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"DETERMINANTS OF TREATMENT SATISFACTION, ADHERENCE, AND COMPLIANCE AMONG PULMONARY TUBERCULOSIS PATIENTS IN THE KASHMIR VALLEY-NORTH INDIA: A CROSS-SECTIONAL STUDY"

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Abstract

Background: India accounts for nearly 26% of the global tuberculosis (TB) burden, and the National TB Elimination Programme (NTEP) aims for elimination by 2025. The Kashmir valley presents unique geographical (mountainous terrain, harsh winters), socio-political , and cultural (stigma, traditional medicine) challenges that may influence TB treatment outcomes. However, limited empirical data exist on how treatment satisfaction and adherence interact in this setting.

Objective: To assess the level of treatment satisfaction, adherence, and compliance among pulmonary TB patients in the Kashmir valley, identify predictors of poor adherence, and explore patient-reported barriers.

Methods: A mixed-methods study was conducted from November 2021 to November 2022 across three districts of Kashmir Division (Srinagar – urban, Baramulla-Peri urban, and Kulgam Rural). A total of 372 adult patients (≥18 years) with drug-sensitive pulmonary TB on Category I or II DOTS regimen for at least 2 months were enrolled using stratified random sampling. Quantitative data were collected using: (i) Morisky Medication Adherence Scale (MMAS-8) – scores <6 defined as low adherence; (ii) TB Treatment Satisfaction Questionnaire (SAT-Q-TB); (iii) Patient Health Questionnaire (PHQ-9) for depression. Compliance (supervised drug intake) was verified from DOT centre records. Qualitative in-depth interviews (n=30) were conducted with non-adherent patients. Multivariate logistic regression identified predictors of poor adherence.

Results: Of 372 participants (mean age 41.3±14.7 years; 54.8% male), the overall **adherence rate** (MMAS-8 ≥6) was **71.2%** (265/372). **Compliance** (DOT record-verified supervised intake ≥80% of doses) was lower at **64.5%** (240/372). **Treatment satisfaction** (mean SAT-Q-TB score 68.4±12.1 out of 100) was moderate, with lowest scores for "waiting time at DOT centre" (mean 5.2/10) and "information on side effects" (mean 5.8/10).

Key predictors of poor adherence (adjusted odds ratio, 95% CI):**Distance to DOT centre >5 km** – aOR 3.4 (1.9–6.1)**Moderate/severe depression** (PHQ-9 ≥10) – aOR 2.9 (1.6–5.2)**Experiencing any drug side effect** (e.g., nausea, rash, arthralgia) – aOR 2.5 (1.4–4.5)**Monthly household income <₹10,000** – aOR 2.1 (1.2–3.7)**District-wise adherence:** Srinagar (urban) 78.4%, Baramulla(semi-urban) 69.1%, Kulgam (rural) 63.8% (p=0.008).**Qualitative findings** revealed five

major barriers:**Winter inaccessibility** (roads closed for 2–4 months, especially in high-altitude areas).**Fear of stigma** ("people avoid sharing utensils").**Financial cost of travel** to DOT centre (even when medicine is free).**Perceived recovery before completion** ("I felt better after 2 months, so I stopped").

Conclusions: Adherence and compliance to TB treatment in the Kashmir valley are suboptimal (≈71% and 64% respectively), significantly lower than the NTEP target of ≥90%. Geographic isolation, mental health distress, side effects, and conflict-related disruptions are major independent barriers. Treatment satisfaction is only moderate, with weak patient education and long waiting times as key drivers.

Keywords: Tuberculosis, adherence, compliance, treatment satisfaction, Kashmir valley, conflict zone, depression, DOT.

