ISSN: 2321-5690
IJOPT
INDIAN JOURNAL OF PHYSICAL THERAPY
AN INTERNATIONAL JOURNAL
INDIAN JOURNAL OF PHYSICAL THERAPY
AN INTERNATIONAL JOURNAL
editor.ijopt@gmail.com

EVALUATION OF SLEEP QUALITY AND FATIGUE LEVEL AMONG THE PARTICIPANTS SUFFERING FROM PULMONARY TUBERCULOSIS – A CROSS-SECTIONAL STUDY

Dr. Dimpal Paija (PT) [1], Dr. Jayshree M Sutaria [2]

[1] MPT Assistant Professor at Ashok & Rita Patel Institute of Physiotherapy, Charusat, Gujarat, India

[2] MPT, PhD, I/C Principal, Government Physiotherapy College, Ahmedabad, Gujarat, India

Corresponding Author:
(Dr. Dimpal Paija (PT) Ashok & Rita Patel Institute of Physiotherapy, Charusat, Gujarat, India,
Email: dimpalpaija3598@gmail.com, Phone Number: +9195371 23535)

DOI: https://doi.org/10.63299/ijopt.060328

ABSTRACT

Background: Pulmonary tuberculosis (TB) continues to be a significant public health issue, particularly in countries like India. While diagnostic and treatment protocols have improved, the non-respiratory consequences of TB—such as sleep disturbances and fatigue remain under-addressed, despite their substantial impact on recovery, quality of life, and treatment adherence.

Objectives: This study aimed to assess sleep quality and fatigue levels in individuals with pulmonary TB and to determine the correlation between these two variables.

Methods: A cross-sectional observational study was conducted at the Tuberculosis and Chest Diseases (TBCD) Ward of Civil Hospital, Ahmedabad. Fifty-six participants diagnosed with pulmonary TB for over three months were evaluated. Sleep quality was measured using the Pittsburgh Sleep Quality Index (PSQI), and fatigue levels were assessed using the Piper Fatigue Scale (PFS-12). Descriptive statistics and Pearson/Spearman correlation tests were used to analyse the data.

Results: Participants had poor sleep quality (mean PSQI = 15.64) and moderate to high fatigue (mean PFS = 6.22). Among them, 73.2% experienced moderate fatigue and 26.8% had severe fatigue. A statistically significant moderate positive correlation ($r = 0.515$, $p < 0.01$) was found between sleep quality and fatigue levels. Disease duration showed a strong positive correlation with poor sleep ($\rho = 0.866$) and moderate correlation with fatigue ($\rho = 0.441$), highlighting a progressive impact.

Conclusion: Poor sleep and significant fatigue are highly prevalent in pulmonary TB patients and are strongly correlated. These findings emphasize the need for routine screening and integrative management strategies including sleep hygiene education, fatigue interventions, and psychological support. Future studies should explore longitudinal changes and evaluate targeted interventions to improve quality of life and treatment outcomes in TB care.

Keywords: Pulmonary Tuberculosis, Sleep Quality, Fatigue, Pittsburgh Sleep Quality Index (PSQI), Piper Fatigue Scale (PFS), Fatigue Management, Quality of Life.

INTRODUCTION

Tuberculosis (TB) remains a leading global public health challenge, particularly in low- and middle-income countries like India. Despite significant progress in diagnosis, treatment, and awareness, TB continues to claim numerous lives and disrupt the well-being of millions annually. According to the World Health Organization (WHO) Global TB Report 2022, India's TB incidence for the year 2021 stood at 210 per 100,000 population a substantial 18% reduction from the baseline year of 2015 (256 per 100,000). This decline is notably higher than the global average of 11%, placing India in the 36th position in terms of TB incidence worldwide [1]. While this trend highlights success in TB control measures, the disease still poses significant physical, psychological, and social burdens on affected individuals.

