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Original Article

Effect of Pharmaceutical Care Interventions on Health-Related Quality of Life (HRQoL) Among Patients with Drug Resistant Tuberculosis: A Prospective Study

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ABSTRACT

Introduction: Quality of Life (QoL) reflects an individual's perception of physical, psychological, social, and environmental well-being and is an important indicator of overall health and life satisfaction. Purpose: This study aimed to evaluate the effect of pharmaceutical care interventions on Health-Related Quality of Life (HRQoL) among patients with drug-resistant tuberculosis through a prospective follow-up approach, A multicentric study. **Materials and Methods:** A prospective multicentric study was conducted from April 2025 among patients receiving treatment for Drug-Resistant Tuberculosis (DR-TB) at the District Tuberculosis Centre, Belagavi, and affiliated Primary Health Centres in North Karnataka, India. Ethical approval was obtained from the Institutional Human Ethics Committee and the State Tuberculosis Centre. Eligible participants were enrolled based on predefined criteria. Baseline data were collected, followed by individualized counselling. Health-related quality of life was assessed using the WHO-BREF questionnaire at baseline and during two subsequent follow-ups. All responses were recorded systematically and analysed using appropriate descriptive and inferential statistical methods. **Results:** Significant improvements were observed across all HRQoL domains during follow-up. Physical health scores increased with mean differences of 5.00±1.05 at the first follow-up and 11.94±1.09 at the second follow-up ($p<0.001$). Psychological, social, and environmental domains also showed statistically significant enhancement, indicating sustained benefits of counselling and supportive care. **Conclusion:** The findings emphasize the importance of incorporating structured follow-up, psychosocial support, and pharmaceutical care into routine DR-TB management. A coordinated and comprehensive care approach can improve treatment outcomes, enhance quality of life, and promote long-term health benefits among patients with drug-resistant tuberculosis.

Keywords: Drug resistant tuberculosis, Health related quality of life, Multicentric study, Patient counselling, Patient-centred care, Pharmaceutical care.

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INTRODUCTION

Drug-Resistant Tuberculosis (DR-TB) occurs when Mycobacterium tuberculosis develops resistance to one or more commonly used anti-tuberculosis drugs. The World Health Organization's Global TB Report 2023 estimated that around 410,000 people worldwide developed Multidrug-Resistant or Rifampicin-Resistant TB (MDR/RR-TB) in 2022, reflecting a decline from 450,000 cases in 2021 and 437,000 cases in 2020. Despite this reduction, only about 175,650 individuals were bacteriologically confirmed and initiated on standardized treatment, indicating that approximately 43% of affected patients were diagnosed and managed appropriately. This level remains below the pre-pandemic Figures reported in 2019. China accounts for an estimated 30,000 MDR/RR-TB cases, with a gradual decline observed since 2015. Nevertheless, treatment outcomes remain suboptimal. Among patients enrolled in 2020 and treated with second-line anti-tuberculosis regimens, only 51% achieved successful outcomes by 2022, which is substantially lower than the global success rate of 63% reported in 2020. Drug-resistant tuberculosis continues to pose a serious global public health concern due to its high rates of illness and death, lengthy treatment courses, and significant economic burden. In addition to physical complications, DR-TB negatively affects mental health, emotional well-being, social functioning, and financial stability, ultimately leading to a diminished quality of life. Consequently, sustained efforts from researchers, healthcare professionals, and policymakers are essential to strengthen

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prevention, diagnosis, treatment, and long-term management of DR-TB (Wang *et al*., 2024).

According to the World Health Organization, Drug-Resistant Tuberculosis (DR-TB) is categorized into mono- or poly-drug resistant TB, Rifampicin-Resistant TB (RR-TB), Multidrug-Resistant TB (MDR-TB), pre-Extensively Drug-Resistant TB (pre-XDR-TB), and Extensively Drug-Resistant TB (XDR-TB). Multidrug-resistant TB is defined by resistance to at least rifampicin and isoniazid, without additional resistance to second-line anti-tubercular medications (Putra *et al*., 2025a).