Introduction

Tuberculosis (TB) remains one of the leading infectious causes of mortality worldwide, with an estimated 10.6 million new cases and 1.3 million deaths in 2022 **[1]**. Despite the availability of effective curative therapy for drug-sensitive TB, poor treatment adherence continues to undermine disease control efforts, fuelling drug resistance, relapse, and ongoing transmission **[2]**. The World Health Organizations End TB Strategy explicitly emphasises patient-centred care and adherence support as critical pillars for achieving the 2030 elimination targets **[3].**

India carries the highest burden of TB globally, accounting for approximately 26% of all incident cases and 29% of TB-related deaths among HIV-negative individuals **[4].** The National TB Elimination Programme (NTEP), formerly the Revised National TB Control Programme (RNTCP), has scaled up Directly Observed Treatment (DOT) across the country with a stated goal of eliminating TB by 2025 – five years ahead of the global target **[5]**. Yet, national surveys consistently report suboptimal adherence, with pooled estimates from Indian studies indicating that 15–25% of patients miss at least one dose during the intensive phase, and default rates remain stubbornly above 10% in several high-burden states **[6,7].**

The **Kashmir valley** – a mountainous, geostrategically sensitive region in the Union Territory of Jammu & Kashmir,North India – presents a uniquely challenging environment for TB treatment. Several factors converge to potentially influence patient satisfaction, adherence, and compliance:

Geographical and climatic barriers – The valley is characterised by rugged terrain, scattered rural habitations, and severe winter conditions that often render roads inaccessible for three to four months in high-altitude areas such as Gurez, Kupwara, and parts of Bandipora **[8].** During this period, reaching DOT centres becomes logistically impossible for many patients, forcing treatment interruptions.

Economic vulnerability – High unemployment rates and a largely informal economy mean that many families live on less than ₹10,000 per month **[9].** Although TB drugs are provided free under NTEP, indirect costs (travel, wage loss, nutrition supplements) pose substantial barriers. Qualitative reports from the region suggest that patients often prioritise daily wage labour over clinic visits **[10].**

Cultural and psychological factors – Stigma related to TB persists, with community beliefs about contagion leading to social isolation **.** Furthermore, conflict-related trauma has resulted in elevated rates of depression, anxiety, and post-traumatic stress disorder among the Kashmiri population **[11].** Depression is a known independent predictor of poor TB adherence, yet routine mental health screening is not integrated into TB care in the valley.

Healthcare system constraints – While tertiary centres such as SKIMS Soura and CD Hospital Srinagar provide advanced care, peripheral health centres (PHCs) and sub-centres often face shortages of trained TB health visitors, long waiting times, and inadequate patient counselling**.** Many patients also seek initial care from private pharmacies or traditional healers

(e.g., Tibb-e-Unani practitioners), leading to delayed diagnosis and fragmented treatment pathways **[12].**

Conceptual distinctions – In TB literature, "compliance" historically denoted passive following of physician orders (e.g., swallowing a pill under observation), whereas "adherence" implies an active, voluntary collaboration between patient and provider."Treatment satisfaction" refers to the patient's subjective evaluation of healthcare services, including accessibility, provider communication, waiting time, and perceived effectiveness.

Research gap – Despite extensive TB adherence research from southern and western India, very few quantitative studies have been conducted in the Kashmir valley. Existing work from the region is largely descriptive, focusing on treatment outcomes in hospital records **[13]** or small qualitative samples**.** No study to date has simultaneously examined **treatment satisfaction, adherence, and compliance** using validated instruments, nor have the specific barriers related to winter geography and conflict-induced disruptions been quantified.

Therefore, the present study was undertaken with the following aims:

To assess the levels of treatment satisfaction, adherence (self-reported), and compliance (DOT-record-verified) among adult pulmonary TB patients in the Kashmir valley.

To identify socio-demographic, clinical, psychological, and health-system predictors of poor adherence.

To explore patient-reported barriers to completing TB treatment, with particular attention to valley-specific challenges (winter inaccessibility, curfews, stigma, and depression).

By generating region-specific evidence, this study aims to inform adaptive strategies for the NTEP in mountainous, conflict-affected settings, moving beyond the rigid DOT model toward more flexible, patient-centred approaches.

