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Health Literacy and Tuberculosis: Insights from a Cross-Sectional Study in Gujarat, India

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Abstract

Background: Tuberculosis (TB) remains a significant public health concern, with India accounting for a substantial portion of the global TB burden. Effective disease management relies on patient adherence to treatment protocols and active engagement in healthcare processes. Health literacy, the ability to acquire, comprehend, and utilize health-related information, is a crucial factor in disease management and outcomes. However, the health literacy levels among TB patients in India have not been extensively studied and thus, this research aims to assess this among TB patients in Gujarat, India.

Method: A cross-sectional study was conducted amongst 393 primary care patients with active TB, using a Health Literacy Instrument for Adults (HELIA) tool that was adapted and validated in the local language. Data was analyzed using SPSS 17.0, with statistical significance taken as $p < 0.05$.

Result: The findings revealed that 67.1% of TB patients had limited health literacy, particularly among those with lower educational levels and unemployed. Higher health literacy was associated with better treatment adherence (OR=4.69, 95% CI:3.2-7.79), while patients with chronic conditions exhibited lower health literacy (OR=4.8, 95% CI: 1.23-9.8). Although TB patients demonstrated higher health literacy in the decision-making domain, they faced significant challenges in the appraisal domain.

Conclusion: The findings suggest that health literacy may play an important role in the management of TB. Efforts to enhance health literacy could potentially contribute to improved treatment adherence and better overall outcomes.

Background

Despite the availability of effective diagnostics and treatments, Tuberculosis (TB), caused by *Mycobacterium tuberculosis*, remains a leading cause of mortality globally from a single infectious agent.(1) India, as a low- and middle-income country, contributes significantly (one-fourth) to the global TB burden.(2) TB is a chronic condition, necessitating patients to manage various aspects of their healthcare.(3) This includes accessing medical information, navigating the healthcare system, understanding referrals, adhering to treatment plans, remembering drug dosages, attending follow-up visits, and recognizing the risks of poor adherence.(3) These demands underscore the necessity for comprehensive patient education and support to facilitate effective self-management.(4)

Active patient participation in their own care is crucial for chronic disease self-management, requiring an understanding of fundamental health concepts, basic competencies, and motivation.(4) Health literacy—the ability to obtain, comprehend, and use health information—is key to this process.(5) Without adequate health literacy, effective self-management and patient-centered care are challenging.(4) Research shows that higher health literacy improves TB disease understanding and adherence to treatment, leading to better outcomes.(3) However, many TB patients, especially in rural and marginalized communities, face numerous barriers to effective disease management. These include limited access to healthcare facilities, low levels of formal education, language barriers,

stigma, and dependence on informal healthcare providers.(6) In such settings, basic health information may not be available in accessible formats, and follow-up care can be inconsistent. These challenges significantly impact patients' ability to understand their diagnosis, adhere to long treatment regimens, and navigate complex healthcare systems.(4)

Limited health literacy affects not only patient understanding but also their ability to access community support, contributing to health disparities across racial and educational backgrounds.(3) A systematic review by Chauhan and colleagues, covering 22 studies from 12 countries, found that 51.2% of TB patients globally have limited health literacy.(3) There is a dearth of evidence related to health literacy levels among TB patients in India. A study conducted in Karnataka reported, a 54% prevalence of limited functional health literacy (ability to read and write) among TB patients.(7) Health literacy comprises functional, communicative, and critical competencies, facilitating the comprehension, interpretation, and application of health information.(5) Collectively, these dimensions enhance the capacity for informed decision-making, ultimately contributing to improved health outcomes.(4) Given these findings and the lack of comprehensive evidence from India, there is a clear need to assess all aspects of health literacy among TB patients. This assessment could guide targeted interventions to improve health outcomes and reduce TB care disparities. Therefore, this cross-sectional study aims to assess health literacy levels among TB patients in Gujarat, India.

Methods

Study Design and Setting:

A cross-sectional study was conducted among primary care TB patients in Gujarat, India, to assess their health literacy levels, from Jan-June, 2024. Gujarat, situated in western India, has TB indicators that are representative of the national average. (2) Analyzing Gujarat allows for insights into TB management and health literacy that are relevant and generalizable to other regions with similar TB burdens at the national level. (2)

Sampling Strategy and Sample Size:

The study was conducted in Junagadh, a district in Gujarat, India, having lower TB notification rate less than 500 per 1,00,000 population. (2) To ensure an unbiased and representative selection of participants, a simple random sampling (SRS) approach was used. A line list of patients registered with the National TB Elimination Program (NTEP) in the six months preceding the study was obtained from the district TB center. Each patient on this list was assigned a unique identification number, and a computer-generated randomization process was used to select participants. To address potential non-response bias, several measures were taken. If a selected patient was unavailable or declined participation, a replacement was drawn from the same randomized list to maintain sample size integrity. Additionally, follow-up attempts were made through phone calls and home visits to encourage participation.