Multiple factors influence the quality of life of patients with tuberculosis, including family support, medication adherence, psychological well-being, demographic characteristics, educational status, and access to counselling services. Individuals with drug-resistant TB often experience a poorer quality of life and are more vulnerable to mental health conditions, particularly depression. Depression among TB patients is frequently associated with poor treatment adherence, which can compromise therapeutic outcomes and reduce treatment success. Therefore, assessing health-related quality of life is essential for evaluating treatment effectiveness in patients with drug-resistant TB, alongside conventional indicators such as cure rates, morbidity, and mortality. Despite its importance, quality of life as a treatment outcome in drug-resistant TB patients has received limited research attention (Putra and Purnamasari, 2025).

Quality of Life (QoL) is a comprehensive and multidimensional construct encompassing physical health, psychological state, social relationships, economic conditions, and overall well-being. It represents an individual's general satisfaction with life and is typically evaluated using self-reported measures that capture perceptions of health status, daily functioning, and overall wellness. Since QoL is inherently subjective and shaped by cultural background, personal values, expectations, aspirations, and concerns, accurately assessing it can be complex and methodologically challenging. Therefore, QoL is best understood as a reflection of patients' personal preferences and values rather than solely as an evaluation by healthcare professionals. HRQoL, which captures patients' perceptions of their physical and mental health, is essential for understanding and measuring the true impact of illness. Numerous studies have also demonstrated a strong association between pulmonary function and quality of life in both acute and chronic respiratory conditions (Jagadeesh *et al*., 2025).

Multiple studies have reported that patients with tuberculosis experience substantially reduced Health-Related Quality of Life (HRQoL) across most domains when compared with healthy individuals, with more severe impairment observed in those with multidrug-resistant TB than in patients with drug-susceptible disease. In this context, the present study sought to assess the HRQoL of individuals with drug-resistant TB. Furthermore, HRQoL was evaluated systematically, and personalized patient counselling was provided to address individual concerns, enhance treatment adherence, and support overall well-being.

METHODOLOGY

A prospective, multicentric pre-post study was conducted in patients receiving treatment for drug-resistant tuberculosis from April 2025 at the District Tuberculosis Centre, Belagavi, and four affiliated Primary Health Centres in Belagavi, North Karnataka, India. The study was carried out as part of a doctoral research program and received ethical approval from the Institutional Human Ethics Committee (Ref. No. KAHER/EC/24-25/D-743) and additional permission was granted by the State Tuberculosis Centre, Department of Health and Family Welfare, Karnataka, India (LEVIRAKSHAKE/NTEP/PPM/02/2025-26). Patients receiving standardized treatment for drug-resistant tuberculosis were enrolled in the study, and their Health-Related Quality of Life (HRQoL) was systematically evaluated using validated and standardized questionnaires. In addition, all participants received individualized counselling focused on improving HRQoL. Only patients who survived and continued DR-TB treatment were included, and informed consent was obtained from all participants.

The study was conducted at government-monitored District Tuberculosis Centres under the National Tuberculosis Elimination Programme (NTEP). During the study period, all active DR-TB patients receiving treatment at the selected centres were approached for participation. As the study aimed to include the entire accessible population of DR-TB patients during the study period, a consecutive sampling approach was adopted and therefore we have kept sample size as universal sample size.

Health-Related Quality of Life (HRQoL) was evaluated using the WHOQOL-BREF questionnaire developed by the World Health Organization, which is a validated and standardized instrument. HRQoL-focused counselling was provided through individualized sessions and the distribution of patient information leaflets. Follow-up assessments were conducted at four-month intervals, with a total of two follow-ups carried out to evaluate changes in HRQoL over time.