The United Nations, through its Sustainable Development Goals (SDG 3.3), and the WHO's End TB Strategy (2016–2035), have emphasized the need to eliminate TB as a global health threat [2]. These initiatives have brought substantial advancements in the accessibility and affordability of anti-tubercular therapy (ATT), especially in resource-constrained settings [3,4]. However, adverse drug reactions (ADRs) related to prolonged treatment regimens ranging from hepatotoxicity to peripheral neuropathy remain a persistent challenge, often affecting treatment adherence and patient outcomes [5].

One of the lesser-addressed consequences of both the disease and its treatment is sleep disturbance. Sleep quality is increasingly recognized as an important aspect of health, particularly in the context of chronic diseases. TB patients often report insomnia or disrupted sleep patterns, which may be attributed to night sweats, chronic coughing, anxiety, depression, dyspnea, and ADRs such as liver dysfunction or gastrointestinal discomfort. These symptoms contribute to poor sleep quality, which, if persistent, can severely impair daily functioning, recovery, and quality of life [6]. Moreover, poor sleep is known to compromise immune function, thereby potentially worsening infectious diseases like TB [7]. Pro-inflammatory cytokines such as interleukin-1 (IL-1), tumour necrosis factor-alpha (TNF-α), and interferon-gamma (IFN-γ) are elevated in active TB and are known to interfere with sleep architecture, especially non-REM sleep, causing fragmented sleep and fatigue. In addition, the tubercle bacilli may induce systemic inflammation, which activates the hypothalamic-pituitary-adrenal (HPA) axis, leading to increased cortisol levels, which in turn disrupt circadian rhythm and melatonin secretion. This neuroendocrine imbalance is closely linked with sleep onset insomnia and reduced sleep efficiency. [6,7]

Another commonly overlooked yet critical issue among TB patients is fatigue. Fatigue in TB is multifactorial resulting from the systemic inflammatory response, psychological stress, nutritional deficiencies, physical inactivity, and prolonged medication use. Fatigue in TB is not merely a symptom but a complex condition that impairs physical endurance, cognitive clarity, and emotional resilience. Patients with persistent fatigue often report difficulties performing routine activities, maintaining work productivity, and coping with emotional stress, leading to a diminished quality of life [8].

Fatigue may be linked with the energy demands of sustained immune activation. TB leads to mitochondrial dysfunction, increased oxidative stress, and muscle catabolism due to cytokine-driven cachexia. These physiological changes reduce ATP production, leading to cellular energy deficits that manifest as physical and mental fatigue. Additionally, liver dysfunction caused by ATT may impair glycogen storage and glucose metabolism, further contributing to energy depletion and persistent tiredness. [8,9]

In a study conducted among TB patients during the COVID-19 pandemic, sleep disturbances and chronic fatigue were among the most frequently reported non-respiratory symptoms, highlighting their prevalence and impact on patient well-being [9]. Additionally, fatigue has been shown to be a significant barrier to medication adherence, particularly in long-term therapies such as those required for TB. When combined, poor sleep and fatigue can create a detrimental cycle that hampers recovery and increases the risk of treatment failure or relapse.

Despite the clinical importance of these symptoms, sleep quality and fatigue levels in TB patients remain under-assessed in routine care. Most research in TB management has traditionally focused on bacteriological cure rates, medication

adherence, and prevention strategies. However, holistic TB care must also address the subjective experiences of patients, including fatigue and sleep disturbances, to ensure comprehensive recovery.

Need of the study arises as Tuberculosis (TB) remains a chronic and debilitating illness that imposes significant physical, psychological, and social burdens on affected individuals. Among the most commonly reported, yet under-recognized, issues faced by TB patients are sleep disturbances and fatigue symptoms that arise due to persistent coughing, night sweats, systemic inflammation, and the increased work of breathing. Adequate sleep and energy conservation are crucial for recovery in chronic illnesses, as sleep deprivation and fatigue have been shown to impair immune function, reduce physical endurance, and negatively affect mental health and treatment adherence.