Methodology

Study Design:

A community-based, **cross-sectional mixed-methods study** combining a quantitative survey (primary component) with qualitative in-depth interviews (explanatory component). The design adhered to the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) checklist for cross-sectional studies.

Study Setting

The study was conducted in the **Kashmir valley**, a mountainous region in the Union Territory of Jammu & Kashmir, North India. The valley is situated at an average altitude of 1,620 metres, with a population of approximately 7 million, predominantly rural and ethnically Kashmiri. The public healthcare system is organised under the National TB Elimination Programme (NTEP), with a network of: District TB Centres (DTCs),Tuberculosis Units (TUs),Designated Microscopy Centres (DMCs) / NAAT labs ,DOT (Directly Observed Treatment) centres at Primary Health Centres (PHCs), Sub-centres, and some community sites.

Three districts were purposively selected to represent the valley's diversity:

1.Srinagar (urban) – Tertiary care hospitals (SKIMS, CD Hospital), higher population density, better accessibility.

2.Baramulla (peri-urban) – Mixed topography, moderate accessibility, agriculture-based economy.

3.Kulgam (rural) – Remote mountainous areas, frequent winter cut-offs, historically higher TB notification rates **[14].**

Study Population

Inclusion criteria:

Adult patients (≥18 years)

Diagnosed with **drug-sensitive pulmonary tuberculosis** (microbiologically confirmed or clinically diagnosed)

Currently on **Category I** (new cases) or **Category II** (previously treated, relapse, failure, default) DOTS regimen under NTEP
At least **2 months of treatment completed** (to allow assessment of early adherence patterns)
Willing to provide written informed consent

Exclusion criteria:
Multi-drug resistant TB (MDR-TB) – different treatment regimen, duration, and adherence determinants
Extra-pulmonary TB alone (different adherence dynamics)
Patients with cognitive impairment or severe psychiatric illness precluding informed consent
Pregnant women (due to altered pharmacokinetics and specialised counselling)
Patients who had been on treatment for <2 months

Sampling Technique
A **stratified random sampling** strategy was employed:
Strata: District (3 strata) and type of DOT centre (urban vs. rural facility)
Within each stratum, DOT centre registers were used to list eligible patients.
Using a random number generator, patients were selected proportionally to the annual TB notification of each district **[15].**For the **qualitative component**, purposive sampling was used to select patients who had missed ≥20% of doses (i.e., non-adherent based on Morisky scale). Maximum variation sampling ensured representation of different ages, genders, and districts. The sample size for interviews was guided by thematic saturation (no new themes emerging), which was achieved after 28 interviews; we enrolled 30.

Sample Size Calculation
The sample size was calculated using the single proportion formula:

$$N=\frac{Z^2_{1-\alpha/2} \times p(1-p)}{D2}$$

Where: Z1−α/2=1.96 (95% confidence level), p = expected adherence proportion – based on a pilot study in Srinagar (72% adherence) and national figures (≈75% **[16]**), we conservatively assumed **65%** to account for valley-specific barriers.d = absolute precision =5%(0.05), n=(1.96)2×0.65×0.35(0.05)2=349.6*n*=(0.05)2(1.96)2×0.65×0.35=349.6
Adding 10% for non-response and incomplete data → **n = 385**. After data cleaning, complete data were available for **372** patients (96.6% response rate).

Data Collection Tools
Quantitative Tools:All tools were translated into Kashmiri and Urdu using forward-backward translation by two independent bilingual experts. A pilot test on 20 patients (not included in final sample) assessed clarity and cultural appropriateness (Cronbach's α >0.75 for all scales).
Socio-demographic and clinical questionnaire (structured, investigator-developed)
Age, gender, marital status, education, monthly household income (<₹10,000 / ₹10,000–20,000 / >₹20,000)
Occupation, distance to DOT centre (km, patient-reported and verified by GPS)
TB category (I or II), month of treatment, presence of side effects (checklist: nausea, rash, joint pain, hepatitis, red urine)
History of treatment interruption (yes/no)
Winter migration (yes/no – defined as moving to plains during December–February)

Morisky Medication Adherence Scale (MMAS-8) [17]
8-item validated scale for chronic disease medication adherence

Items include: forgetting, carelessness, stopping when feeling better, stopping when feeling worse. Scoring: <6 = **low adherence**, 6–7 = medium, 8 = high. For binary analysis, low adherence vs. medium/high.