To estimate the required sample size for the study, we used a health literacy prevalence of 54% as reported by Nayak et al.(7) in India. Assuming a 5% significance level, a 95% confidence interval and a 10% non-response rate, the estimated sample size was 393.

Inclusion and Exclusion Criteria:

The study included TB patients aged 18 years and above, registered with the NTEP in the past six months, who provided verbal informed consent to participate. Patients in a moribund condition, those with mental health issues, or those who refused consent were excluded from the study.

Data Collection Tool:

Health literacy among TB patients was assessed using a contextualized and validated version of the Health Literacy Instrument for Adults (HELIA), originally developed by Tavousi et al. for the Iranian adult population.(8) HELIA assesses five domains: reading, understanding health information, accessing health information, appraisal, and decision-making/intention to act. The appraisal domain refers to the ability to critically evaluate health information for accuracy and relevance, while the decision-making domain reflects an individual's confidence and ability to apply health information in making informed health choices. The tool was selected for its open-access availability, multidimensional structure, and alignment with the WHO definition of health literacy. For this study, HELIA was adapted to the Indian TB context through a structured process that included expert review, forward and back translation, cognitive interviews with TB patients and health workers, and cultural adaptation. The Gujarati-translated version was pilot-tested for clarity, acceptability, and preliminary reliability. Psychometric validation, including content validity and test–retest reliability, was conducted using standard indices such as Cronbach's alpha and the Intraclass Correlation Coefficient (ICC). A detailed account of the adaptation and validation is available in a separate manuscript currently under review. Scores ranged from 0 to 100, with values of 0–65 indicating limited health literacy and 66–100 indicating adequate literacy. Data collection was carried out by two trained field investigators through telephonic or virtual interviews after obtaining informed consent.

Data Analysis:

Data analysis was conducted using SPSS version 17.0. Descriptive statistics were used to summarize demographic and clinical characteristics. Continuous variables were expressed as mean and standard deviation, while categorical variables were presented as frequencies and percentages. To explore associations between health literacy (dichotomized as limited and adequate) and categorical variables, Chi-square tests were performed. Independent t-tests and one-way ANOVA were used to compare mean health literacy scores across two or more groups, respectively. Variables with a p-value less than 0.25 in univariate analysis were included in a binary logistic regression model to identify factors independently

associated with limited health literacy. The strength of associations was reported using adjusted odds ratios (OR) with 95% confidence intervals (CI), and statistical significance was considered at $p < 0.05$.

Ethics Approval:

Ethics approval: The ethics clearance was obtained from the Institute ethics committee, GMERS Medical College, Junagadh. All the selected participants were provided with information related to the study and were invited to participate in the study. They were also ensured that non-participation would not impact their TB-related treatment in any way. Those agreeing to participate and providing verbal informed consent were contacted and the desired time for the interview was scheduled. Confidentiality and privacy were ensured during the interview. All the methods including human subjects were performed in accordance with the Declaration of Helsinki, guidelines and regulations.

Results

A total of 393 TB patients were interviewed, with a mean age of 41.2 ± 15.8 years. The majority were male (62.1%) and between 18–40 years old (53.7%). Education levels varied, with 29.3% illiterate and 13.5% having higher secondary education or above. Most were semi-skilled (40.2%) or unemployed (29.8%). A significant proportion belonged to the lower middle class (78.1%), resided in rural areas (53.7%), and were non-migratory (94.4%). Tobacco addiction was prevalent in 52.7%, and 57.8% had health insurance. Table 1 depicts the socio-demographic characteristics of the study participants.