Despite these critical concerns, there is a clear paucity of research focusing specifically on the evaluation of sleep quality and fatigue levels among individuals with pulmonary TB. Most existing studies prioritize bacteriological cure and medication adherence while overlooking the subjective experiences that significantly impact quality of life. The current observational study, therefore, aims to bridge this gap by systematically assessing sleep quality and fatigue in TB patients. The findings can inform the development of comprehensive, patient-centered care models that incorporate sleep hygiene education, fatigue management strategies, psychological counseling, and rehabilitative interventions—ultimately enhancing recovery and long-term health outcomes.

Objectives of the Study:

To evaluate the sleep quality by Pittsburgh Sleep Quality Index (PSQI) and fatigue level by Piper fatigue scale-12 (PFS-12) in Pulmonary tuberculosis participants.

To find out correlation between Sleep Quality and Level of Fatigue among Pulmonary tuberculosis participants.

METHODOLOGY

Study Design: This was a cross-sectional observational study designed to evaluate the sleep quality and fatigue levels in individuals diagnosed with pulmonary tuberculosis.

Study Setting: The study was conducted in the Tuberculosis and Chest Diseases (TBCD) Ward at Civil Hospital, Ahmedabad, a tertiary care government hospital.

Sampling Technique: Participants were selected using a consecutive sampling technique, where every eligible patient visiting the TBCD ward during the study period was considered for inclusion until the required sample size was reached.

Sample Size: A total of 56 participants were enrolled in the study.

Inclusion Criteria:

- Individuals aged 18 years or above.
- Confirmed diagnosis of pulmonary tuberculosis by a pulmonologist with disease duration of more than 3 months.
- Willingness to participate and sign the informed consent form.
- Both male and female participants were eligible.

Exclusion Criteria:

- Presence of any other medical or surgical condition that could interfere with sleep quality or fatigue assessment.
- Subjects with diagnosed COPD or other chronic pulmonary comorbidities.

Materials Used:

- Institutional Consent and Assessment Forms
- Stationery for recording responses
- Pulse oximeter (for SpO_2)
- Weighing scale
- Stadiometer
- Standardized tools: PSQI Scale and PFS Scale

Procedure:

All patients attending the TBCD ward were screened. Of 68 individuals initially considered, 12 were excluded due to: age <18 years (n = 3), unwillingness to provide consent (n = 5), and presence of COPD (n = 4). The remaining 56 participants (41 males and 15 females) were included in the study.

After obtaining written consent, baseline demographic data were recorded. Anthropometric

measurements, including height and weight, were taken using a stadiometer and weighing scale respectively. Oxygen saturation levels were measured using a pulse oximeter.

Sleep quality and fatigue levels were then assessed using standardized outcome measures.

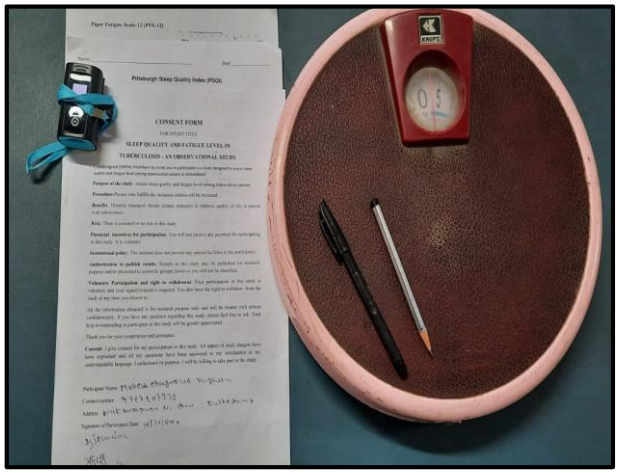


Figure 1: Materials

Outcome Measures:

Pittsburgh Sleep Quality Index (PSQI):

The PSQI is a validated, self-rated questionnaire used to measure sleep quality and disturbances over a 1-month interval. It consists of 19 items grouped into seven components (sleep latency, duration, efficiency, disturbances, etc.), generating a global score ranging from 0 to 21. Higher scores indicate poorer sleep quality. The PSQI has demonstrated good internal consistency with a Cronbach's alpha of 0.88, and is widely used in both clinical and research settings for patients with chronic illnesses.[10]