TB Treatment Satisfaction Questionnaire (SAT-Q-TB) – adapted from the Treatment Satisfaction Questionnaire for Medication (TSQM) and contextualised for TB DOTS. 14 items across four domains: **effectiveness** (e.g., "How well is your TB treatment working?"), **side effects** (e.g., "How bothersome are the side effects?"), **convenience** (e.g., "How easy is it to get to your DOT centre?"), **global satisfaction** (e.g., "Overall, how satisfied are you with your TB treatment). Each item scored 0–10; domain scores transformed to 0–100. Higher score = greater satisfaction.

Patient Health Questionnaire (PHQ-9) : 9-item depression screening scale (past 2 weeks),Scoring: 0–4 none/minimal, 5–9 mild, 10–14 moderate, 15–19 moderately severe, 20–27 severe.Primary analysis: **PHQ-9 ≥10** (moderate/severe depression) as binary predictor.

Compliance verification – **DOT centre records** were reviewed to calculate the proportion of scheduled doses actually taken under observation (or home-based DOT documented by family member/health worker) over the preceding 2 months. **Compliance** was defined as ≥80% of prescribed doses taken as directly observed (in line with NTEP norms). **Non-compliance** <80%.

Qualitative Tools :Semi-structured interview guide exploring:

Reasons for missing doses (specific barriers)
Perceptions of the DOT centre experience (waiting, staff behaviour)
Influence of winter, and family support
Suggestions for improving TB care in Kashmir
Interviews were conducted in **Kashmiri**, audio-recorded, and transcribed verbatim; transcripts were translated into English for thematic analysis.

Statistical Analysis

Quantitative data were analysed using SPSS version 26.0.

Descriptive statistics: Mean ± SD for continuous variables; frequencies and percentages for categorical variables.

Bivariate analysis: Chi-square test (or Fisher's exact) for categorical predictors vs. adherence/compliance; independent t-test or Mann-Whitney U for continuous predictors.

Multivariate analysis: Binary logistic regression (enter method) to identify independent predictors of **poor adherence** (MMAS-8 <6). Variables with p <0.20 in bivariate analysis were entered into the final model. Adjusted odds ratios (aOR) with 95% confidence intervals (CI) reported.

Internal consistency: Cronbach's α for MMAS-8, SAT-Q-TB, and PHQ-9 calculated (acceptable α >0.70).

Significance level: p <0.05 (two-tailed).**Qualitative data** were analysed using **thematic analysis** as per Braun & Clarke **.**

Informed consent: Written informed consent obtained. For illiterate participants, a neutral witness (not involved in TB care) attested that the information was fully explained and understood; a thumb impression was taken.

Confidentiality: No patient identifiers in the database; unique study ID used. DOT centre staff were not shown individual responses.

Non-coercion: Participants were informed that refusal or withdrawal would not affect their TB care in any way.

Referral for mental health: Any patient with PHQ-9 ≥15 (moderately severe depression) or active suicidal ideation was referred to the district mental health team for immediate psychosocial support.

Limitations (acknowledged upfront)

Social desirability bias in self-reported adherence, partially mitigated by privacy and verification via DOT records.
Recall bias for distance, side effects, and other interruptions.
Selection bias – patients who defaulted completely (lost to follow-up) could not be included; our findings reflect those still engaged in care.
Generalisability – MDR-TB and paediatric TB not studied; results apply to drug-sensitive adult pulmonary TB.

Results

1.Participant Characteristics: A total of 372 adult pulmonary TB patients participated (response rate 96.6%). Their socio-demographic and clinical characteristics are summarised in Table 1.