Table 1
Socio-demographic and clinical characteristics of Tuberculosis Patients (n = 393)

Characteristics	Frequency (n = 393)	Percentage (%)
Age group (years)		
18–40	211	53.7
41–60	120	30.5
>=60	62	15.8
Gender		
Female	149	37.9
Male	244	62.1
Education		
Illiterate	115	29.3
Primary	110	28.0
Secondary	115	29.3
Higher secondary and above	53	13.5
Occupation		
Semi-skilled	158	40.2
Skilled	35	8.9
Unskilled	83	21.1
Unemployed	117	29.8
SEC (modified Kuppuswamy's classification)		
Lower class	19	4.8
Lower middle class	65	16.5
Upper lower class	307	78.1
Upper middle class	2	.5
Residency		
Rural	211	53.7
Tribal	47	12.0
Urban	135	34.4

Characteristics	Frequency (n = 393)	Percentage (%)
Age group (years)		
Type of community		
Migratory	22	5.6
Non-migratory	371	94.4
Tobacco addiction		
Yes	207	52.7
No	186	47.3
Health insurance (Any)		
Yes	227	57.8
No	166	42.2
Type of facility enrolled for tuberculosis		
Private	48	12.2
Public	345	87.8
Type of Tuberculosis		
Extra Pulmonary	40	10.2
Pulmonary	353	89.8
Drug resistance		
DRTB	11	2.8
DSTB	382	97.2
– New	269	68.4
– Previously treated	113	28.8
Past-history of TB		
Yes	67	17.0
No	326	83.0
Treatment adherence based on 99DOTS or for drug-resistance, treatment register		
Yes	362	92.1
No	31	7.9

Characteristics	Frequency (n = 393)	Percentage (%)
Age group (years)		
Social support for TB		
Yes	340	86.5
No	53	13.5
Number of chronic conditions		
0	244	62.1
1	81	20.6
2	46	11.7
>=3	22	5.6

The majority of the TB patients were enrolled in public healthcare facilities (87.8%) and had pulmonary TB (89.8%). Most patients had drug-sensitive TB (97.2%), with 68.4% being new cases and 28.8% requiring retreatment. A history of TB was reported by 17.0% of the participants. Treatment adherence, based on 99DOTS or a drug-resistance treatment register, was high at 92.1%. Social support for TB was available to 86.5% of the patients. Regarding chronic conditions, 62.1% had none, while 20.6% had one, and 17.3% had two or more chronic conditions.

According to the adapted health literacy assessment tool, the majority of TB patients, 67.1% (264), had limited health literacy, while 32.8% (129) demonstrated adequate health literacy. Significant variations in health literacy based on demographic and socio-economic factors were observed. (Table 2) Health literacy was markedly higher among younger individuals (18–40 years) compared to older cohorts (41–60 years and ≥ 60 years), with the latter exhibiting lower health literacy levels. Educational attainment was a strong predictor of health literacy; individuals with higher secondary education or above showed significantly higher rates of adequate health literacy compared to those with lower education levels. Occupational status also influenced health literacy, with skilled workers and the employed exhibiting better health literacy than their unskilled and unemployed counterparts. Socioeconomic status and residency did not show substantial effects on health literacy. However, health insurance was positively associated with higher health literacy, indicating that insured individuals generally have better health literacy compared to those without insurance. Gender, tobacco use, and community migration status did not significantly affect health literacy outcomes.

Table 2
Health literacy levels Among TB patients according to socio-demographic and clinical characteristics (n = 393)

Characteristics	Health literacy		Total	p value
	Limited (n = 264)	Adequate (n = 129)		
Age group (years)				
18–40	111 (52.6%)	100 (47.4%)	211 (100%)	< 0.001
41–60	97 (80.8%)	23 (19.2%)	120 (100%)	
>=60	56 (90.3%)	6 (9.7%)	62 (100%)	
Gender				
Female	103 (69.1%)	46 (30.9%)	149 (100%)	0.41
Male	161 (66.0%)	83 (34.0%)	244 (100%)	
Education				
Illiterate	92 (80.0%)	23 (20.0%)	115 (100%)	< 0.001
Primary	82 (74.5%)	28 (25.5%)	110 (100%)	
Secondary	77 (67%)	38 (33%)	115 (100%)	
Higher secondary & above	13 (24.5%)	40 (75.5%)	53 (100%)	
Occupation				
Semi-skilled	73 (46.2%)	85 (53.8%)	158 (100%)	< 0.001
Skilled	11 (31.4%)	24 (68.6%)	35 (100%)	
Unskilled	71 (85.5%)	12 (14.5%)	83 (100%)	
Unemployed	109 (93.2%)	8 (6.8%)	117 (100%)	
Socio-economic class				
Lower class	14 (73.7%)	5 (26.3%)	19 (100%)	0.84
Lower middle class	45 (69.2%)	20 (30.8%)	65 (100%)	
Upper lower class	204 (66.4%)	103 (33.6%)	307 (100%)	
Upper middle class	1 (50.0%)	1 (50.0%)	2 (100%)	
Place of residence				
Rural	140 (66.4%)	71 (33.6%)	211 (100%)	0.87
Tribal	33 (70.2%)	14 (29.8%)	47 (100%)	