Piper Fatigue Scale (PFS):

The PFS is a 22-item multidimensional self-report scale that evaluates subjective fatigue in four domains: behavioural/severity, affective meaning, sensory, and cognitive/mood. Scores range from 0 (no fatigue) to 10 (severe fatigue), with domain scores contributing to a total fatigue score. The tool has been shown to have excellent internal consistency, with a reliability coefficient of 0.963, making it suitable for fatigue assessment in both acute and chronic disease populations. [11]

Figure 2: Therapist Administering Sleep and Fatigue Scales to TB Patient

RESULTS

Table 1: Descriptive Statistics of Demographic and Clinical Characteristics in Pulmonary Tuberculosis Patients

Variable (N= 56)	Minimum	Maximum	Mean	Standard Deviation
Age (years)	18.00	69.00	34.89	12.49
Weight (kg)	28.00	60.00	44.66	8.10
Height (cm)	140.00	170.00	156.47	5.87
BMI (kg/m²)	13.00	25.00	18.39	3.03
Duration of TB (months)	3.00	46.00	15.27	11.52
PSQI Score	7.00	21.00	15.64	3.51
PFS Score	4.08	8.00	6.22	0.87

The descriptive analysis reveals that the average age of participants was 34.89 years, with most falling in the young to middle-aged category. The mean BMI was 18.39, indicating that a majority of patients were underweight, a common finding in tuberculosis due to chronic illness and poor nutritional status. The average duration of illness was 15.27 months, suggesting both recent and long-standing cases.

Notably, participants reported poor sleep quality (mean PSQI = 15.64) and moderate to high fatigue levels (mean PFS = 6.22), highlighting significant non-respiratory burdens that impact overall well-being and recovery.

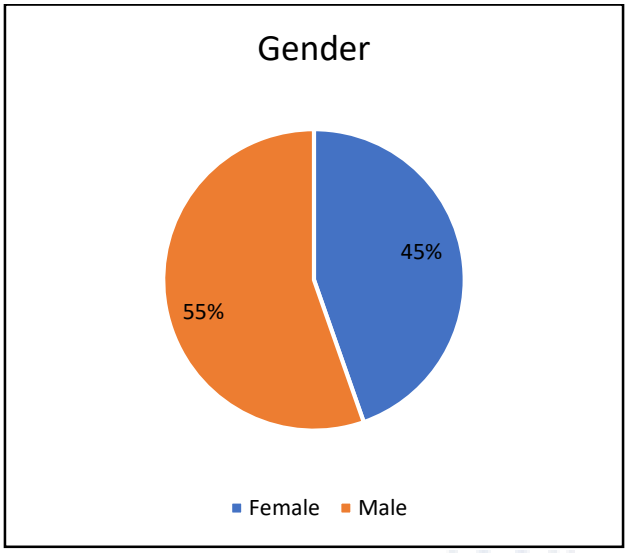


Chart 1: Gender Distribution

The pie chart shows the gender distribution of the participants. Out of 56 individuals, 31 (55%) were male and 25 (45%) were female, indicating a slightly higher representation of males in the study population.

Table 2: Correlation Between Sleep Quality, Fatigue, Physiological Parameters, and Demographic Variables in Recreational Badminton Players (n = 56)

Variables	**Method**	**Correlation Coefficient (r / ρ)**	**Significance (p-value)**	**N**	**Interpretation**
PSQI & PFS	Pearson	0.515**	0.000	56	Moderate positive correlation
	Spearman	0.512**	0.000	56	
Disease Duration & PSQI	Spearman	0.866**	0.000	56	Strong positive correlation
Disease Duration & PFS	Spearman	0.441**	0.001	56	Moderate positive correlation
Disease Duration & BMI	Spearman	-0.993**	0.000	56	Strong negative correlation
Age & BMI	Spearman	0.105	0.439	56	No significant correlation
Age & PSQI	Spearman	0.993**	0.000	56	Strong positive correlation
Age & PFS	Spearman	0.997**	0.000	56	Strong positive correlation
PSQI & Heart Rate (HR)	Pearson	0.667**	0.000	56	Strong positive correlation
	Spearman	0.649**	0.000	56	
Heart Rate & PFS	Pearson	0.264*	0.049	56	Weak positive correlation
	Spearman	0.260	0.053	56	Borderline significance

