circumstance presents defines the driving motive for the current study that seeks to explore missed TB cases among diabetic patients regardless of their sustained contact with local health facilities.

2. Materials and methods

Objectivist approach was employed to answer research questions in a scientific manner. The study area was carried out in JM Kariuki County Referral Hospital in Nyandarua County, Kenya. The study capitalized in diabetic patients enrolled in the Diabetic outpatient clinic at the JM Kariuki County Hospital as the study population. All consented patients who met the criteria underwent TB screening and done Gene-Xpert, FM microscopy, and X-ray tests as part of their constitution in the study. Fisher's formula was utilized to determine the sample size. A sample size of 139 study subjects was used for the study.

Data was collected through face to face interviews and recorded in a structured interviewer checklist. Sputum specimens were collected from all diabetic patients by guiding the client on the proper sputum collection process. TB smear microscopy was done using fluorescent staining on each of the sampled sputum to check for presence of *Mycobacterium Tuberculosis* bacilli. Gene-Xpert Molecular Technique was also done on the samples and patients were also subjected to Chest X-ray to confirm TB in patients suspected to have the disease. The outcomes of the tests were recorded in the Ministry of Health laboratory data entry tools.

SPSS version 22 was used to analyze the data. Descriptive statistics such percentages and frequencies were used to summarize data on socio demographic information, socio economic status and personal habits relevant for TB infection.

3 Results

The study factors in socio-economic elements, including age, occupation, gender, and health behavior (i.e., alcohol consumption, smoking, and blood sugar management outcomes) as socioeconomic elements in the investigation of the occurrence of TB infection among diabetics. The section focuses on age and gender before going to occupation, alcohol consumption and smoking where establishment of association between specific socioeconomic factors and TB-Diabetes co-occurrences was done.

3.1 Age of TB-Infected Diabetic Patients

This sub-section identifies the most affected age-groups when it comes to TB infection among diabetic patients. Table 1 illustrates the number of TB cases as per the age-group of patients taking diabetes treatment at the outpatient clinic in question.

Table 1: Age-Group Comparison of TB Occurrence among Diabetics at JM Kariuki County Referral Hospital

Age	Positive TB yields	Sample size	Prevalence
1-20	1	2	50.00%
21-40	0	28	0.00%
41—60	2	53	3.77%
61-80	2	85	2.35%
81-100	0	20	0.00%
Total	5	188	2.65%

As indicated in Table 1 above, the prevalence of TB was 50% among patients aged 1-20, and 3.77% and 2.35% among patients aged 41 to 60 and 61 and 80 years respectively. The prevalence of TB in different age-groups was used to develop error graphs in Figure 1 below

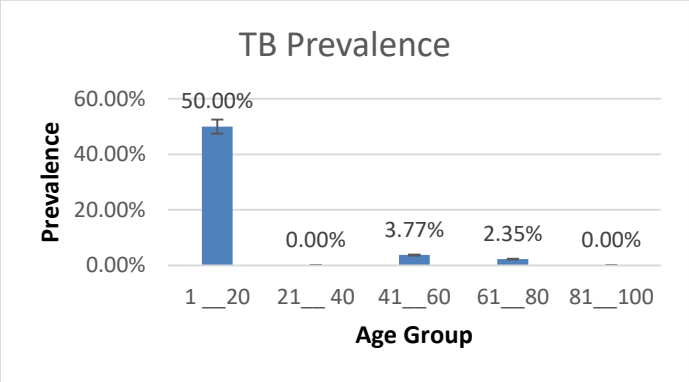

Figure 1: Comparison on TB Occurrence among Different Age-Groups of Diabetics

As illustrated above, the prevalence of TB infection was 3.77% among the 41-60 age group and 2.35% among the 61-80 age-group. Although 50% of patients aged 1-20 years had active TB infections, this outcome is not statistically meaningful because of the reduced sample size proportion of patients in this age category (n=2).

The confidence interval of age group 1-20 was null considering that the difference between the sample size and the frequency (n-x) must be greater or equal to 5 for estimations to occur. Pearson's Chi-square test was further used to test the existence of a statistical association between the age of diabetics and TB infection. The results are as summarized below:

Table 2: Chi-Square Test: Relationship between Age-group and TB-Diabetes Co-occurrence

Statistic	*Value*	*df*	*Asymp. Sig. (2-tailed)*
Pearson Chi-Square	18.80	4	0.001

A P-value of 0.001 (≤0.05) was found, suggesting the existence of a strong statistical relationship between TB infection and the age of diabetic patients. What these results suggest is that diabetes patients get more susceptible to TB infection as they age

3.2 Gender of TB-Infected Diabetic Patients

This sub-section identifies the most affected gender when it comes to TB infection among diabetic patients. Table 3 illustrates the number of TB cases per gender of patients taking diabetes treatment at the outpatient clinic in question.

