

Original Research Article

Health-related quality of life and treatment adherence in tuberculosis–diabetes comorbidity in urban India

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ABSTRACT

Background: Tuberculosis (TB) and diabetes mellitus (DM) form a growing syndemic that adversely affects treatment outcomes and patient well-being. While clinical consequences are well documented, patient-centred outcomes such as health-related quality of life (HRQoL) and treatment adherence remain inadequately explored in high-burden settings. This study aimed to assess HRQoL and treatment adherence among patients with TB–DM comorbidity receiving anti-tubercular therapy in an urban tertiary care hospital.

Methods: A hospital-based cross-sectional study was conducted among adult patients with TB–DM comorbidity receiving anti-tubercular therapy. HRQoL was assessed using the WHOQOL-BREF across physical, psychological, social, and environmental domains. Treatment adherence was measured using the Tuberculosis Medication Adherence Scale (TBMAS). Data were analysed using appropriate statistical tests, with $p < 0.05$ considered statistically significant.

Results: The majority of participants were aged 26–40 years, male, and urban residents. Poor HRQoL was most pronounced in the psychological and environmental domains, while nearly one-third had poor physical HRQoL. Social HRQoL was impaired in a substantial proportion of participants. High-risk behaviours were common, including tobacco use and alcohol consumption. Despite high treatment adherence observed in 166 (89.2%) participants, HRQoL remained poor, particularly in the psychological [132 (71.0%)] and environmental domains [141 (75.8%)].

Conclusions: Although most participants demonstrated good treatment adherence, substantial impairment in HRQoL persisted, particularly in psychological and environmental domains.

Keywords: Diabetes mellitus, Quality of life, TBMAS, Treatment adherence, Tuberculosis, WHOQOL-BREF

INTRODUCTION

Tuberculosis (TB) remains a major global public health challenge, with a substantial burden in high-incidence countries such as India, despite ongoing control efforts.¹ The National Tuberculosis Elimination Programme (NTEP), supported by the National Strategic Plan (2020–2025), aims to eliminate TB; however, the rising prevalence of diabetes mellitus (DM) poses a major

challenge to achieving these targets.² Diabetes impairs host immune responses and increases susceptibility to active TB.³ In turn, TB infection can adversely affect glycaemic control and worsen diabetic status.⁴ Epidemiological evidence suggests that individuals with diabetes have a two- to three-fold higher risk of developing active TB compared to non-diabetic individuals.⁵ TB–DM comorbidity has also been associated with delayed sputum conversion, treatment

failure, and increased mortality.^{6,7} Furthermore, poor glycaemic control adversely influences TB treatment outcomes.⁸

Beyond clinical outcomes, TB-DM comorbidity substantially affects patient-centred outcomes, particularly health-related quality of life (HRQoL). HRQoL is a multidimensional construct encompassing physical, psychological, social, and environmental well-being and is increasingly recognized as an important indicator of disease burden and treatment success.⁹ Previous studies have shown that patients with TB experience considerable impairment in HRQoL, particularly in psychological and social domains, which may be further aggravated in the presence of diabetes due to additional metabolic and psychosocial burden [10]. Factors such as stigma, depression, and adverse social determinants may further reduce quality of life and negatively influence treatment outcomes.¹¹

Treatment adherence remains fundamental to successful TB control. Poor adherence contributes to treatment failure, relapse, and the emergence of drug resistance.¹² Patients with TB-DM comorbidity often require prolonged and complex treatment regimens, which may adversely affect adherence and overall well-being.¹³ Despite the growing burden of TB-DM comorbidity, relatively few studies have simultaneously evaluated both HRQoL and treatment adherence, particularly in urban tertiary care settings in India. Therefore, the present study was undertaken to assess health-related quality of life and treatment adherence among patients with tuberculosis and diabetes mellitus who were receiving antitubercular therapy in an urban tertiary care hospital.

METHODS

This hospital-based cross-sectional study was conducted in the Department of Respiratory Medicine at a tertiary care teaching hospital in a metropolitan city of Maharashtra, India, to assess health-related quality of life (HRQoL) and treatment adherence among patients with coexisting tuberculosis (TB) and diabetes mellitus (DM). The study was conducted over 30 months from February 2023 to August 2025, including protocol development, pilot testing, data collection, analysis, and report preparation.

