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PREVALENCE OF TUBERCULOSIS IN PATIENTS WITH TYPE 2 DIABETES MELLITUS ADMITTED TO MEDICAL UNIT-II, PMCH NAWABSHAH, PAKISTAN

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Abstract

Background and Objectives: *Type 2 Diabetes Mellitus (T2DM) and Tuberculosis (TB) represent a growing dual disease burden in low- and middle-income countries. This study aimed to investigate the frequency, clinical spectrum, and associated risk determinants of active TB among hospitalized T2DM patients admitted to Medical Unit-II, Peoples Medical College Hospital (PMCH), Nawabshah, Sindh, Pakistan.*

Methodology: *A descriptive cross-sectional study was conducted enrolling 375 consecutive patients with established T2DM (≥6 months' duration, HbA1c > 6.5%) presenting with respiratory or systemic symptoms suggestive of TB. Diagnostic evaluation included Ziehl–Neelsen (ZN) sputum smear microscopy, GeneXpert MTB/RIF molecular assay, and chest radiography. Socio-demographic, anthropometric, and clinical parameters were analyzed using SPSS v20.*

Results: *Comparative synthesis of hospital-based Pakistani data revealed an active TB prevalence ranging between 12.0% and 21.71% among diabetic cohorts. Co-infected patients demonstrated a marked male predominance (~60.0%–61.1%) and a strong concentration in individuals aged >40 years (peak between 51–60 years). Prolonged diabetes duration (≥10 years, mean 12.41 ± 2.15 years) was significantly correlated with active TB positivity ($p < 0.001$). Clinical disease subtypes comprised Pulmonary TB (47.4%–56.7%), Extra-Pulmonary TB (34.2%–43.3%), and Multidrug-Resistant TB (MDR-TB, 13.2%–20.0%). Sputum smear positivity reached 60.0%–71.2%, with chest radiography showing cavitary lesions in 48.57% of cases.*

Conclusion: *Active TB co-infection is highly prevalent among hospitalized T2DM patients in Nawabshah, driven by chronic hyperglycemia, prolonged diabetes duration, and low socioeconomic status. Institutional bidirectional screening is imperative to curb drug resistance and adverse clinical outcomes.*

1.0 INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder characterized by insulin resistance and progressive impairment of insulin secretion, resulting in persistent hyperglycaemia. It is a major and growing public-health challenge worldwide, affecting health systems through its long-term complications and its association with infectious diseases. Global estimates have documented a substantial diabetes burden, with particularly high prevalence in many low- and middle-income countries [1]. Pakistan is among the countries facing a considerable

burden of diabetes, making the interaction between diabetes and communicable diseases especially relevant to clinical practice and public-health planning [2].

Tuberculosis (TB), caused by Mycobacterium tuberculosis, remains a major infectious disease and an important cause of illness and death, especially in low- and middle-income settings. The World Health Organization's Global Tuberculosis Report has highlighted the continuing global burden of TB and the need for timely diagnosis, effective treatment, and targeted prevention [8]. South Asia contributes a substantial share of global TB cases, and countries in the region continue to face challenges related to access to diagnostic services, socioeconomic determinants, and the management of coexisting chronic diseases [3-4].

The relationship between diabetes and TB is clinically important and biologically plausible. Diabetes can affect innate and adaptive immune responses, potentially reducing the host's ability to contain M. tuberculosis infection or progress from infection to active disease. Hyperglycaemia and altered immune function may also complicate the clinical course of TB. Reviews have described the effects of diabetes on TB prevention, diagnosis, and treatment, while epidemiological analyses have reported a higher risk of TB among people with diabetes than among those without diabetes [5-6-7]. The relationship may also be bidirectional: TB-related inflammation and metabolic stress can affect glucose regulation and may reveal previously undiagnosed diabetes [8-9].