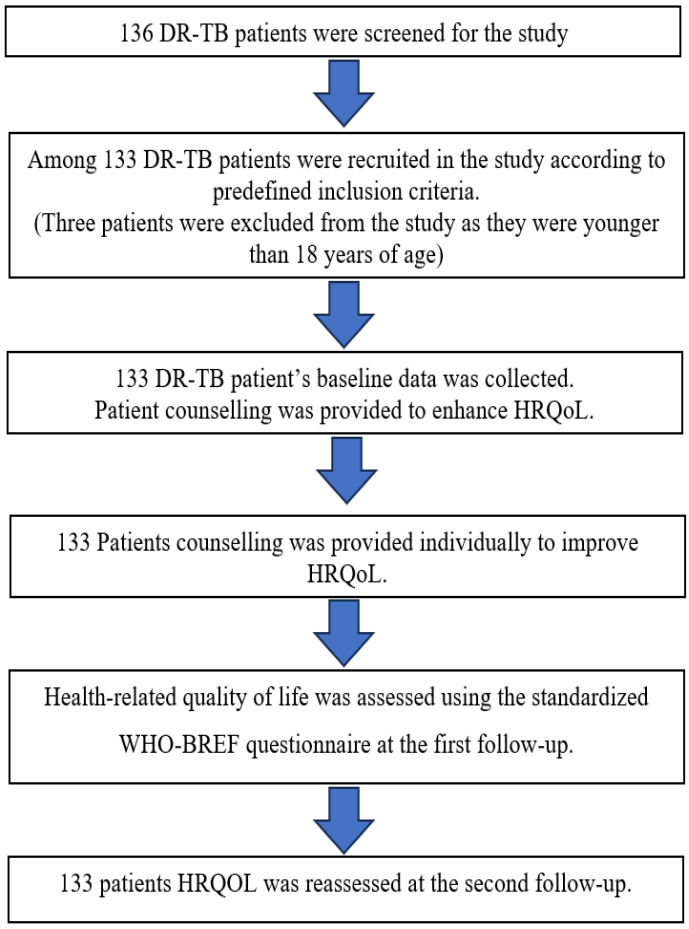
Patients aged 18 years or older, of either gender, diagnosed with Drug-Resistant Tuberculosis (DR-TB) and receiving treatment at the study centres during the study period were considered eligible for inclusion. Patients below 18 years of age and those unwilling to participate were excluded. A total of 136 DR-TB patients were screened, of whom 133 were enrolled in the study. The high enrolment rate can be attributed to the inclusion of patients receiving treatment under the NTEP program, where nearly all eligible patients attending the study centres during the study period were approached and included. As a result, the study

population closely represents the available DR-TB patient at the study sites.

Data Collection procedure

The study followed a systematic and structured methodology. A total of 136 patients with Drug-Resistant Tuberculosis (DR-TB) were initially screened according to predefined inclusion and exclusion criteria. Of these, 133 patients fulfilled the eligibility criteria and were enrolled in the study, and their baseline data were collected. Three patients were excluded as they were below 18 years of age. During this phase, individualized patient counselling was provided to 133 patients to enhance HRQoL. Subsequently, HRQoL was evaluated at the first follow-up using the standardized WHO-BREF questionnaire to assess the initial impact of counselling and supportive care. A second assessment was carried out for 133 patients during the subsequent follow-up to determine the sustainability of the observed improvements. All responses were systematically recorded, and the collected data were analysed using appropriate descriptive and inferential statistical techniques to evaluate the effectiveness of the intervention and follow-up process.

Study Procedure



RESULTS

The demographic profile of the study patients (n=133) shows that the majority belonged to the 25-44 years age group, accounting for 59 patients (44.36%), followed by those aged 45-60 years with 39 patients (29.32%). The 18-24 years group comprised 15 patients (11.28%), while 13 patients (9.77%) were above 60 years of age. This indicates that most patients were from the economically productive age group. Regarding gender distribution, 82 patients (61.65%) were male and 51 patients (38.35%) were female, reflecting a male predominance in the study population.

With respect to lifestyle habits, 32 patients (24.06%) reported alcohol consumption, whereas 101 patients (75.94%) did not consume alcohol. Smoking was observed in 23 patients (17.29%), while 110 patients (82.71%) were non-smokers. Chewable tobacco use was reported by 62 patients (46.62%), and 71 patients (53.38%) did not use smokeless tobacco.