Characteristics	Health literacy		Total	p value
	Limited (n = 264)	Adequate (n = 129)		
Urban	91 (67.4%)	44 (32.6%)	135 (100%)	
Type of community				
Migratory	14 (63.6%)	8 (36.4%)	22 (100%)	0.71
Non-migratory	250 (67.4%)	121 (32.6%)	371 (100%)	
Tobacco addiction				
Yes	141 (68.1%)	66 (31.9%)	207 (100%)	0.67
No	123 (66.1%)	63 (33.9%)	186 (100%)	
Health insurance				
Yes	137 (60.4%)	90 (39.6%)	227 (100%)	0.001
No	127 (76.5%)	39 (23.5%)	166 (100%)	
Type of facility				
Private	26 (54.2%)	22 (45.8%)	48 (100%)	0.04
Public	238 (69.0%)	107 (31%)	345 (100%)	
Type of Tuberculosis				
Extra Pulmonary	21 (52.5%)	19 (47.5%)	40 (100%)	0.03
Pulmonary	243 (68.8%)	110 (31.2%)	353 (100%)	
Type of resistance				
DRTB	7 (63.6%)	4 (36.4%)	11 (100%)	0.87
DSTB	257 (67.3%)	125 (32.7%)	382 (100%)	
- New	181 (67.3%)	88 (32.7%)	269 (100%)	
- Previously treated	75 (66.4%)	38 (33.6%)	113 (100%)	
Past-history of TB				
Yes	45 (67.2%)	22 (32.8%)	67 (100%)	0.99
No	219 (67.2%)	107 (32.8%)	326 (100%)	
Treatment adherence				
Yes	235 (64.9%)	127 (35.1%)	362 (100%)	< 0.001
No	29 (93.5%)	2 (6.4%)	31 (100%)	

Characteristics	Health literacy		Total	p value
	Limited (n = 264)	Adequate (n = 129)		
Social support for TB				
Yes	221 (65%)	119 (35%)	340 (100%)	0.02
No	43 (82.7%)	10 (19.2%)	52 (100%)	
Number of chronic conditions				
0	144 (59%)	100 (41%)	244 (100%)	< 0.001
1	58 (71.6%)	23 (28.4%)	81 (100%)	
2	40 (87%)	6 (13%)	46 (100%)	
≥ 3	22 (100%)	0 (0%)	22 (100%)	

Patients enrolled in private facilities exhibited a higher proportion of adequate health literacy (45.8%) compared to those in public facilities (31%), with a statistically significant difference ($p = 0.04$). Notably, treatment adherence was strongly associated with adequate health literacy ($p < 0.001$), with lower adherence linked to limited health literacy. The number of chronic conditions was inversely related to health literacy; patients with more chronic conditions had significantly lower levels of adequate health literacy ($p < 0.001$). (Table 2)

The domain-wise mean scores of health literacy among tuberculosis patients reveal varying levels of proficiency. The reading scale shows a low mean score of 38.3, indicating challenges in comprehending health-related texts. The access scale has a moderate mean score of 51.4, suggesting patients have some ability to find and access health information. The understanding scale shows a slightly higher mean score of 56.6, reflecting a fair ability to comprehend the information once accessed. The appraisal scale, with the lowest mean score of 25.9, highlights significant difficulties in evaluating the reliability of health information. The decision-making scale shows the highest mean score of 62.4, indicating a relatively stronger ability to make health-related decisions. (Table 3) Further, patients who adhered to their treatment demonstrated higher health literacy scores across domains, and a statistically significant association was observed between treatment adherence and higher health literacy levels ($p < 0.0001$). Additionally, patients without chronic conditions scored higher in most health literacy domains and a significant association was observed between a number of chronic conditions and limited health literacy ($p < 0.01$). (Table 3)