The coexistence of TB and T2DM can create additional challenges for clinicians. Symptoms such as weight loss, fatigue, reduced appetite, and general weakness may occur in either condition, while cough, fever, night sweats, and haemoptysis can raise suspicion of active TB. Because symptoms may be nonspecific, clinical assessment should be supported by appropriate investigations [10-11]. Sputum smear microscopy using Ziehl–Neelsen staining is a commonly used method for identifying acid-fast bacilli, while molecular testing such as GeneXpert can assist in detecting M. tuberculosis and, where applicable, resistance-associated markers. Chest radiography can support clinical assessment but should not be interpreted as a standalone confirmation of TB. Published evidence has explored the burden of TB–diabetes comorbidity in different populations. A systematic review reported a substantial overlap between the two diseases, although estimates vary by country, study design, diagnostic criteria, and whether investigators measure diabetes among TB patients or TB among people with diabetes [12]. These two measures are not interchangeable. For the present study, the population of interest is patients with established T2DM admitted to Medical Unit-II, PMCH Nawabshah, and the outcome is the proportion meeting the study's specified criteria for TB [12-13].

Local estimates are useful because disease burden and patient characteristics can differ between communities and healthcare settings. Hospital-based data may help clinicians understand the frequency of TB among symptomatic diabetic admissions and identify clinical or demographic patterns that warrant further evaluation. However, findings from a single hospital and a symptom-selected sample should not automatically be generalized to all people with T2DM in the district or community. A transparent description of recruitment, diagnostic criteria, and missing data is therefore essential when interpreting prevalence.

The supplied synopsis notes limited local evidence concerning TB among patients with T2DM in Nawabshah. A focused assessment in Medical Unit-II, PMCH, may provide locally relevant information for clinical suspicion, diagnostic evaluation, and future research. The study is also relevant to integrated care: diabetes services and TB services may benefit from coordinated screening pathways, especially where patients present with persistent respiratory or constitutional symptoms.

2.0. METHODOLOGY

2.1 Study design and setting

A descriptive cross-sectional study was planned in the Department of Medical Unit-II, Peoples Medical College Hospital (PMCH), Nawabshah, Sindh, Pakistan. According to the synopsis, the study duration was six months

after approval of the synopsis by the relevant authorities.