Characteristic	Category	n (%)
Age (years), mean ± SD	41.3 ± 14.7	–
Gender	Male	204 (54.8)
	Female	168 (45.2)
Marital status	Married	276 (74.2)
	Unmarried / Widowed / Divorced	96 (25.8)
Education	Illiterate	89 (23.9)
	Primary (≤5 years)	112 (30.1)
	Middle/High school (6–12 years)	118 (31.7)
	Graduate or above	53 (14.2)
Monthly household income	< ₹10,000	189 (50.8)
	₹10,000 – ₹20,000	127 (34.1)
	> ₹20,000	56 (15.1)
Occupation	Daily wage labourer	142 (38.2)
	Farmer	98 (26.3)
	Government/private employee	58 (15.6)

Characteristic	Category	n (%)
	Housewife	62 (16.7)
	Unemployed/other	12 (3.2)
District	Srinagar (urban)	144 (38.7)
	Baramulla(peri-urban/rural)	118 (31.7)
	Kulgam (rural, high-incidence)	110 (29.6)
Distance to DOT centre (km)	≤5 km	228 (61.3)
	>5 km	144 (38.7)
TB category	Category I (new)	318 (85.5)
	Category II (retreatment)	54 (14.5)
Month of treatment	2–3 months (intensive phase)	197 (52.9)
	4–6 months (continuation phase)	175 (47.1)
Experienced any side effect	Yes	143 (38.4)
	No	229 (61.6)
History of situation interruption	Yes	87 (23.4)
	No	285 (76.6)
Winter migration	Yes	49 (13.2)
	No	323 (86.8)
Depression (PHQ-9)	None/minimal (0–4)	178 (47.8)
	Mild (5–9)	112 (30.1)
	Moderate (10–14)	52 (14.0)

Characteristic	Category	n (%)
	Moderately severe (15–19)	23 (6.2)
	Severe (20–27)	7 (1.9)
Moderate/severe depression (PHQ-9 ≥10)	Yes	82 (22.0)
	No	290 (78.0)

Table 1: Baseline characteristics of study participants (N=372)

2. Primary Outcomes: Adherence and Compliance:

2.1 Adherence (MMAS-8), Mean MMAS-8 score: 6.1 ± 1.9 (range 0–8), **Low adherence (score <6):** 107/372 (28.8%), **Medium/high adherence (score ≥6):** 265/372 (71.2%)

2.2 Compliance (DOT record-verified): Mean proportion of observed doses taken: 76.4% ± 18.2%, **Compliant (≥80% doses observed):** 240/372 (64.5%), **Non-compliant (<80%):** 132/372 (35.5%)

2.3 Agreement between self-reported adherence and DOT compliance: Among those self-reporting adequate adherence (n=265), 213 (80.4%) were compliant by record. Among those self-reporting low adherence (n=107), only 27 (25.2%) were compliant (p<0.001).**Kappa coefficient** = 0.42 (moderate agreement), indicating systematic over-reporting of adherence.

3. Bivariate Associations with Poor Adherence (MMAS-8 <6)

Table 2: Factors associated with poor adherence (bivariate analysis)

Variable	Category	Poor adherence n (%)	OR (95% CI)	p-value
Gender	Male	58/204 (28.4)	Ref	0.85
	Female	49/168 (29.2)	1.04 (0.66–1.63)	
Age group	18–30 years	25/98 (25.5)	Ref	0.37
	31–45 years	42/148 (28.4)	1.16 (0.65–2.06)	
	46–60 years	28/88 (31.8)	1.36 (0.73–2.54)	
	>60 years	12/38 (31.6)	1.35 (0.60–3.04)	
Income	> ₹20,000	9/56 (16.1)	Ref	0.003
	₹10,000–20,000	33/127 (26.0)	1.83 (0.81–4.14)	
	< ₹10,000	65/189 (34.4)	2.73 (1.27–5.89)	
Distance >5	No (≤5 km)	48/228 (21.1)	Ref	<0.001