Concerning comorbid conditions, 26 patients (19.55%) were diagnosed with hypertension, and 19 patients (14.29%) had diabetes mellitus. The majority were free from hypertension (107 patients, 80.45%) and diabetes (114 patients, 85.71%). In terms of marital status, most patients were married (103 patients, 77.44%), while 30 patients (22.56%) were unmarried, indicating a predominantly married study population. HIV status assessment revealed that 10 patients (7.46%) were HIV-positive, whereas 123 patients (91.79%) were HIV-negative, suggesting a low prevalence of HIV infection among the respondents.

Analysis of family income showed that 70 patients (52.63%) belonged to the ₹10,000-₹20,000 income group, followed by 51 patients (38.35%) earning ₹5,000-₹10,000 per month. Only 11 patients (8.27%) had an income above ₹20,000, and 1 participant (0.75%) reported an income below ₹5,000, indicating that most patients belonged to the lower to middle socioeconomic strata, as depicted in Refer Table 1.

The paired sample analysis demonstrated a significant improvement in physical health scores across the follow-up assessments. The comparison between baseline and the first follow-up showed a mean increase of 5.00±1.05, which was statistically significant (t=-54.72, p<0.001). Further improvement was observed between the first and second follow-ups, with a mean difference of 6.93±0.32 (t=-250.08, p<0.001). The largest overall change was seen when baseline was compared with the second follow-up, where the mean difference reached 11.94±1.09 (t=-125.68, p<0.001). The calculated Cohen's d values indicated very large effect sizes across all comparisons, suggesting a substantial improvement in the physical health domain over time. presented in Refer Table 2.

The paired sample analysis showed a significant improvement in psychological health scores across all follow-up periods. The comparison between baseline and the first follow-up demonstrated

a mean increase of 1.42±1.19, which was statistically significant (t=-13.78, p<0.001). A greater improvement was observed between the first and second follow-ups, with a mean difference of 5.95±0.20 (t=-329.63, p<0.001). The overall comparison between baseline and the second follow-up showed the highest improvement, with a mean difference of 7.36±1.12 (t=-75.60, p<0.001). The calculated Cohen's d values indicated large to very large effect sizes, reflecting a substantial improvement in psychological health over time, as shown in Table 3.

The paired sample analysis indicated a significant increase in social health scores across the follow-up periods. The comparison between baseline and the first follow-up showed a mean difference of 1.75±0.81, which was statistically significant (t=-24.91, p<0.001). Further improvement was observed between the first and second follow-ups, with a mean difference of 2.90±0.29 (t=-112.28, p<0.001). The overall comparison between baseline and the second follow-up demonstrated the greatest improvement, with a mean difference of 4.65±0.82 (t=-64.97, p<0.001). The calculated Cohen's d values indicated very large effect sizes, suggesting a marked improvement in social health throughout the study period, m as represented in Table 4.

The paired sample analysis showed a significant improvement in environmental health scores across all follow-up periods. The comparison between baseline and the first follow-up demonstrated a mean increase of 2.87±1.96, which was statistically significant (t=-16.92, p<0.001). A greater improvement was observed between the first and second follow-ups, with a mean difference of 7.99±1.80 (t=-50.76, p<0.001). The overall comparison between baseline and the second follow-up showed the largest improvement, with a mean difference of 10.81±2.53 (t=-49.29, p<0.001). The calculated Cohen's d values indicated very large effect sizes, suggesting a substantial enhancement in environmental health over the course of the study, as illustrated in Table 5.

Repeated measures ANOVA revealed significant changes in all health domains across the three assessment points (p<0.001). Physical health scores increased from 16.88 ± 3.24 at baseline to 21.89±3.59 at the first follow-up and 28.83±3.52 at the second follow-up (F(2,264)=11880.83, partial η^2=0.989). Psychological health also improved from 16.31±2.41 to 17.74±3.02 and 23.69±2.94 across the respective time points (F(2,264)=4465.72, partial η^2=0.971). Similarly, social relationship scores increased from 7.56±1.32 at baseline to 9.31±1.68 and 12.21±1.60 during subsequent follow-ups (F(2,264)=3085.57, partial η^2=0.959). Environmental health scores showed a comparable trend, rising from 21.78±3.08 to 24.66±4.27 and 32.60±4.60 (F(2,264)=1854.74, partial η^2=0.934). The large effect sizes across all domains indicate a substantial improvement over time following the intervention (Table 6).