The correlation analysis revealed several significant relationships among the study variables. A moderate positive correlation was found between PSQI and PFS, indicating that poor sleep quality is associated

with increased fatigue. Disease duration showed a strong positive correlation with PSQI and a moderate correlation with PFS, suggesting that longer illness duration is linked to poorer sleep and higher fatigue. A strong negative correlation was observed between disease duration and BMI, implying a decrease in BMI with longer disease duration. Age showed no significant correlation with BMI but had strong positive correlations with both PSQI and PFS, indicating that older individuals reported poorer sleep and more fatigue. Heart rate showed a strong positive correlation with PSQI and a weak-to-borderline significant correlation with PFS, suggesting a possible physiological link between heart rate, sleep quality, and fatigue levels.

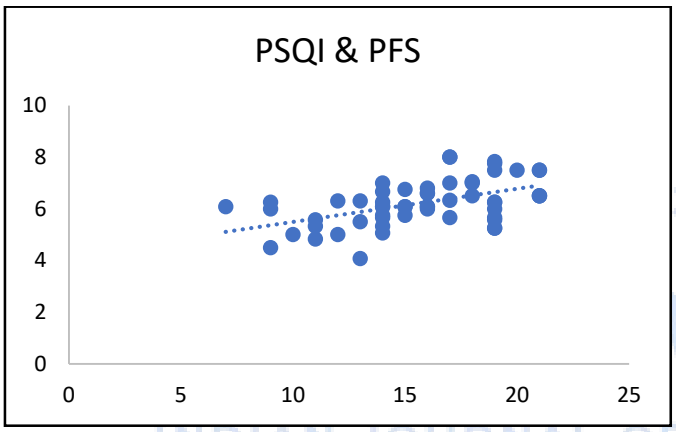


Chart 2: Relationship Between Sleep Quality (PSQI) and Fatigue (PFS) Among Participants

The chart illustrates the correlation between Pittsburgh Sleep Quality Index (PSQI) and Piper Fatigue Scale (PFS) scores among 56 participants. Both Pearson ($r = 0.515$, $p < 0.01$) and Spearman ($\rho = 0.512$, $p < 0.01$) correlation coefficients indicate a moderate positive correlation. This suggests that as sleep quality worsens (higher PSQI scores), fatigue levels tend to increase (higher PFS scores). The strong significance ($p = 0.000$) confirms that this relationship is statistically meaningful.

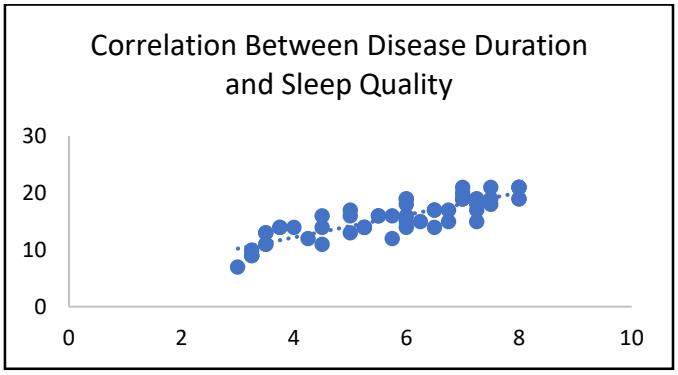


Chart 3: Correlation Between Disease Duration and Sleep Quality (PSQI)

This chart depicts the relationship between disease duration and Pittsburgh Sleep Quality Index (PSQI) scores among 56 participants. The Spearman correlation coefficient ($\rho = 0.866$, $p < 0.01$) indicates a strong positive correlation, meaning that as the duration of the disease increases, sleep quality significantly worsens. The high correlation value and statistical significance ($p = 0.000$) suggest a consistent and meaningful association between longer disease duration and poor sleep quality.