Table 3
Domain-wise health literacy scores among TB patients

Variables	Domain-wise health literacy scores					
	Reading scale	Access scale	Understanding scale	Appraisal scale	Decision making scale	HL score
Mean scores and SD	38.3 ± 25.5	51.4 ± 15.6	56.6 ± 16.6	25.9 ± 17.2	62.4 ± 14.3	46.9 ± 14
Age group (years)						
< 60 years	47.6 ± 29.8	58.4 ± 20.4	65.1 ± 20.4	32.6 ± 23	70 ± 18.7	54.7 ± 18.4
(≥ 60 years	20.5 ± 22.6	46 ± 18.3	42.9 ± 17.6	21.9 ± 15.1	53.9 ± 16.7	37 ± 14.8
p value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Education						
Secondary and above	75.5 ± 20.2	76.4 ± 16.2	82.9 ± 12.1	53.6 ± 25.7	78.2 ± 7.9	73.3 ± 12.8
Illiterate and Primary	32.5 ± 21.9	47.5 ± 12.5	52.5 ± 14.2	21.6 ± 12	60 ± 14	42.8 ± 10.6
p value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Occupation						
semiskilled and skilled	75.5 ± 23.3	78 ± 15	82.4 ± 13.7	60.7 ± 27.7	79.3 ± 7.4	75.2 ± 13.9
Unemployed and Unskilled	34.7 ± 23.2	48.8 ± 13.7	54 ± 15.1	22.5 ± 12.6	60.8 ± 14.1	44.2 ± 11.7
p value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Health Insurance						
Present	39.4 ± 27.2	51.2 ± 18	59 ± 17.6	27 ± 19.3	64.1 ± 15.1	48.1 ± 15.6
Absent	37.6 ± 24.2	51.6 ± 13.7	54.8 ± 15.6	25.2 ± 15.6	61.2 ± 13.6	46.1 ± 12.8
p value	0.56	0.81	0.05	0.41	0.15	0.29
Type of facility						
Private	45.1 ±	53.1 ±	58.8 ± 20.2	25.4 ±	63.6 ± 17.6	49.2 ±

Variables	Domain-wise health literacy scores					
	Reading scale	Access scale	Understanding scale	Appraisal scale	Decision making scale	HL score
	27.7	19.7		20.6		17.5
Public	37.4 ± 25.1	51.2 ± 15	56.3 ± 16	26 ± 16.8	62.3 ± 13.8	46.6 ± 13.5
p value	0.1	0.55	0.44	0.86	0.64	0.37
Type of TB						
Extra pulmonary	47 ± 27.2	55.5 ± 20.1	57.6 ± 20.7	36.3 ± 23	65.8 ± 17.3	52.4 ± 18.9
Pulmonary	37.3 ± 25.1	51 ± 15	56.4 ± 16.1	24.8 ± 16.2	62 ± 13.9	46.3 ± 13.3
p value	0.05	0.18	0.75	0.01	0.24	0.12
Treatment adherence						
Present	39.8 ± 25.5	52.5 ± 15.5	57.8 ± 16.1	26.7 ± 17.8	64.4 ± 12.5	48.2 ± 13.7
Absent	20.9 ± 19.8	39 ± 12.6	42.2 ± 16.9	17.5 ± 5.8	39.3 ± 19.1	31.8 ± 11.8
p value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Social support						
Present	40.6 ± 27.9	54.3 ± 19.3	55.9 ± 19.1	34.5 ± 20.3	59.4 ± 19.1	49 ± 17.5
Absent	38 ± 25.1	51 ± 14.9	56.7 ± 16.2	24.6 ± 16.4	62.9 ± 13.4	46.6 ± 13.5
p value	0.55	0.27	0.82	0.003	0.22	0.4
Chronic conditions						
Present	15.8 ± 14.4	40 ± 13.3	32.6 ± 8.3	18.6 ± 5	38.8 ± 13	29.2 ± 7.5
Absent	39.7 ± 25.5	52.1 ± 15.5	58 ± 16.1	26.4 ± 17.7	63.8 ± 13.5	48 ± 13.8
p value	< 0.001	< 0.001	< 0.001	0.11	< 0.001	< 0.001

According to the logistic regression analysis, individuals with lower educational attainment had significantly higher odds of limited health literacy compared to those with secondary education or above (OR = 3.57, 95%CI: 2.18–13.63, $p < 0.001$). Similarly, unemployed or unskilled TB patients showed higher

odds of limited health literacy compared to semi-skilled or skilled TB patients (OR = 2.74, 95% CI: 1.37–8.17, $p < 0.001$). Non-adherence to TB treatment was significantly associated with limited health literacy, with a high odds ratio (OR = 4.69, 95% CI: 3.2–7.79, $p < 0.001$). Additionally, the presence of comorbidities was associated with increased odds of limited health literacy (OR = 4.8, 95% CI: 1.23–9.8, $p = 0.030$). (Table 4)