Bonferroni-adjusted pairwise comparisons demonstrated significant improvements across all WHOQOL-BREF domains between baseline, first follow-up, and second follow-up assessments (all p<0.001), indicating a progressive improvement in quality of life over the study period (Table 7).

To evaluate clinical significance, Minimal Clinically Important Difference (MCID) values were derived using a distribution-based method, defined as half of the baseline standard deviation.

Table 1: Demographic details.

Particular	Frequency	Percentage
Age		
18-24	15	11.28
25-44	59	44.36
45-60	39	29.32
>60	13	9.77
Gender		
Female	51	38.35
Male	82	61.65
Alcohol consumption		
Yes	32	24.06
No	101	75.94
Smoking		
Yes	23	17.29
No	110	82.71
Chewable tobacco		
Yes	62	46.62
No	71	53.38
Hypertension		
Yes	26	19.55
No	107	80.45
Diabetes		
Yes	19	14.29
`No	114	85.71
Marital status		
Married	103	77.44
Unmarried	30	22.56
HIV		
Positive	10	7.46
Negative	123	91.79
Family Income		
<5000	1	0.75
>20000	11	8.27
10000-20000	70	52.63
5000-10000	51	38.35
Total	133	100.00

Table 2: Physical health.

Physical Health	Paired Differences				*t*-value	*p*-value	Cohen's d	Effect size
	Mean difference±SD	Std. Error Mean	95% CI of the Difference					
			Lower	Upper				
Baseline - First follow-up	5.00±1.05	0.09	-5.18	-4.82	-54.72	<0.001*	4.75	Very large
First follow-up- Second follow-up	6.93±0.32	0.02	-6.99	-6.88	-250.08	<0.001*	21.68	Very large
Baseline - Second follow-up	11.94±1.09	0.09	-12.13	-11.75	-125.68	<0.001*	10.90	Very large

Table 3: Psychological health.

Psychological health	Paired Differences				*t*- value	*p*-value	Cohen's d	Effect size
	Mean difference±SD	Std. Error Mean	95% CI of the Difference					
			Lower	Upper				
Baseline - First follow-up	1.42±1.19	0.10	-1.63	-1.22	-13.78	<0.001*	1.19	Large
First follow-up- Second follow-up	5.95±0.20	0.01	-5.99	-5.91	-329.63	<0.001*	4.95	Very Large
Baseline - Second follow-up	7.36±1.12	0.09	-7.57	-7.19	-75.60	<0.001*	6.57	Very Large

Table 4: Social health.

Social health	Paired Differences				*t*- value	*p*-value	Cohen's d	Effect size
	Mean difference±SD	Std. Error Mean	95% Confidence Interval of the Difference					
			Lower	Upper				
Baseline - First follow-up	1.75±0.81	0.07	-1.89	-1.61	-24.91	<0.001*	2.16	Very large
First follow-up- Second follow-up	2.90±0.29	0.02	-2.95	-2.85	-112.28	<0.001*	10.00	Very large
Baseline - Second follow-up	4.65±0.82	0.071	-4.79	-4.51	-64.97	<0.001*	5.67	Very large

The mean changes observed between baseline and the second follow-up exceeded these MCID thresholds across all WHOQOL-BREF domains. The magnitude of improvement was 11.95 (MCID: 1.62) for physical health, 7.38 (MCID: 1.21) for psychological health, 4.65 (MCID: 0.66) for social health, and 10.82 (MCID: 1.54) for environmental health. In each domain, the observed changes were several times greater than the respective MCID values, demonstrating clinically meaningful enhancement in quality of life. Overall, these results indicate that the improvements are not only statistically significant but also of clear clinical importance Refer Table 8.