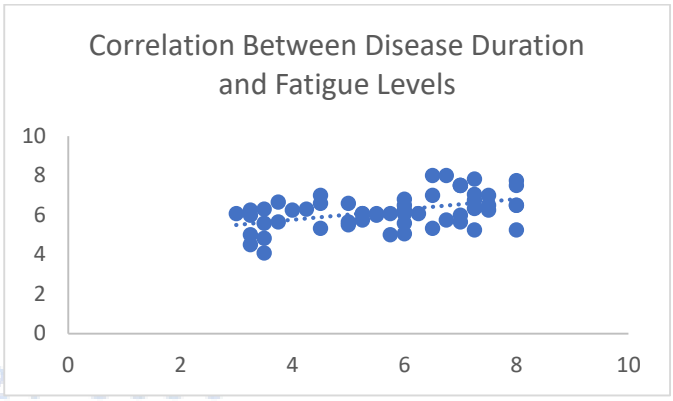


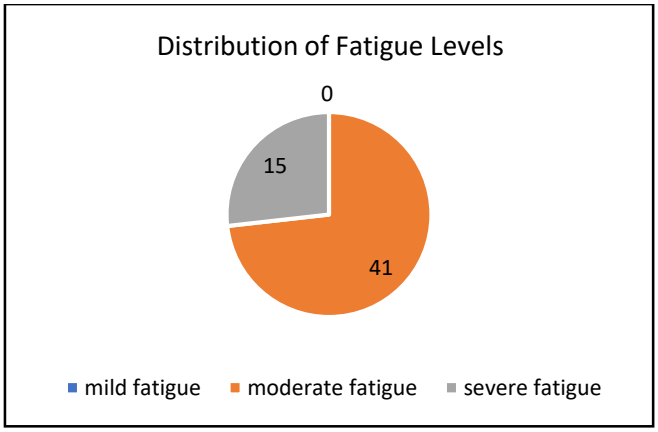
Chart 4: Correlation Between Disease Duration and Fatigue Levels (PFS)

The chart illustrates the relationship between disease duration and fatigue levels measured by the Piper Fatigue Scale (PFS) in 56 participants. The Spearman correlation coefficient ($\rho = 0.441$, $p = 0.001$) indicates a moderate positive correlation, suggesting that individuals with a longer duration of illness tend to experience higher levels of fatigue. This relationship is statistically significant, emphasizing a meaningful association between prolonged disease and increased fatigue.

Table 3: Distribution of Fatigue Levels Among Participants (Based on PFS Scores)

Category	frequency	Percentage
No fatigue	0	0%
mild fatigue	0	0%
moderate fatigue	41	73.2%
severe fatigue	15	26.8%

Chart 5: Distribution of Fatigue Levels Among Participants



Out of 56 participants, none reported no fatigue or mild fatigue. The majority, 41 participants (73%), experienced moderate fatigue, while 15 participants (27%) reported severe fatigue. This indicates that all individuals in the study experienced clinically relevant fatigue, with moderate fatigue being the most prevalent level.

DISCUSSION

The present observational study aimed to assess sleep quality and fatigue levels in individuals with pulmonary tuberculosis (TB) using validated tools—Pittsburgh Sleep Quality Index (PSQI) and Piper Fatigue Scale (PFS). Findings revealed that sleep quality was markedly poor among participants, and fatigue was prevalent at moderate to high levels, with a statistically significant moderate positive correlation between the two variables ($r = 0.515$, $p < 0.01$). These results highlight the critical yet under-addressed burden of sleep disturbances and fatigue in TB management.