Table 3: Gender Comparison of TB Occurrence among Diabetics at JM Kariuki County Referral Hospital

Gender	Positive TB yields	Sample size	Prevalence
Male	2	56	3.57%
Female	3	132	2.27%

As described in Table 3 above, 2 out of 56 diabetic males tested TB positive whereas 3 of 132 female diabetics tested positive of TB. Figure 2 illustrates these comparisons too.

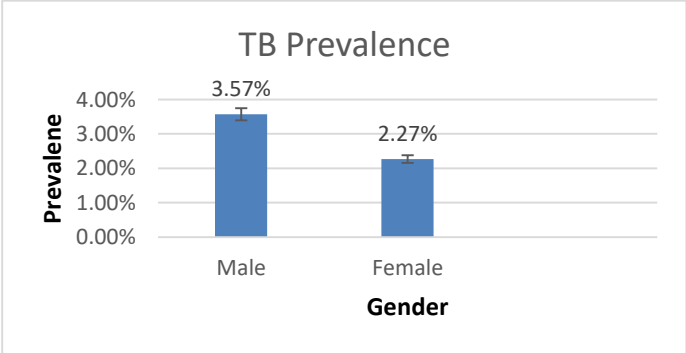

Figure 2: Comparison of TB Occurrence by Gender among the diabetic patients in the study findings.

The prevalence of TB among male diabetics was 3.57% which was comparatively higher than the prevalence of TB among female diabetics (2.27%) and in the general cohort (2.66%).

Pearson's Chi-square test was applied to evaluate the existence of a relationship between the gender study participants and TB infection. The results are as summarized below in table 4:

Table 4: Chi-Square Test: Relationship between Gender and TB-Diabetes Comorbidity

Statistic	*Value*	*df*	*Asymp. Sig. (2-tailed)*
Pearson Chi-Square	0.26	1	0.613

A p-value of 0.613 (≥0.05) suggests the lack of existence of an association between the gender of diabetic patient and TB infection. These findings suggest that gender does not influence the risk of TB infection among diabetic patients.

3.3 Occupation of TB-Infected Diabetic Patients

The current sub-section describes the occupation of TB infected diabetic patients. Table 5 illustrates the number of TB cases as per occupations of diabetic patients.

Table 5: Occupation of TB-Infected Diabetic Patients

Occupation	Positive	Negative	Sample Size	Prevalence
Farmer	**4**		**161**	**2.5%**
Unemployed	**0**		**3**	**0**
Pupils	**1**		**11**	**9%**
House help	**0**		**4**	**0**
Civil Servants	**0**		**4**	**0**
Informal employment	**0**		**5**	**0**

4 of 161farmers and 1 of 11 pupils had TB. Zero TB cases were noted unemployed (above 18yrs but not working) (N=3), House-helps/House-wives (N-4), civil servants (N=4) and informal employment (N=5).

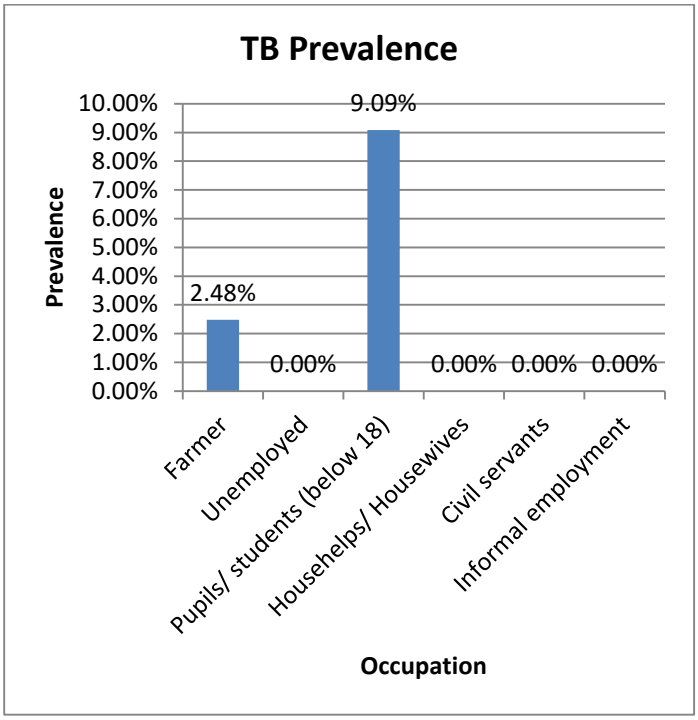

Figure 3: Comparison on TB Occurrence among Different Occupations of Diabetics Patients

As indicated in Figure 3 above, TB infection was noted in two specific occupation groups, including pupils with a prevalence rate of 9.09% (CI 95%) and Farmers, with a prevalence rate of 2.48% (CI 95%).

Table 6: Chi-Square Test: Relationship between Occupation and TB-Diabetes Co-occurrence

Statistic	**Value**	**df**	**Asvmo. Sio. (2-tailed)**
Pearson Chi-Square	17.92	5	0.003

The p-value is 0.003(≤0.05), suggesting the existence of association between TB and Occupation. These findings suggest that TB is most prevalent in Farmers and Children, implying that daily socioeconomic activities influence the exposure of DM patients to TB infection.