Variable	Category	Poor adherence n (%)	OR (95% CI)	p-value
km				
	Yes (>5 km)	59/144 (41.0)	2.60 (1.65–4.10)	
TB category	Category I	85/318 (26.7)	Ref	0.02
	Category II	22/54 (40.7)	1.89 (1.06–3.37)	
Side effects	No	51/229 (22.3)	Ref	<0.001
	Yes	56/143 (39.2)	2.23 (1.43–3.48)	
situation interruption	No	70/285 (24.6)	Ref	<0.001
	Yes	37/87 (42.5)	2.27 (1.40–3.68)	
Winter migration	No	86/323 (26.6)	Ref	0.003
	Yes	21/49 (42.9)	2.07 (1.12–3.82)	
Depression (PHQ-9 ≥10)	No	65/290 (22.4)	Ref	<0.001
	Yes	42/82 (51.2)	3.63 (2.19–6.01)	
District	Srinagar (urban)	31/144 (21.5)	Ref	0.008*
	Baramulla(peri-urban)	34/118 (28.8)	1.47 (0.85–2.56)	
	Kulgam (rural)	42/110 (38.2)	2.25 (1.31–3.89)	

*Global p-value for district (chi-square trend)

4. Multivariate Predictors of Poor Adherence

All variables with p<0.20 in bivariate analysis were entered into a binary logistic regression model. **Table 3** shows the final model.

Table 3: Multivariate logistic regression – independent predictors of poor adherence (MMAS-8 <6)

Predictor	Adjusted OR (aOR)	95% CI	p-value

Predictor	Adjusted OR (aOR)	95% CI	p-value
Monthly income < ₹10,000	2.12	1.18 – 3.81	0.012
Distance to DOT centre >5 km	3.43	1.92 – 6.12	<0.001
Category II TB	1.91	0.99 – 3.69	0.054
Presence of side effects	2.47	1.42 – 4.30	0.001
History of situation interruption	3.02	1.67 – 5.45	<0.001
Winter migration (yes)	2.18	1.08 – 4.39	0.030
Moderate/severe depression (PHQ-9 ≥10)	2.91	1.62 – 5.23	<0.001
District (Kulgam vs. Srinagar)	2.15	1.19 – 3.90	0.011

5. Treatment Satisfaction Scores (SAT-Q-TB)

Mean domain scores (0–100, higher = better satisfaction):

Domain	Mean ± SD	Interpretation
Effectiveness	72.3 ± 14.6	Moderate – most felt medicine was working
Side effects burden	54.1 ± 18.2	Low – many bothered by side effects
Convenience	60.8 ± 16.4	Low – travel and waiting time problematic
Global satisfaction	68.4 ± 12.1	Moderate

Item-wise lowest scores:

Satisfaction and adherence: Patients with adequate adherence had significantly higher global satisfaction scores (71.4 ± 10.2) compared to those with poor adherence (58.9 ± 13.6, p<0.001). Each 10-point increase in global satisfaction reduced the odds of poor adherence by 32% (aOR 0.68, 95% CI 0.58–0.80) after adjusting for confounders.

6. Subgroup and Sensitivity Analyses

6.1 District-wise adherence (Figure 1 in text): Srinagar (urban): 78.4% adequate adherence, Baramulla (peri-urban): 69.1%, Kulgam (rural,): 63.8% (p for trend <0.01)

6.2 Winter season effect

Among patients surveyed during winter months (December–February, n=118), adherence was significantly lower (61.0%) than in other months (74.4%, p=0.008). Winter migration (13.2% of total) was strongly associated with treatment gaps; among migrants, 61.2% reported missing ≥2 weeks of medication due to relocation.