This study found that sleep quality is poor in participants with pulmonary tuberculosis, possibly due to chronic coughing, night sweating, and side effects of anti-tubercular therapy (ATT). Such symptoms are commonly reported in TB patients and directly interfere with sleep architecture, including difficulty initiating and maintaining sleep. These findings are consistent with previous research. For instance, Jeffrey Pradeep Raj et al. [12] reported that 17% of TB patients experienced poor sleep quality, and 32% were at risk of restless leg syndrome (RLS), a condition known to disrupt sleep. These rates were significantly higher than in the general population, suggesting that TB patients on ATT may constitute a high-risk group for sleep-related disorders.

In our study, fatigue incidence was universal, with 73.2% of participants reporting moderate fatigue and 26.8% experiencing severe fatigue. This is comparable to the findings by Wipratchaya Thedthong et al., who found that 88% of pulmonary TB patients reported fatigue, primarily at a medium level (52%). Their study also demonstrated that sleep quality significantly co-predicted fatigue ($\beta = .226$, $p < .05$), reinforcing our result that poor sleep is a contributing factor to fatigue in TB [13].

The observed correlation between PSQI and PFS scores in this study further supports the hypothesis that disturbed sleep contributes to physical exhaustion. Increased work of breathing, night sweats, systemic inflammation, and insufficient restorative sleep impair the body's ability to produce energy, accumulate protein, or regulate hormonal balance, ultimately leading to persistent fatigue. This is particularly concerning in TB patients, where immune recovery and physical rehabilitation heavily depend on quality sleep and adequate energy reserves [14,15].

In addition, a strong positive correlation was found between disease duration and both PSQI ($\rho = 0.866$) and PFS ($\rho = 0.441$), suggesting that longer illness duration leads to progressively worsening sleep and fatigue symptoms. This could be attributed to cumulative drug toxicity, psychological stress, and prolonged physiological demands on the body. Our findings echo those of other study by Choudhary S, et al. (2021) that have shown a direct relationship between chronic disease duration and decline in quality of life metrics, including sleep and energy levels [16].

Another significant finding was the strong positive correlation between age and both PSQI and PFS, indicating that older patients experience worse outcomes in these domains. This may be due to age-related decline in sleep efficiency, pre-existing comorbidities, and altered metabolism of ATT drugs. Furthermore, although not deeply explored in this study, gender-based differences may also play a role in fatigue perception and sleep patterns, as suggested in existing literature [17].

Additionally, heart rate showed a strong positive correlation with PSQI ($r = 0.667$, $p < 0.01$) and a weaker correlation with fatigue, which may reflect the physiological stress and sympathetic overactivity associated with chronic infection and poor sleep. This autonomic imbalance is known to

disrupt circadian rhythm and may perpetuate both fatigue and sleep disturbances [18].

Our results are consistent with multiple recent studies. As mentioned, Raj et al. (2021) and Thedthong et al. (2022) both highlight the prevalence of poor sleep and fatigue in TB patients and suggest a bidirectional relationship between the two [12,13]. Similarly, Singh et al. (2021) and Yilmaz et al. (2022) documented high levels of fatigue and sleep disruption among TB patients, often aggravated by medication side effects, systemic inflammation, and psychosocial stressors [15,19]. What sets our study apart is the quantitative demonstration of the correlation between sleep quality and fatigue levels in a public tertiary care hospital population in India, providing localized evidence for patient-centered interventions.

There are certain limitations to this study. Its cross-sectional design limits our ability to infer causality between variables. Self-reported measures (PSQI and PFS) may be influenced by subjective bias or recall inaccuracy. The single-center sampling and relatively small sample size (n = 56) may limit generalizability to broader TB populations. Additionally, psychosocial, nutritional, and environmental variables that could impact sleep and fatigue were not included in the analysis.

The findings highlight the importance of integrating sleep and fatigue assessments into standard TB care protocols. Simple interventions like sleep hygiene counselling, relaxation therapy, Breathing exercises, fatigue education, and graded physical activity, Yoga could be added to medical management plans. Given the established link between poor sleep, fatigue, and treatment non-adherence, addressing these symptoms could improve compliance and treatment success. Furthermore, interdisciplinary collaboration between physicians, physiotherapists, psychologists, and social workers may offer holistic care and accelerate recovery in TB patients.