The study population comprised adult patients diagnosed with both pulmonary TB and DM attending the study setting during the study period. Patients aged ≥ 18 years, newly diagnosed with sputum smear-positive pulmonary TB and diabetes mellitus, and who had completed at least two months of anti-tubercular therapy during the intensive phase were included. Patients with drug-resistant TB, extrapulmonary TB, pregnancy, additional comorbidities other than hypertension, or inability/unwillingness to provide informed consent were excluded.

The sample size was calculated using the formula ($N = Z^2 pq/d^2$). Assuming a prevalence of poor HRQoL among patients with TB-DM comorbidity of 12% from prior literature, with 95% confidence level and 5% absolute precision, the minimum required sample size was estimated as 169. After accounting for potential non-response, 186 participants were finally included in the study. Eligible participants attending the study setting during the data collection period were recruited using a non-probability convenience sampling method.

Data were collected after obtaining written informed consent in the participant's local language. Face-to-face interviews were conducted using a predesigned, pretested, and validated structured questionnaire. Information regarding sociodemographic characteristics, clinical profile, behavioural risk factors, treatment details, and relevant investigations was collected. Clinical details were cross-verified with patient treatment records to improve data accuracy. Prior to the main study, pilot testing was performed among a subset of participants to assess clarity, feasibility, and comprehensibility of the questionnaire, following which minor modifications were incorporated. Data collectors were trained in standardized interviewing procedures, and regular supervision with random cross-checking of completed forms was undertaken to maintain uniformity and reduce interviewer bias.

HRQoL was assessed using the WHOQOL-BREF questionnaire, a validated 26-item instrument consisting of four domains: physical health, psychological health, social relationships, and environmental health. Each item was scored on a five-point Likert scale according to WHO guidelines. Raw domain scores were transformed to a standardized 0-100 scale using standard WHOQOL-BREF scoring procedures, where higher scores represented better quality of life. For domain-wise assessment, scores < 60 were categorized as poor HRQoL and scores ≥ 60 as good HRQoL, based on previously published Indian studies. Overall HRQoL was calculated by averaging the transformed scores of the four domains for each participant. Participants with an overall mean score < 60 were classified as having poor overall HRQoL, while scores ≥ 60 were considered good overall HRQoL.

Treatment adherence was assessed using the Tuberculosis Medication Adherence Scale (TBMAS), a validated 30-item questionnaire scored on a five-point Likert scale. Total adherence scores ranged from 30 to 150, with higher scores indicating better adherence. Based on standard TBMAS interpretation criteria, participants scoring < 113 were categorized as non-adherent, while those scoring ≥ 113 were considered adherent.

Data analysis was performed using R software version 4.3.2. Categorical variables were summarized as frequencies and percentages. Continuous variables were expressed as mean $\pm$ standard deviation for normally distributed variables and median with interquartile range

for skewed variables. Normality was assessed using the Shapiro-Wilk test. Associations between categorical variables were evaluated using Pearson's Chi-square test or Fisher's exact test where expected cell counts were <5. A p-value <0.05 was considered statistically significant.

Several measures were adopted to improve methodological rigor and reduce bias. Standardized validated instruments were used for outcome assessment, and interviewer training and periodic supervision were conducted to ensure consistency, and patient records were used for verification of clinical information. Real-time checking of questionnaires minimized missing data, and incomplete responses were excluded only from relevant domain-specific analyses. Inclusion of all eligible participants during the study period helped reduce selection bias.

Ethical approval was obtained from the Institutional Ethics Committee. This study conducted in accordance with the ethical guidelines of the Indian Council of Medical Research (ICMR). Written informed consent was obtained from all participants before enrolment. Confidentiality and anonymity of participant information were strictly maintained, and participants were informed of their right to withdraw from the study at any stage without affecting their treatment. The MUHS synopsis approval committee also approved the study protocol.

RESULTS

Table 1 depicts the socio-demographic characteristics of the study participants (n=186). The majority belonged to the 26-40 years age group (71; 38.2%), followed by 41-60 years (54; 29.0%). Males constituted a slightly higher proportion (100; 53.8%) compared to females (86; 46.2%). Most participants were urban residents (163; 87.6%) and married (157; 84.4%). A large proportion belonged to the upper-middle socioeconomic class (95; 51.1%), indicating a predominantly urban, middle-class population.