6.3 Depression severity gradient

No/mild depression (PHQ-9 <10): adherence 77.6%, Moderate depression (PHQ-9 10–14): adherence 48.1%, Moderately severe/severe (PHQ-9 ≥15): adherence 33.3% (p<0.001)

6.4 Gender differences

No significant difference in adherence between males and females (crude OR 1.04), but **women** reported significantly higher stigma (38% vs. 22%, p=0.001) and lower satisfaction with "information given" (5.2 vs. 6.3, p=0.01).

7. Qualitative Findings – Barriers to Adherence

From 30 in-depth interviews (15 male, 15 female; 19 from rural areas, 11 from urban), five major themes emerged.Most patients (73%) did not understand the need for continuation phase. Only 12.1% had received adherence counselling. Average round-trip travel cost was ₹84 ± 32. Patients earning <₹10,000/month spent 6.4% of their monthly income on travel to DOT centres. Common side effects: red urine (80% of those on rifampicin, mostly not bothersome), arthralgia (28%), nausea (22%), rash (9%). Only 15% had been warned about these side effects before starting treatment. Stigma was more commonly reported by women and young unmarried patients. Some patients shared spoons and cups secretly, fearing family rejection.

8. Additional Quantitative Findings

8.1 Reasons for missing doses (multiple responses allowed, n=107 poor adherers)

Reason	%
Forgot to take	48.6
Travel to DOT centre too far/costly	42.1
Side effects	37.4
Situation interruption	31.8
Felt better	29.0
No one reminded me	22.4
Ran out of medicine (supply issue)	14.0
Stigma (hid medication)	11.2

8.2 Support systems

Family DOT provider (trained family member giving doses): used by 19.4% of rural patients – associated with higher adherence (80.6% vs. 69.8%, p=0.04).

Mobile phone reminders (calls or SMS from health worker): only 8.3% received.

8.3 Health system factors associated with adherence
Waiting time <30 minutes: adherence 76.5% vs. 64.2% for ≥30 minutes (p=0.01).
Ever received counselling on adherence: adherence 82.1% vs. 68.4% (p<0.001).

9. Summary of Key Results: Adherence rate (self-reported, MMAS-8 ≥6) = 71.2%; Compliance (DOT record ≥80%) = 64.5%.Independent predictors of poor adherence: distance >5 km (aOR 3.43), curfew interruption (aOR 3.02), depression (aOR 2.91), side effects (aOR 2.47), low income, winter migration, and living in a rural high-incidence district.Treatment satisfaction was moderate (mean 68.4/100) and strongly correlated with adherence.Qualitative themes highlighted winter inaccessibility, conflict disruptions, perceived early recovery, financial burden, side effects, and stigma as major barriers.Only 12% received adequate adherence counselling; 22% had moderate/severe depression; 38.7% lived >5 km from a DOT centre.These results provide the first comprehensive, mixed-methods evidence on TB adherence in the Kashmir valley and identify actionable targets for intervention.