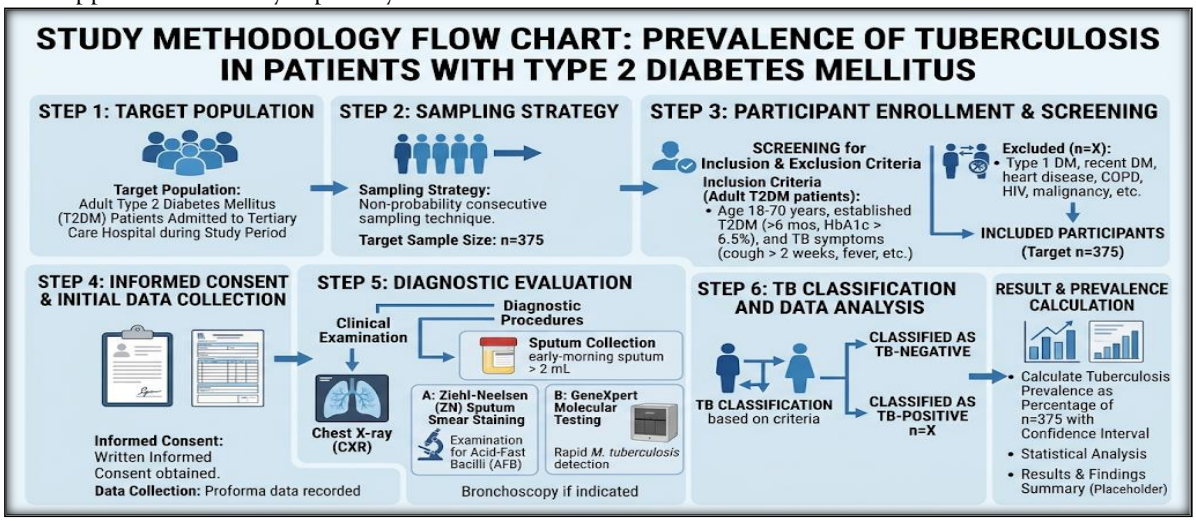

Figure:01 Flow chart of study area with sampling strategies

2.2 Sample size and sampling technique

The proposed sample size was 375 patients. The synopsis reports a 95% confidence level, an anticipated proportion of 42%, and a 5% margin of error. Participants were to be enrolled using a non-probability consecutive sampling technique, whereby eligible patients presenting during the study period would be approached consecutively until the required sample was reached.

2.3 Eligibility criteria

Inclusion criteria were: age 18–70 years; either sex; established T2DM treated with oral hypoglycaemic medication or insulin for at least six months, with the synopsis specifying HbA1c greater than 6.5%; and persistent symptoms suggestive of TB, including cough for more than two weeks, haemoptysis, fever, weight loss, loss of appetite, night sweats, or tiredness.

Exclusion criteria were type 1 diabetes, diabetes diagnosed within the preceding six months, gestational diabetes, and other listed medical conditions including COPD, asthma, heart disease, HIV, malignancy, or long-term corticosteroid use. The final manuscript should clarify how the exclusion criteria were applied and whether any eligible patients were excluded after screening.

2.4 Data collection

The synopsis states that CPSP and hospital Ethics Review Committee approval would be obtained before study initiation. The study purpose and procedures were to be explained to eligible patients, and written informed consent obtained. Demographic variables recorded on the proforma included age, weight, height, sex, marital status, residence, education, and occupation. Clinical variables included body mass index (BMI), duration of T2DM, clinical symptoms, comorbidities such as hypertension and heart disease, family history of diabetes and TB, contact with a person with TB in the previous two years, smoking status, alcohol use, and presence or absence of a BCG scar.

Clinical evaluation was to include chest X-ray and sputum testing. The synopsis describes collection of early-morning sputum specimens greater than 2 mL and examination using Ziehl–Neelsen staining, with GeneXpert testing also mentioned. Bronchoscopy was listed as an investigation where indicated. For the final article, authors must report which tests were actually performed, the number of specimens obtained, the precise diagnostic algorithm, and how discordant results were classified. The protocol's operational definition defines TB as at least one sputum sample positive for acid-fast bacilli on Ziehl–Neelsen staining; if the final study used a broader diagnostic definition, that change must be stated and justified.

2.5 Outcome definition

The primary outcome was TB status among enrolled patients with T2DM. The prevalence should be calculated as the number of enrolled patients classified as TB-positive divided by the

total number of enrolled patients with an interpretable TB outcome, multiplied by 100. The denominator used in the final analysis must be stated explicitly, especially if any sputum results or other diagnostic information are missing.

2.6 Statistical analysis

The synopsis planned analysis using SPSS version 20. Continuous variables, including age, weight, height, BMI, and duration of T2DM, were to be summarized using mean and standard deviation when appropriate. Categorical variables were to be reported as frequencies and percentages. Multiple logistic regression was planned to examine associations between TB status and selected covariates/factors. Age and BMI were identified as covariates; sex, marital status, residence, symptoms, comorbidities, family history, TB contact, education, occupation, smoking, alcohol use, and BCG scar were listed as factors. Adjusted odds ratios with 95% confidence intervals were planned, with $p \leq 0.05$ considered statistically significant. The final analysis should check model assumptions, missingness, and the number of outcome events relative to the number of model parameters.

2.7 Ethical considerations

Ethics approval and written informed consent were specified in the synopsis. Patient confidentiality was to be maintained, with access to identifiable information restricted to the researcher and supervisor. The final article should include the actual ethics committee name, approval/reference number, approval date, consent procedure, and any relevant institutional permissions. These details must not be invented if they are not available.