3.4 Positive Yield of Gene Xpert, Chest X-ray, and FM Microscopy

Table 7: The Positive Yield of Gene Xpert, Chest X-ray, and FM Microscopy

Type of Test	Positive TB yields	Sample size	Prevalence
Gene Xpert	3	188	1.60%
Chest X-ray	1	188	0.53%
FM Microscopy	1	188	0.53%

Table 7 above illustrates the positive yield of TB diagnosis by FM microscopy, GeneXpert and chest X-ray. As illustrated above, the highest positive yield (p= 1.60%, 95%) was noted for Gene-Xpert in comparison to Chest X-ray and FM microscopy (p= 0.053%, 95%). No statistically significant difference was noted in the effectiveness of the diagnostic methodologies in testing for active TB in DM patients.

3.5 A comparison of TB Occurrence amongst Diabetics with Low, Moderate, and High Blood Sugar Levels

Table 8: Blood sugar levels comparison

Sugar level	Positive cases	Sample Size	Prevalence
Low (<3)	0.00	6	0.00%
Normal (3.5-7)	0.00	52	0.00%
High (7<)	5.00	129	3.88%

All Positive TB cases had high sugar levels. The prevalence rate of TB cases in people with diabetes was 3.88%.

4. Discussions

In resource-limited regions, TB continues causing high mortality rates. While the most prevalent causes of deaths in middle-income and low-income countries are cerebrovascular disease and ischemic heart disease, TB and HIV exist among the five leading causes of death (World Health Organization, 2017). Similar to the WHO (2017) report, the finding of this study exposes a strong connection between socioeconomic and behavioral characteristics and TB-diabetes comorbidity. For example, a high prevalence rate was noted among farmers and children (dependents who are less than 18 years of age), outlining these two as the most at-risk groups among diabetic patients in Nyandarua county. In general, poor access to health services, and poverty have been stated as important risk factors when it comes to TB care provision, but few investigations focus on how these issues affect hard-to-reach groups such as diabetes patients (Mburu *et al.*, 2018). The WHO reported 10.5 million new TB cases and about 1.8 million TB-associated deaths in 2017. The report outlines 416 million cases of DM and 4.9 million DM-associated deaths in the past five years. Similarly, 75% of DM case and 96% of TB cases existed in developing /middle or low income economies such as South East Asia and Africa (World Health Organization, 2017).

Similarly, the findings of the current investigation indicate that TB is most common among people aged 40 and above, among cigarette smokers, and alcoholics. Chi-square -value of less 0.05 indicates alcoholism and cigarette smoking as risk factors for TB-diabetes comorbidity. The WHO and international collaboration against TB and Lung Disease (IUATLD) developed a TB and diabetes control framework that is premised on implementing a bi-directional screening for DM and TB that priorities DM patients who are above the age of 40 for TB testing. WHO recommends screening for TB among older diabetic patients in all primary health-care setting for all countries across the world (World Health Organization, 2017). The framework emphasized the application of active TB case finding in inpatient and outpatient DM management centers as a way to allow early TB detection, which increases the chances for successful TB treatment (Havlir *et al.*, 2008; Wu *et al.*, 2016). Nonetheless, targeted screening presents a preferable initiative in resource-limited contexts. Targeted screening (encompassing making screening decisions based on local epidemiology data) has also been proposed by Huang (2017) who presents DM-patient sub-groups including those above 40 years of age, those who are overweight (body mass index of more than 25), those with alcohol consumption, and cigarette smoking habits as most-at-risk populations.

5. Conclusion

In Kenya, the prevalence of TB is an estimated 558 per 100,000 Population and the prevalence of diabetes is gauged to be 4.56%, accounting for 750,000 persons and yearly deaths amounting to 20,000 (International Diabetes Federation, 2015). The World Health organization recommends screening of TB on diabetics' patients. However, the recommendation has not been implemented in Nyandarua County JM Kariuki Memorial County Referral Hospital. The findings of this investigation indicate a high prevalence rate of TB (2.66%) among diabetics in Nyandarua County. Considering that the World Health Organization (2017) reported that 60% of TB cases in diabetes patients are yet to be diagnosed in developing /middle or low income economies, these findings indicate a need to implement active TB case finding programs among farming communities and children (those aged below 18 years) in Nyandarua County as they are the most affected groups.

6. Recommendation

i. JM Kariuki County Hospital should prioritize TB screening among a range of DM-patient subgroups, including those above 40 years of age, those with alcohol consumption and cigarette smoking habits;
ii. Researchers and scholars to explore and conduct more studies on related topics such as the financial viability of incorporating TB treatment and screening in DM management in JM Kariuki County Hospital

iii. Targeted screening to be conducted on persons above 40 years of age, those who are overweight, those with alcohol consumption, and cigarette smoking habits as most-at-risk populations.

Acknowledgements

Special thanks to JM Kariuki County Hospital, Mount Kenya University and Nyandarua County Department of Health for the assistance.

Conflict of interest

The author declares no conflict of interest.

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