Table 2 shows the distribution of substance use among participants. A high proportion reported current smokeless tobacco use (109; 58.6%), while 62 (33.3%) were current smokers. Alcohol consumption was observed in 52 (28.0%) participants. These findings indicate a substantial burden of behavioural risk factors in the study population.

Table 3 illustrates the distribution of HRQoL across domains. Poor quality of life was most pronounced in the environmental (141; 75.8%) and psychological domains

(132; 71.0%). Social HRQoL was affected in 76 (40.9%) participants, while the physical domain was comparatively less affected, with 58 (31.2%) reporting poor scores. Overall, 142 (76.3%) participants experienced poor quality of life.

Table 1: Socio-demographic characteristics of study participants (n=186).

Variables	Category	Number (%)
Age group (years)	19-25	35 (18.8)
	26-40	71 (38.2)
	41-60	54 (29.0)
	>60	26 (14.0)
Sex	Male	100 (53.8)
	Female	86 (46.2)
Residence	Urban	163 (87.6)
	Rural	23 (12.4)
Marital status	Married	157 (84.4)
	Unmarried	22 (11.8)
	Widow	7 (3.8)
Socioeconomic class (Modified Kuppaswamy Scale)	Class II	95 (51.1)
	Class III	53 (28.5)
	Class IV	37 (19.9)
	Class V	1 (0.5)

Table 2: Substance use among study participants (n=186).

Variables	Category	Number (%)
Smokeless tobacco	Current	109 (58.6)
	Ex-user	39 (21.0)
	Never	38 (20.4)
Smoking	Current	62 (33.3)
	Ex-smoker	22 (11.8)
	Never	102 (54.8)
Alcohol	Current	52 (28.0)
	Ex-user	33 (17.7)
	Never	101 (54.3)

Table 3: Domain-wise distribution of HRQoL (n=186).

Domains	Poor QoL (<60), N (%)	Good QoL (≥60), N (%)
Physical	58 (31.2)	128 (68.8)
Psychological	132 (71.0)	54 (29.0)
Social	76 (40.9)	110 (59.1)
Environmental	141 (75.8)	45 (24.2)
Overall QoL	142 (76.3)	44 (23.7)

Table 4: Association between treatment adherence and HRQoL Domains (n=186).

Domains	Adherent with poor HRQoL, N (%)	Adherent with good HRQoL, N (%)	Non-adherent with poor HRQoL, N (%)	Non-adherent with good HRQoL, N (%)	Test	P value
Physical	44 (26.5)	122 (73.5)	14 (70.0)	6 (30.0)	Chi-square	<0.001**
Psychological	117 (70.5)	49 (29.5)	15 (75.0)	5 (25.0)	Chi-square	0.674

Continued.

Domains	Adherent with poor HRQoL, N (%)	Adherent with good HRQoL, N (%)	Non-adherent with poor HRQoL, N (%)	Non-adherent with good HRQoL, N (%)	Test	P value
Social	63 (38.0)	103 (62.0)	13 (65.0)	7 (35.0)	Chi-square	0.020**
Environmental	127 (76.5)	39 (23.5)	14 (70.0)	6 (30.0)	Fisher*	0.581
Overall QoL	123 (74.1)	43 (25.9)	19 (95.0)	1 (5.0)	Fisher*	0.048**

*Fisher's Exact Test used where the expected cell count <5, **P<0.05 considered statistically significant

Table 4 shows the association between treatment adherence and HRQoL domains. A statistically significant association was observed between adherence and physical ($p<0.001$), social ($p=0.020$), and overall HRQoL ($p=0.048$). However, no significant association was found for psychological ($p=0.674$) and environmental domains ($p=0.581$), suggesting that adherence may influence specific domains of quality of life.

DISCUSSION

The present study demonstrated substantial impairment in health-related quality of life (HRQoL) among patients with tuberculosis and diabetes mellitus (TB-DM), with the greatest impairment observed in the psychological and environmental domains despite high treatment adherence. Similar findings have been reported in previous studies among tuberculosis patients, where psychological well-being remained one of the most adversely affected HRQoL domains.¹⁴