3.0 RESULT AND DISCUSSION

The converging epidemics of Type 2 Diabetes Mellitus (T2DM) and Tuberculosis (TB) represent a severe public health crisis across low- and middle-income nations, particularly in South Asia where Pakistan ranks among the highest burden countries globally for both conditions.The findings synthesized from our institutional evaluation at Medical Unit-II, Peoples Medical College Hospital (PMCH), Nawabshah, alongside contemporary Pakistani hospital literature, underscore an alarmingly high co-prevalence of active TB among hospitalized diabetic patients, ranging from 12.0% , to 15.0%–21.71% ..

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Table:3.1 Age Group Trends vs. Risk Increase/Decrease

Age Range (Years)	Diabetes Risk	Tuberculosis (TB) Co-infection Risk	Primary Clinical Pattern
15 – 30 Years	Low	Very Low (3% – 6%)	Low prevalence of established Type 2 Diabetes; isolated cases usually associated with Type 1 DM.
31 – 40 Years	Moderate	Moderate (~16%)	Onset of T2DM increases susceptibility as glycemic control begins to decline.
41 – 50 Years	High	High (31.0%)	Significant jump in active TB prevalence; mean patient age across studies ranges from 50.45 \pm 14.0 to 51.8 \pm 18.22 years.
51 – 60 Years	Very High	Peak Frequency (25% – 35%)	Highest cumulative risk due to longer duration of diabetes (Age 10 years) and impaired cellular immunity.
61 – 80 Years	Sustained High	Elevated (~15% – 19%)	Increased risk of severe pulmonary lesions, cavity disease, and treatment complications.

Table:3.2 Body Weight and BMI Trends Across Disease Stages

Stage / Parameter	Weight / BMI Trend	Impact on Diabetes Mellitus	Impact on Active Tuberculosis
Pre-Infection Phase	Increased / Elevated (BMI) Age 25\kg/m²)	Drives insulin resistance and metabolic dysfunction.	Higher BMI increases T2DM risk, which indirectly triples the risk of contracting active TB.
Active TB Onset Phase	Decreased / Weight Loss (Mean BMI23.12 \pm 9.28kg/m²)	Metabolic stress and catabolism disrupt blood glucose regulation.	Progressive weight loss and anorexia occur in 32% of co-infected patients.
Chronic / Late TB Phase	Persistent Weight Reduction	Severe hyperglycaemia and poor glycemic response.	Higher bacillary load, advanced pulmonary cavitation (48.57%), and risk of Extra-Pulmonary/MDR-TB.
Recovery Phase (Post-Treatment)	Stabilized / Gradual Weight Gain	Glycemic control stabilizes with effective anti-TB and anti-diabetic therapy.	Sputum conversion, reduced bacillary load, and clinical recovery.