DISCUSSION

The present study included 133 participants, with a predominance of males (61.65%) and most individuals aged 25-44 years (44.36%). Most participants were married (77.44%). Smoking

Table 5: Environmental health.

Environmental health	Paired Differences				*t*- value	Sig. (2-tailed)	Cohen's d	Effect size
	Mean±SD	Std. Error Mean	95% Confidence Interval of the Difference					
			Lower	Upper				
Baseline - First follow-up	2.87±1.96	0.17	-3.21	-2.54	-16.92	<0.001*	1.46	Very large
First follow-up- Second follow-up	7.99±1.80	0.156	-8.24	-7.63	-50.76	<0.001*	4.41	Very large
Baseline - Second follow-up	10.81±2.53	0.219	-11.25	-10.38	-49.29	<0.001*	4.27	Very large

Table 6: Repeated ANOVA test.

Variable	Baseline Mean±SD	1st Follow-up Mean±SD	2nd Follow-up Mean±SD	F value	d_f	*p*-value	Partial η^2
Physical health	16.88±3.24	21.89±3.59	28.83±3.52	11880.83	(2,264)	<0.001	0.989
Psychological health	16.31±2.41	17.74±3.02	23.69±2.94	4465.72	(2,264)	<0.001	0.971
Social health	7.56±1.32	9.31±1.68	12.21±1.60	3085.57	(2,264)	<0.001	0.959
Environmental health	21.78±3.08	24.66±4.27	32.60±4.60	1854.74	(2,264)	<0.001	0.934

(17.29%), alcohol use (24.06%), and chewable tobacco use (46.62%) were common, and notable comorbidities such as hypertension (19.55%), diabetes (14.29%), and HIV (7.46%) were observed. Most participants belonged to moderate-income groups, indicating relatively stable economic conditions. These findings highlight the influence of lifestyle-related risk factors and comorbidities on health outcomes. In contrast, the study by *Kebayaone et al.*, included 72 participants, with 70.8% males and a mean age of 42.1±14.6 years. Half of the participants resided in rural areas, and most were unemployed (61.1%) with no regular income (59.7%), reflecting significant socioeconomic challenges. Lower rates of smoking (8.3%) and alcohol use (16.7%) were reported. This suggests that economic vulnerability played a major role in influencing health outcomes in this population. Overall, both studies showed male predominance and middle-aged representation. However, the present study emphasizes behavioural and clinical risk factors, whereas the previous study highlights socioeconomic disadvantages, indicating the need for context-specific interventions (Gare *et al.*, 2024).

The present study demonstrated significant improvements in all health domains during follow-up. Physical health improved with mean differences of 5.00±1.05 at first follow-up and 11.94±1.09 at second follow-up (p<0.001). Psychological health showed improvements of -1.42 and -7.38, while social health improved by 1.75±0.81 and 4.65±0.82. Environmental health also increased by -2.88 and -10.87 from baseline to second follow-up (p<0.001 for all). In contrast *Janet Bamidele et al.*, reported moderate baseline quality of life among 165 drug-resistant patients, with an overall QOL score of 4.0±0.8 and general health satisfaction of 3.9±0.9. Domain scores were higher for psychological (64.7±11.8), environmental (64.9±14.6), and social health (63.9±19.4) than for physical health (59.2±11.2), indicating greater physical impairment. Overall, while the previous study reflected moderate baseline QOL, the present study showed significant improvements across physical, psychological, social, and environmental domains, highlighting the importance of regular follow-up and supportive care in improving quality of life among drug-resistant patients (Bamidele *et al.*, 2024).