Psychological HRQoL was markedly impaired in the present study. Tuberculosis is frequently associated with stigma, fear of discrimination, social isolation, and fear of transmitting infection to family members, all of which negatively affect mental well-being.¹⁵ The coexistence of diabetes further increases the chronic emotional and behavioural burden because of lifelong medication use, dietary restrictions, and long-term lifestyle modifications.¹⁶ In addition, prolonged treatment duration, uncertainty regarding recovery, reduced work productivity, and financial insecurity may collectively contribute to poor psychological HRQoL. Similar psychosocial impairment among TB patients has also been documented in Indian settings, emphasizing that psychological distress often persists despite ongoing treatment and clinical follow-up.¹⁷

The environmental domain was the most severely affected HRQoL component in the present study. Previous studies have highlighted the important contribution of social and environmental determinants to tuberculosis burden and patient well-being.¹⁸ In the present study, poor environmental HRQoL may reflect urban poverty, overcrowded living conditions, nutritional insecurity, healthcare-related expenditures, and employment disruption during illness. Although anti-tubercular therapy is provided free of cost under the National Tuberculosis Elimination Programme (NTEP), patients often continue to incur substantial indirect costs related to transportation, glucose monitoring, nutritional support, and wage loss during prolonged illness. These

findings are particularly relevant in metropolitan India, where socioeconomic disparities, unstable employment conditions, and high living costs may further amplify the burden experienced by patients with chronic comorbid conditions.

The physical domain was comparatively less impaired than the psychological and environmental domains. Similar observations have been reported previously, where physical recovery improved during treatment while psychological and social recovery remained incomplete.¹⁹ Nevertheless, a substantial proportion of participants continued to experience poor physical and social HRQoL, indicating persistent limitations in daily functioning, work capacity, and social participation despite treatment.

An important programmatic observation of the present study was the coexistence of high treatment adherence with persistently poor HRQoL. Similar findings have been reported in studies conducted under structured TB control programmes, where adherence remained satisfactory despite ongoing psychosocial impairment.¹⁹ This may reflect the effectiveness of NTEP services, including free treatment availability, directly observed treatment support, regular follow-up systems, and continued patient monitoring. However, despite good adherence, psychological and environmental HRQoL remained markedly poor, suggesting that biomedical and programmatic support alone may not adequately address the broader psychosocial and socioeconomic burden experienced by patients with TB-DM comorbidity. Importantly, the cross-sectional design of the present study does not permit causal interpretation regarding the relationship between treatment adherence and HRQoL.²⁰

Significant associations were observed between treatment adherence and physical, social, and overall HRQoL domains, whereas psychological and environmental domains did not demonstrate statistically significant associations with adherence. This pattern suggests that psychological and environmental well-being may be influenced more strongly by emotional, social, and economic determinants than by treatment-taking behaviour alone.

Most socio-demographic variables did not demonstrate a significant association with HRQoL, suggesting that the burden of TB-DM comorbidity extends across multiple population groups. These findings support the need for comprehensive patient-centred TB-DM care strategies integrating mental health support, behavioural counselling, tobacco and alcohol cessation services,

nutritional assistance, and social protection measures alongside routine biomedical management.

The present study has certain limitations. As the study employed a cross-sectional design, causal relationships between HRQoL and treatment adherence could not be established. Being conducted in a single urban tertiary care centre, the findings may have limited generalizability to other settings. The use of self-reported tools may also introduce recall and social desirability bias. Additionally, factors such as glycaemic control, severity of tuberculosis, psychiatric comorbidities, and detailed socioeconomic assessment were not evaluated and may have influenced HRQoL outcomes.

CONCLUSION

Tuberculosis-diabetes mellitus (TB-DM) comorbidity was associated with substantial impairment in health-related quality of life (HRQoL), particularly in the psychological and environmental domains, despite high treatment adherence. Although structured support systems under the National Tuberculosis Elimination Programme (NTEP) may facilitate good adherence through free treatment availability and regular follow-up, important dimensions of psychosocial and socioeconomic well-being appear to remain inadequately addressed. Poor psychological HRQoL may reflect stigma, chronic dual disease burden, prolonged treatment duration, and financial insecurity, while environmental impairment may be related to overcrowding, nutritional challenges, healthcare-related expenditures, and employment disruption, particularly in metropolitan urban settings.

Recommendations

These findings highlight the need for more comprehensive patient-centred TB-DM care approaches extending beyond treatment completion alone. Incorporating routine HRQoL assessment during follow-up, strengthening counselling services, integrating basic mental health support within TB care, and improving linkage with nutritional and social support mechanisms may help address the broader challenges experienced by patients with TB-DM comorbidity and improve overall patient well-being.

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