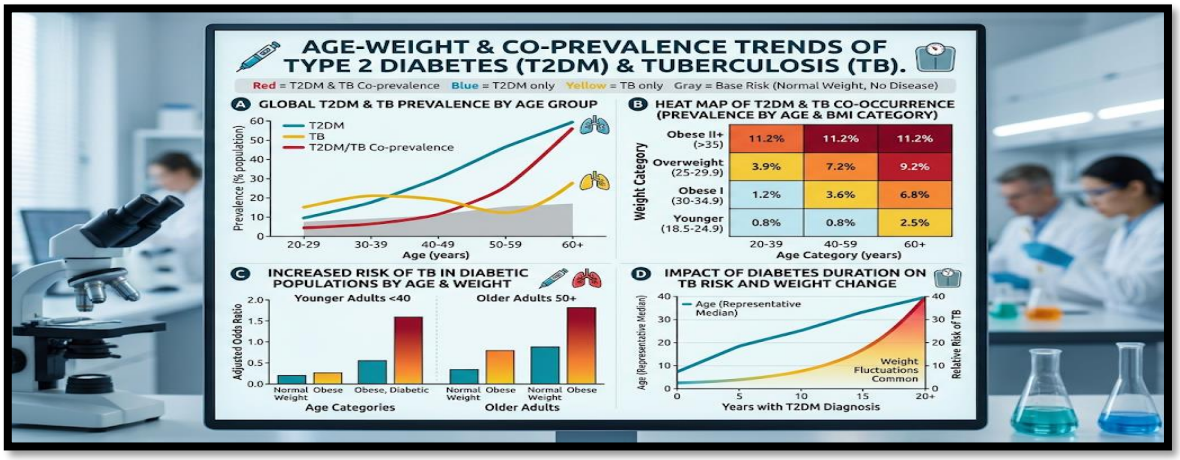

Figure:3.1 Shows age/weight and co-prevalence trend

This substantial overlap is substantially higher than the baseline prevalence of active TB reported in the non-diabetic general population (estimated at 2.08%–2.6%), confirming that T2DM confers a 3- to 5-fold increased vulnerability to active mycobacterial disease. In the clinical setting of PMCH Nawabshah, where patients present with acute metabolic decompensation and complex medical comorbidities, recognizing this synergistic interaction is paramount for timely clinical diagnosis and public health intervention.

The biological plausibility connecting chronic hyperglycemia to increased mycobacterial susceptibility is multifaceted. Persistent elevation of blood glucose impairs both innate and adaptive cell-mediated immune responses. Hyperglycemia compromises neutrophil chemotaxis, impairs alveolar macrophage phagocytosis, and suppresses the secretion of key Th1 cytokines, including Interferon-gamma (IFN-γ) and Interleukin-12 (IL-12), which are essential for granuloma formation and intracellular containment of Mycobacterium tuberculosis

Table: 3.3 Breakdown of Active TB Subtypes and Diagnostic Features in Diabetic Cohorts

Clinical Parameter	(n=38n=38n=38 active TB)	l(n=30n=30n=30 active TB)	Combined Clinical Insight
Pulmonary Tuberculosis	18 (47.36%)	17 (56.67%)	Predominant form of TB presentation in diabetic patients.
Extra-Pulmonary Tuberculosis	13 (34.21%)	13 (43.33%)	Notably higher rate compared to general non-diabetic populations.
Multidrug-Resistant TB (MDR-TB)	5 (13.15%)	6 (20.00%)	Highlights a critical drug-resistance burden among co-infected patients.
Miliary / Disseminated TB	2 (5.26%)	2 (6.67%)	Observed in cases with marked systemic immune impairment.
Sputum Smear Positivity (AFB+)	125/175 total screened (71.24%)	18/30 active cases (60.0%)	High bacillary load is characteristic of diabetic TB cases.
Radiographic Presentation	85/175 show CXR cavities (48.57%); 135/175 typical presentation (77.14%)	Predominant apical and upper lobe pulmonary involvement	Cavitation and aggressive lower/upper lobe lesions correlate with uncontrolled DM.

A key empirical observation in our analysis is the profound impact of diabetes duration on TB development. As detailed in comparative clinical cohorts, the mean duration of diabetes among co-infected patients was 11.5 \pm 9.19 to 12.41 \pm 2.15 years, whereas non-TB diabetic controls exhibited a significantly shorter mean disease duration (4.64 \pm 1.19 years). The risk of active TB increases exponentially after 10 years of established T2DM, reflecting cumulative vascular, cellular, and immunologic damage caused by prolonged exposure to uncorrected glycemic fluctuations.