The present study demonstrated significant improvements in all quality-of-life domains over time. Physical health improved by 5.00±1.05 at the first follow-up and 11.94±1.09 at the second follow-up (p<0.001). Psychological health showed mean changes of 1.42±1.19 and 7.38±1.12, while social health improved by 1.75±0.81 and 4.65±0.82 from baseline to the second follow-up (p<0.001). Environmental health also improved substantially, with mean differences of 2.88±1.97 and 10.87±1.96 (p<0.001), indicating progressive enhancement with continued monitoring and care. In contrast, *Zenawi et al.* and colleagues observed significantly lower QOL scores in patients with RR/MDR-TB compared to patients with drug-sensitive TB across all domains. The physical domain score was 42.94±19.60 in RR/MDR-TB patients versus 61.80±17.18 in DS-TB patients (t=4.9094, p<0.001). Psychological domain scores were 48.28±20.83 compared to 76.63±15.32 (t=7.4342, p<0.001). Similarly, social (45.83±25.26 vs. 67.39±19.71) and environmental (40.63±10.72 vs. 66.17±15.26) scores were markedly lower among RR/MDR-TB

patients (p<0.001), indicating greater overall impairment associated with drug resistance (Araia *et al*., 2021).

The present study demonstrated significant improvement in quality-of-life domains among DR-TB patients following structured follow-up and supportive care. Physical health improved by 5.00±1.05 at the first follow-up and 11.94±1.09 at the second follow-up, while psychological, social, and environmental domains showed sustained improvements of 7.38±1.12, 4.65±0.82, and 10.87±1.96, respectively (p<0.001). These findings highlight the positive impact of regular monitoring and comprehensive care on patient well-being. In contrast *Wang et al.* reported significantly lower quality-of-life scores among DR-TB patients compared with the China standing model. Physiological, psychological, social, and environmental scores were markedly reduced (p<0.001), indicating substantial impairment associated with drug-resistant tuberculosis. Overall, while previous studies emphasize poor baseline quality of life in DR-TB patients, the present findings demonstrate that targeted follow-up, continuous support, and psychosocial care can lead to meaningful improvement in health outcomes and quality of life (Wang *et al*., 2024).

The present study demonstrated significant improvement across all quality-of-life domains following structured follow-up and supportive interventions. From baseline to second follow-up, physical, psychological, social, and environmental health improved by 11.94±1.09, 7.38±1.12, 4.65±0.82, and 10.87±1.96, respectively (p<0.001). These results indicate that although quality of life is often impaired at the onset of treatment, regular monitoring and comprehensive care can result in substantial improvement across multiple domains. In contrast, *Tushar et al.* reported low baseline quality-of-life scores, with mean values of 41.88±12.30 for physical, 33.41±17.08 for psychological, 35.52±20.83 for social, and 41.27±17.32 for environmental domains. The presence of minimum scores of zero in several domains reflects marked variability and severe impairment in a subset of patients, particularly in psychological and social functioning. while previous findings highlight compromised baseline quality of life among DR-TB patients, the present study provides evidence that targeted interventions and continuous follow-up can lead to meaningful improvement in physical, psychological, social, and environmental well-being. These observations emphasize the need for integrated, sustained, and patient-centred care strategies to enhance long-term outcomes in DR-TB management (Sahasrabudhe and Nilgiri, 2024).

Limited studies have evaluated pharmaceutical care among all categories of DR-TB patients. In the present study, all active DR-TB patients undergoing treatment were included, allowing a comprehensive assessment of the challenges experienced during therapy. Various patient-related difficulties, such as medication adherence issues, adverse drug reactions, and psychosocial stress, were identified. Pharmacist-led counselling and follow-up were provided to address these challenges through patient education,

Table 7: Bonferroni Post-hoc Pairwise Comparisons of WHOQOL-BREF Domain Scores.

Domain	Comparison	Mean Difference	Std. Error	95% Confidence Interval	*p*-value (Bonferroni)
Physical health	Baseline vs First follow-up	-5.01	0.09	-5.23 to -4.79	<0.001
	Baseline vs Second follow-up	-11.95	0.10	-12.18 to -11.72	<0.001
	First vs Second follow-up	-6.94	0.03	-7.01 to -6.87	<0.001
Psychological health	Baseline vs First follow-up	-1.43	0.10	-1.68 to -1.18	<0.001
	Baseline vs Second follow-up	-7.38	0.10	-7.62 to -7.15	<0.001
	First vs Second follow-up	-5.96	0.02	-6.00 to -5.91	<0.001
Social health	Baseline vs First follow-up	-1.75	0.07	-1.92 to -1.58	<0.001
	Baseline vs Second follow-up	-4.65	0.07	-4.83 to -4.48	<0.001
	First vs Second follow-up	-2.90	0.03	-2.97 to -2.84	<0.001
Environmental health	Baseline vs First follow-up	-2.87	0.17	-3.29 to -2.47	<0.001
	Baseline vs Second follow-up	-10.87	0.22	-11.35 to -10.29	<0.001
	First vs Second follow-up	-7.94	0.16	-8.32 to -7.56	<0.001

Table 8: Clinically Meaningful Improvement (WHOQOL-BREF).