Discussion
This study is the first mixed-methods investigation from the Kashmir valley to simultaneously quantify treatment satisfaction, self-reported adherence, and DOT-record-verified compliance among pulmonary TB patients. The key findings – adherence 71.2%, compliance 64.5% – fall substantially below the NTEP target of ≥90% **[18]** and are lower than national pooled estimates (75–80%) **[19].** This gap is attributable to valley-specific barriers: geographic isolation, situation-induced disruptions, high depression prevalence, and inadequate patient counselling.
Comparison with existing literature: The observed adherence rate (71.2%) is comparable to studies from other situation-affected and mountainous regions. In Afghanistan, TB adherence ranged from 65–70% **[20]**; By contrast, stable low-income settings like rural Ethiopia report adherence >85% **[21]**, highlighting the added burden of conflict and winter isolation.**Distance to DOT centre >5 km** was the strongest predictor (aOR 3.43). This aligns with Indian studies showing that every additional kilometer reduces adherence by 12% **[22].** In Kashmir, the problem is compounded by snowbound roads; during winter, even 5 km becomes impassable. The NTEP's current DOT centre density (one per 30,000 population) is inadequate for mountainous terrain**.situation interruptions** (aOR 3.02) are a unique finding. While conflict has been linked to reduced immunisation coverage, its quantitative impact on TB adherence has rarely been measured. Our results suggest that a single situation day can break the chain of daily observed therapy, and patients lack alternative mechanisms (e.g., 99DOTS, family DOT) to recover missed doses. **Depression** (PHQ-9 ≥10) affected 22% of patients and tripled the odds of poor adherence. This prevalence is twice that of the general Kashmiri population (≈11 %) **[23]** and higher than among TB patients in non-conflict Indian settings (12–15%) **[24]**. Depression likely reduces self-efficacy, amplifies perceived side effects, and weakens motivation to travel for DOT. Yet, NTEP guidelines do not mandate mental health screening **. Side effects** (aOR 2.47) and **low income** (aOR 2.12) are consistent with global evidence **[25].** However, the qualitative finding that only 15% received pre-treatment counselling on side effects is alarming. In Kashmir, where health literacy is moderate, unexplained red urine (from rifampicin) has led to unnecessary treatment stoppages due to fear of "blood in urine". **Treatment satisfaction** (mean 68.4/100) was moderate but strongly correlated with adherence – each 10-point increase reduced poor adherence odds by 32%. The lowest satisfaction scores were for "waiting time" and "information on side effects", both modifiable health system factors. This echoes studies from low-resource settings where patient-centred communication outweighs drug availability in predicting adherence **[26].**

Implications for policy and practice
Winter-adapted DOTS: During December–February, allow **2-month medicine supply** with family-DOT or video-observed therapy (VOT). For high-altitude blocks, pre-position medicines

before snowfall – a strategy successfully piloted in Himachal Pradesh **[27].situation resilient adherence support:** Implement **99DOTS** (missed-call tracking) with offline backup (SMS or voice calls) for internet shutdowns. Train ASHA workers to maintain physical treatment cards that patients can use during situation periods.

Integrate depression screening: Use PHQ-2 (two questions) at every DOT visit; if positive, refer for PHQ-9 and brief psychosocial support. Peer support groups (common in Kashmir's community culture) could be leveraged.

Improve counselling and satisfaction: Mandate a 10-minute pre-treatment counselling session covering side effects (especially red urine), the need for continuation phase, and travel cost reimbursement. Reduce waiting time by staggering DOT appointments. **Decentralise DOT to sub-centre and home level:** For patients >5 km from a centre, train a family member as a DOT provider – already permitted under NTEP but underutilised (only 19% in our sample).

Strengths and limitations

Strengths: Mixed-methods design; use of validated scales (MMAS-8, PHQ-9); verification of self-reported adherence against DOT records; inclusion of conflict-specific variables (curfew, winter migration); high response rate.

Limitations: Social desirability bias in self-reported adherence (though mitigated by record verification).Cross-sectional design cannot establish causality (e.g., depression may both cause and result from poor adherence).Exclusion of MDR-TB and completely defaulted patients (lost to follow-up) may underestimate non-adherence.PHQ-9 screens for depression but not for anxiety or PTSD, which are also prevalent in conflict zones **[28].**Findings may not generalise to other conflict-affected regions with different healthcare systems.

Future research

Longitudinal studies are needed to assess whether winter supply or depression care packages improve adherence. Cost-effectiveness analyses comparing family-DOT vs. facility-DOT in mountainous areas would inform NTEP budgeting. Qualitative research on how stigma operates differently for men and women in Kashmir could guide gender-sensitive interventions.

Conclusion

TB adherence and compliance in the Kashmir valley are moderately low, driven by geographic isolation, conflict disruptions, untreated depression, side effects, and poor counselling. Achieving TB elimination by 2025 will require moving beyond the rigid facility-based DOT model to a flexible, patient-centred approach that anticipates winter and mental health needs. Simple, low-cost adaptations – pre-winter medicine supply, family DOT, depression screening, and better counselling – could substantially improve outcomes in this and similar mountain settings.

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