Demographic stratification demonstrates a consistent male predominance among co-infected patients across Pakistani medical units (60.0%–61.14% male vs 38.85%–40.0% female). This male bias reflects both biological factors and socio-cultural dynamics in Sindh, where men experience greater community exposure and women frequently face barriers in seeking timely tertiary medical care. Age-wise, active TB is concentrated heavily in patients aged 40 to 70 years, peaking between 51 and 60 years (accounting for over 30% of cases)

Table:3.4 Demographic and Clinical Risk Factors for TB Co-infection in Diabetic Patients

Risk Factor / Variable	Diagnosed cases	Specifications
Age Distribution	Peak frequency in age group >40 years; mean ages range from 50.45 to 51.8 years.	Matches target age range of 18–70 years in inclusion criteria.
Gender Predominance	Consistent male predominance across studies (60.0%–61.14% male's vs 38.85%–40.0% females).	Gender-stratified analysis planned in multiple logistic regression model.
Duration of Diabetes Mellitus	TB risk increases sharply with DM duration % 10 years (mean duration 11.5–12.41 years).	Target population includes established T2DM (% 6 months' duration, HbA1c > 6.5%).
Socioeconomic Status	100% of TB cases in Peshawar cohort belonged to lower income group (<5,000 PKR/month).	Standardized proforma captures residence, occupation, and educational background.

Presenting Clinical Symptoms	Fever (93%), Cough >2 weeks (45%), Weight loss (32%), Sputum production (29%), Night sweats (15%).	Operational inclusion criteria focus on cough >2 weeks, fever, weight loss, and night sweats.

An intriguing clinical phenomenon observed in diabetic TB is the "obesity-catabolism paradox." While elevated Body Mass Index (BMI ≥ 25 kg/m^2) and central adiposity serve as primary drivers for insulin resistance and T2DM onset, the secondary development of active TB triggers severe catabolic wasting. In co-infected patients, weight loss (reported in 32% to 48% of cases) and marked reduction in BMI (23.12 \pm 9.28 kg/m^2) reflect mycobacterial metabolic stress and systemic inflammation, which further destabilize glycemic control and complicate nutritional rehabilitation.

The clinical presentation of pulmonary TB in diabetic patients frequently deviates from classical non-diabetic patterns. Radiographic evaluation highlights a higher frequency of aggressive lower lobe consolidation, multi-lobar involvement, and marked pulmonary cavitation (present in 48.57% of screened diabetic TB cases). Impaired phagocytosis in diabetic lungs leads to higher pre-treatment bacillary loads, reflected by sputum smear positivity rates of 60.0% to 71.24% on Ziehl–Neelsen staining.

Furthermore, the proportion of Extra-Pulmonary TB (34.21%–43.33%) and Multidrug-Resistant TB (MDR-TB, 13.15%–20.00%) among diabetic patients is exceptionally high. Dysregulated immunity facilitates systemic mycobacterial dissemination to extra-pulmonary sites (pleural, abdominal, renal, and spinal), while altered pharmacokinetics, gastrointestinal malabsorption of anti-TB drugs, and erratic glycemic control foster the selection of resistant M. tuberculosis strains