Domain	Baseline Mean±SD	2nd Follow-up Mean±SD	Mean Change	MCID (0.5 SD)
Physical Health	16.88±3.24	28.83±3.52	+11.95	1.62
Psychological Health	16.31±2.41	23.69±2.94	+7.38	1.21
Social Health	7.56±1.32	12.21±1.60	+4.65	0.66
Environmental Health	21.78±3.08	32.60±4.60	+10.82	1.54

medication guidance, and supportive monitoring. This approach contributed to improving the overall Health-Related Quality

of Life among DR-TB patients. Although the present study did not include a control group, the findings still indicate that pharmacist-led counselling, along with the support of other healthcare professionals, may contribute to improvements in HRQoL among DR-TB patients.

CONCLUSION

The present study demonstrates that structured follow-up and supportive interventions significantly enhance the quality of life of DR-TB patients across physical, psychological, social, and environmental domains. The consistent improvements observed during follow-up suggest that although patients initially experience compromised well-being, regular monitoring and comprehensive care can promote substantial recovery and overall health improvement.

Furthermore, the findings emphasize the importance of a multidisciplinary approach in DR-TB management, particularly in improving Health-Related Quality of Life (HRQoL). In collaboration with physicians, clinical pharmacists play a key role in optimizing treatment through comprehensive pharmaceutical care. Their involvement in medication therapy management, early identification and management of adverse drug reactions, promotion of adherence, prevention of drug-drug interactions, and delivery of personalized counselling contributes significantly to improved therapeutic outcomes. These interventions also help reduce treatment-related distress, physical discomfort, and functional limitations, thereby positively influencing patients' physical and psychological well-being.

Overall, this study highlights the need to integrate structured follow-up, psychosocial support, and pharmaceutical care into routine DR-TB treatment programs. A coordinated, patient-centred care model is essential for enhancing treatment effectiveness, improving quality of life, and achieving sustainable long-term health outcomes in patients with drug-resistant tuberculosis.

LIMITATIONS

This study has several limitations. The absence of a control group restricts the ability to attribute the observed improvements solely to the pharmaceutical counselling intervention, as other factors such as ongoing treatment or natural recovery may have influenced the outcomes. The study was conducted in selected centres within a single district, which may limit the generalizability of the findings to other settings. Blinding was not feasible because the intervention was directly provided to all participants, which may introduce response or observer bias. In addition, the use of consecutive sampling may have resulted in selection bias. Participants' awareness of being monitored could also have influenced their responses during follow-up assessments (Hawthorne effect). These factors should be considered when interpreting the study findings.

ABBREVIATIONS

DR-TB: Drug-Resistant Tuberculosis; **HRQoL:** Health-Related Quality of Life; **QoL:** Quality of Life; **WHOQOL-BREF:** World Health Organization Quality of Life-BREF Questionnaire; **WHO:** World Health Organization; **MDR-TB:** Multidrug-Resistant Tuberculosis; **RR-TB:** Rifampicin-Resistant Tuberculosis; **MDR/RR-TB:** Multidrug-Resistant or Rifampicin-Resistant Tuberculosis; **pre-XDR-TB:** Pre-Extensively Drug-Resistant Tuberculosis; **XDR-TB:** Extensively Drug-Resistant Tuberculosis; **NTEP:** National Tuberculosis Elimination Programme; **PHC:** Primary Health Centre; **HIV:** Human Immunodeficiency Virus; **ANOVA:** Analysis of Variance; **MCID:** Minimal Clinically Important Difference.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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