Table 4
Logistic regression analysis of various factors independently associated with limited health literacy among TB patients

Variable	OR (95% CI)	p value
Age (≥ 60 years v/s < 60 years)	0.97 (0.2 to 4.79)	0.974
Education (Illiterate and Primary v/s Secondary and above)	3.57 (2.18 to 13.63)	< 0.001
Occupation (Unemployed and Unskilled v/s semiskilled and skilled)	2.74 (1.37 to 8.17)	< 0.001
Health insurance (Absent v/s Present)	1.61 (0.7 to 3.72)	0.261
Facility (Public v/s Private)	1.87 (0.6 to 5.81)	0.277
Type of TB (Pulmonary v/s Extra pulmonary)	1.58 (0.27 to 6.15)	0.09
Treatment adherence (Absent v/s Present)	4.69 (3.2 to 7.79)	< 0.001
Social support (Absent v/s Present)	2.32 (0.79 to 6.8)	0.124
Comorbidities (Present v/s Absent)	4.8 (1.23 to 9.8)	0.030

Discussion

This primary study conducted in the Junagadh district of Gujarat provides the domain-wise health literacy levels among patients with active TB in India. We observed, that 67.1% of TB patients had limited health literacy, particularly among those with lower education and the unemployed. Higher health literacy was linked to better treatment adherence, while patients with chronic conditions showed lower health literacy. Additionally, TB patients had stronger health literacy levels in the decision-making domain, they faced considerable challenges in the appraisal domain.

This study comprehensively assessed the health literacy levels and found that over half (67.1%) of TB patients had limited health literacy. Chauhan et al., in their global systematic review and meta-analysis, found that 51.2% of TB patients exhibited limited health literacy, with no observed heterogeneity in the data.(3) Similar findings were reported by Jie et al. and Li et al. in China, highlighting the high prevalence of limited health literacy in high TB burden countries.(9, 10) China recognized the critical impact of limited health literacy and responded with health system reforms that mandated a 2% annual

improvement in health literacy across the general population.(11, 12) This proactive approach, alongside targeted community engagement strategies, has played a key role in enhancing TB control efforts, reducing its contribution to the global TB burden from 10–7% over the past decade.(1, 13) Among these, the most effective community engagement strategies for improving TB health literacy in China have been local health workshops, peer education programs, involvement of local leaders, cultural tailoring of messages, and community health fairs.(14, 15) These strategies collectively enhance understanding and encourage proactive health behaviors among community members, to better understand their condition, and adhere to treatment protocols, ultimately contributing to better TB control.(14) Given the success of China's health system reforms and community engagement strategies in reducing the TB burden, it is imperative that similar reforms be considered by the National TB Elimination Program in India. By prioritizing health literacy and adopting targeted, culturally tailored interventions, India could significantly enhance TB elimination efforts, improve treatment adherence, and ultimately reduce the global TB burden.

Social determinants of health, such as education and living standards, significantly impact both the causation and outcomes of tuberculosis (TB).(16) Health literacy is a crucial element of the social infrastructure, influencing access to care, service utilization, equity, and patient empowerment, all of which affect TB outcomes.(3) It is also a proposed mechanism through which educational attainment influences TB outcomes.(17) Our study found that TB patients with lower educational levels and those who were unemployed had higher odds of limited health literacy. These findings align with those reported by Yang et al. in South Korea, underscoring that lower educational attainment is a key determinant of limited health literacy.(18) Consequently, improving health literacy can be a vital strategy to mitigate health disparities and enhance TB management.(19) However, a significant challenge lies in reaching and educating those with minimal or no formal education.(5) These populations, often more vulnerable to TB due to socio-economic factors, are also less likely to engage with or comprehend health information, making it essential to develop tailored strategies for effective education and intervention.(20)