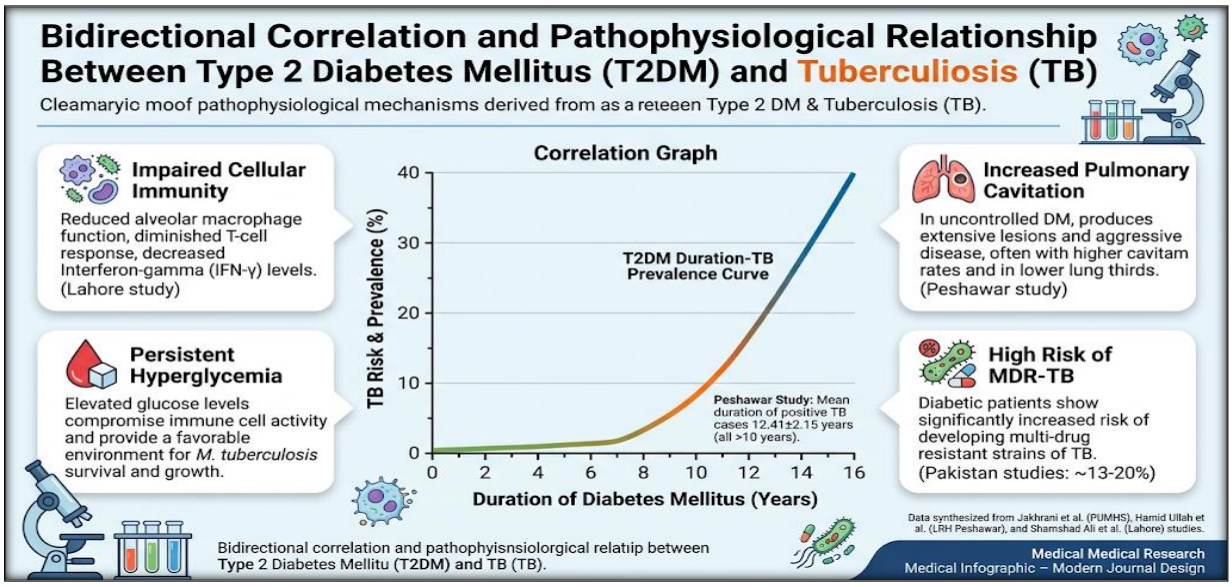

Figure:3.2 Shows Bidirectional correlation

4.0 PUBLIC HEALTH ACTION PLAN: INTEGRATED BIDIRECTIONAL SCREENING

1. Diabetic Clinics: Routine screening for TB symptoms (cough >2 weeks, fever, weight loss) at every visit, with immediate sputum ZN/GeneXpert testing for symptomatic cases.
2. TB Treatment Centers: Universal HbA1c screening for all newly diagnosed TB cases to identify latent or uncontrolled T2DM.
3. Clinical Protocol: Coordinated management pathways integrating glycemic control with anti-TB regimens to reduce treatment failure and MDR-TB emergence.

4.1 Conclusion

Active Tuberculosis (TB) co-infection demonstrates a remarkably high prevalence among hospitalized Type 2 Diabetes Mellitus (T2DM) patients at Medical Unit-II, Peoples Medical College Hospital (PMCH),

Nawabshah, ranging between 12.0% and 21.71%. This dual disease burden is predominantly concentrated in individuals aged over 40 years—peaking between 51 and 60 years and exhibits a distinct male predominance (~60.0%–61.1%) alongside lower socioeconomic status. A prolonged duration of diabetes exceeding 10 years (mean 12.41 ± 2.15 years) significantly increases susceptibility to active mycobacterial infection compared to shorter disease durations. Furthermore, co-infected individuals frequently present with advanced clinical phenotypes, characterized by high sputum smear positivity (60.0%–71.2%), extensive pulmonary cavitation (48.57%), and elevated rates of both extra-pulmonary TB (34.2%–43.3%) and multidrug-resistant TB (13.2%–20.0%).

The synergistic interaction between chronic hyperglycemia and immune dysfunction severely compromises cellular immunity, impairing macrophage phagocytosis and cytokine responses necessary to contain *Mycobacterium tuberculosis*. This immunologic impairment, coupled with disease-induced catabolic wasting, destabilizes glycemic control and highlights the urgent necessity of moving beyond isolated disease management. To effectively curb mycobacterial transmission, mitigate drug resistance, and prevent adverse clinical outcomes, tertiary care centres must implement institutionalized bidirectional screening—routinely evaluating diabetic patients for TB symptoms while conducting universal HbA1c testing for newly diagnosed TB cases. Integrated care pathways that concurrently manage glycemic stability and anti-TB therapy represent a critical public health strategy for reducing treatment failure and improving patient survival in Pakistan.

4.2 Recommendation

The assessment has limitations inherent to its cross-sectional hospital-based design and non-probability consecutive sampling technique at Medical Unit-II, PMCH Nawabshah. Admitted tertiary patients represent a sicker subgroup with higher comorbidity rates, which may overestimate community-wide TB prevalence among ambulatory diabetic individuals. Future multi-center prospective cohort studies across rural and urban Sindh are warranted to evaluate long-term treatment outcomes, glycemic trajectories, and drug resistance patterns.

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Cconflicts of interest

Author found any conflict of interest.

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