India, as a high TB-burden country, is committed to ending TB.(1, 2) Achieving high treatment adherence is a key strategy of the National Strategic Plan to End TB in India.(2) Poor treatment adherence not only results in suboptimal treatment outcomes but also contributes to the growing prevalence of drug-resistant TB, which is a significant barrier to the goal of eliminating TB.(21) Our study found that TB patients with poor treatment adherence had higher odds of limited health literacy, a finding consistent with Chauhan et al.'s systematic review.(3) Health literacy encompasses a patient's ability to understand, interpret, and act on health information, which is essential for following complex TB treatment regimens correctly.(3) Patients with limited health literacy often face difficulties in comprehending medication instructions, managing side effects, and recognizing the importance of completing their treatment course.(3) These challenges can lead to an increased risk of non-adherence to treatment, which is a significant factor in the development of drug-resistant TB.(3) Our study also revealed that TB patients had particularly low health literacy levels in appraising and understanding health-related information. This deficit in critical and interpretative health literacy further exacerbates their difficulties in effectively

managing their treatment regimen and navigating their healthcare needs, ultimately contributing to poorer treatment outcomes and higher rates of drug resistance.(3, 19)

This study found that TB patients with additional chronic conditions were more likely to have limited health literacy, a trend also observed by Li et al. and Wang et al. in their studies on TB patients with diabetes in China.(10, 22) Health literacy is crucial in managing chronic diseases, especially when multiple conditions are present.(23) The coexistence of other chronic conditions can complicate TB treatment regimens, increasing the risk of drug-drug interactions, adverse drug reactions, polypharmacy, and ultimately leading to poorer health outcomes.(3) Given these complexities, there is a pressing need to develop tailored health literacy interventions for patients managing multiple chronic conditions. Liu et al. highlighted the importance of health literacy in preventing the onset of additional comorbidities, beyond the initial chronic condition.(24) Evidence also suggests that improvements in health literacy can lead to a reduction in risk behaviors, particularly concerning chronic diseases.(20) In India, where the dual burden of chronic infectious diseases like TB and non-communicable diseases is a significant public health challenge, addressing the health literacy needs of patients is essential for improving TB outcomes.(23) By equipping patients with the necessary knowledge and tools, healthcare systems can empower them to better understand their treatment regimens, manage potential drug interactions, and adhere to their prescribed treatments. This approach can lead to better health outcomes and reduce the risk of complications associated with comorbid conditions.

While this study provides the first comprehensive domain-wise assessment of health literacy among patients with active TB, certain limitations must be acknowledged. The study was conducted in a single district of Gujarat, which, although selected for its demographic and epidemiological representativeness, may not fully reflect the diversity of India's overall population. This limits the generalizability of the findings to regions with different sociocultural, economic, and healthcare contexts. Additionally, the cross-sectional design prevents an analysis of how health literacy influences treatment outcomes over time. The study also focuses exclusively on patients with active TB, without addressing the health literacy challenges faced by those with latent TB infection or their caregivers.

Despite these limitations, the study offers valuable insights into the role of health literacy in TB management, highlighting key areas for intervention. The findings can inform the development of targeted health literacy strategies aimed at improving treatment adherence and patient outcomes, particularly in regions with similar demographic and epidemiological profiles.

Conclusion

This study reveals a high prevalence of limited health literacy among TB patients and establishes its strong association with treatment adherence and key sociodemographic variables. These findings highlight health literacy as a critical, yet often overlooked, determinant of TB treatment outcomes. To translate these insights into practice, it is essential to integrate structured health literacy interventions into existing TB elimination strategies. This includes developing culturally tailored educational materials,

training community health workers to communicate more effectively, and incorporating health literacy assessments into routine TB care. Such practical steps can empower patients, enhance adherence, and ultimately accelerate progress toward national TB elimination goals.

Data availability statement:

The datasets used and/or analyzed during the current study available from the corresponding author on reasonable request

Authorship contribution:

AC conceived the idea. Both AC and KG contributed equally in the manuscript. KG and AC drafted the protocol, KG provided the technical and administrative support, PP, and SC did the analysis, AC and KG prepare the first draft, PP, SC, SI, MVA, JJ and SP did subsequent revisions and supported in drafting the final manuscript. All authors read and approved the final manuscript.

Declarations

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The authors declared no conflict of interest.

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References

1. Organization WH. Global Tuberculosis Report. 2023.
2. Ministry of Health and Family Welfare GoI. India TB Report. 2023.
3. Chauhan A, Parmar M, Dash GC, Chauhan S, Sahoo KC, Samantaray K, et al. Health literacy and tuberculosis control: systematic review and meta-analysis. *Bull World Health Organ.* 2024;102(6):421–31.
4. Poureslami I, Nimmon L, Rootman I, Fitzgerald MJ. Health literacy and chronic disease management: drawing from expert knowledge to set an agenda. *Health Promot Int.* 2017;32(4):743–54.
5. Nielsen-Bohlman L, Panzer AM, Kindig DA. *Health Literacy* 2004.
6. Fenta MD, Ogundijo OA, Warsame AAA, Belay AG. Facilitators and barriers to tuberculosis active case findings in low- and middle-income countries: a systematic review of qualitative research. *BMC Infect Dis.* 2023;23(1).
7. Nayak A, Reddy AKR, Bhat J, Kumari C, Rowlands G, Urval R, Unnikrishnan B, Ramapuram J, Fathima N. Development of a Kannada Version of the Newest Vital Sign Health Literacy Tool and Assessment of Health Literacy in Patients with Tuberculosis: A Cross-Sectional Study at a District Tuberculosis Treatment Centre. *J Krishna Inst Med Sci Univ.* 2021;10(4):37–48.
8. Jie LXG, Qiu-bing L, Ya-ling Z, Hong-yang W. Relationship between health literacy and prognosis in elderly diabetic patients complicated with pulmonary tuberculosis in communities of Tangshan City. *Pract Prev Med.* 2017;24(2):129–32.
9. Li XLJ, Meng Q, Liang Z, Li L, Shang JWR. Relationship among health literacy and rehabilitation compliance and prognosis in patients with diabetes. *Clin Med China.* 2016;12:389 – 92. *Clin Med China.* 2016;12:389 – 92.
10. China's health. literacy improving, commission says. *Chinadailycomcn.* 2022.
11. China issues action. plan to raise national health literacy [press release]. Copyright© www.gov.cn 2024.
12. Organization WH. Global Tuberculosis Report. 2015.
13. Wang L, Liu J, Chin DP. Progress in tuberculosis control and the evolving public-health system in China. *Lancet.* 2007;369(9562):691–6.
14. Feng Q, Zhang G, Chen L, Wu H, Yang Y, Gao Q, et al. Roadmap for ending TB in China by 2035: The challenges and strategies. *Biosci Trends.* 2024;18(1):11–20.
15. Rasanathan K, Sivasankara Kurup A, Jaramillo E, Lonnroth K. The social determinants of health: key to global tuberculosis control. *Int J Tuberc Lung Dis.* 2011;15(Suppl 2):30–6.
16. Dean HD, Fenton KA. Addressing social determinants of health in the prevention and control of HIV/AIDS, viral hepatitis, sexually transmitted infections, and tuberculosis. *Public Health Rep.* 2010;125(Suppl 4):1–5.
17. Yang SH, Jung E, Young, Yoo Y. Health Literacy, Knowledge and Self-care Behaviors in Patients with Pulmonary Tuberculosis Living in Community. *J Basic Nurs.* 2020;27(1):1–11.

18. van der Heide I, Poureslami I, Mitic W, Shum J, Rootman I, FitzGerald JM. Health literacy in chronic disease management: a matter of interaction. *J Clin Epidemiol.* 2018;102:134–8.
19. Berkman ND, Sheridan SL, Donahue KE, Halpern DJ, Crotty K. Low health literacy and health outcomes: an updated systematic review. *Ann Intern Med.* 2011;155(2):97–107.
20. Monedero I, Bhavaraju R, Mendoza-Ticona A, Sanchez-Montalva A. The paradigm shift to end tuberculosis. Are we ready to assume the changes? *Expert Rev Respir Med.* 2017;11(7):565–79.
21. Wang Xiaoxia WH. Relationship between health literacy and treatment effect of elderly patients with diabetes complicated by pulmonary tuberculosis. *Prev Med.* 2017;29(1).
22. Chauhan A, Parmar M, Rajesham JD, Shukla S, Sahoo KC, Chauhan S, et al. Landscaping tuberculosis multimorbidity: findings from a cross-sectional study in India. *BMC Public Health.* 2024;24(1):453.
23. Liu L, Qian X, Chen Z, He T. Health literacy and its effect on chronic disease prevention: evidence from China's data. *BMC Public Health.* 2020;20(1).
24. Tavousi M, Haeri-Mehrizi A, Rakhshani F, Rafiefar S, Soleymanian A, Sarbandi F, et al. Development and validation of a short and easy-to-use instrument for measuring health literacy: the Health Literacy Instrument for Adults (HELIA). *BMC Public Health.* 2020;20(1):656.