CONCLUSION

This study highlights important non-respiratory symptoms in pulmonary tuberculosis patients, specifically poor sleep quality and high prevalence of fatigue. The major findings revealed that 73.2% of participants experienced moderate fatigue, while 26.8% had high levels of fatigue, with no cases of mild or no fatigue reported. A moderate positive correlation was observed between poor sleep quality and increased fatigue levels, indicating that sleep disturbances may significantly contribute to the physical exhaustion experienced by TB patients.

In terms of practical applications, these results emphasize the need to incorporate routine screening for sleep quality and fatigue into tuberculosis care protocols. Addressing these symptoms through non-pharmacological interventions such as sleep hygiene education, fatigue management programs, physical rehabilitation, and psychological counselling can improve patient comfort, treatment adherence, and overall recovery.

Future research should focus on longitudinal studies to evaluate changes in sleep and fatigue over the course of TB treatment, and assess the effectiveness of targeted interventions. Larger, multicentric studies including broader psychosocial and nutritional variables may further clarify the multidimensional burden of TB and support the development of holistic, patient-cantered care models.

ACKNOWLEDGEMENT: With deep respect and sincere appreciation, I extend my heartfelt gratitude to my esteemed guide for their invaluable mentorship, insightful suggestions, and unwavering support throughout the course of this research. Their expertise and encouragement played a pivotal role in shaping this study. I am profoundly thankful to the Principal and management of my college for fostering an academic environment that encourages research and innovation, and for providing the necessary resources to carry out this project. A special note of gratitude goes to the staff and administration of the Tuberculosis and Chest Diseases (TBCD) Ward, Civil Hospital, Ahmedabad. Their cooperation, kindness, and assistance made data collection and patient interaction seamless and meaningful. I am truly grateful to each and every patient who generously shared their time and experiences, making this research possible. Your participation is the backbone of this study, and I am honoured by your contribution. I also owe a deep debt of gratitude to my parents, whose love, constant motivation, and belief in my abilities have been the driving force behind my academic journey. Finally, I would like to acknowledge the faculty members and staff of the college for their ongoing support and encouragement, which have been instrumental in the successful completion of this study.

Source of Funding: Nil

Conflict of Interest: The authors declare no conflict of interest

REFERENCES

1. World Health Organization. Global Tuberculosis Report 2022. Geneva: WHO; 2022.
2. World Health Organization. The End TB Strategy. Geneva: WHO; 2014.
3. Udwadia ZF, Pinto LM, Uplekar MW. Tuberculosis management by private practitioners in Mumbai, India: has anything changed in two decades? PLoS One. 2010;5(8):e12023.
4. Arinaminpathy N, Batra D, Khaparde S, et al. The number of privately treated tuberculosis cases in India: an estimation from drug sales data. Lancet Infect Dis. 2016;16(11):1255–1260.
5. Tostmann A, Boeree MJ, Aarnoutse RE, et al. Antituberculosis drug-induced hepatotoxicity: concise up-to-date review. J Gastroenterol Hepatol. 2008;23(2):192–202.
6. Bhatti AB, Usman M, Kandi V. Current scenario of tuberculosis in India: a review of the literature. Cureus. 2016;8(10):e890.
7. Irwin MR, Olmstead R, Carroll JE. Sleep disturbance, sleep duration, and inflammation: a systematic review and meta-analysis of cohort studies. Biol Psychiatry. 2016;80(1):40–52.
8. Van Hoorn R, Jaramillo E, Collins D, et al. The effects of tuberculosis on health-related quality of life. Eur Respir J. 2016;48(5):1503–1511.
9. Han Z, Shi Y. Prevalence of neck pain among online learning students during COVID 19. Medicine (Baltimore). 2024;103(3):e3912.
10. Buysse DJ, Reynolds CF III, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. Psychiatry Res. 1989;28(2):193–213.
11. Piper BF, Dibble SL, Dodd MJ, Weiss MC, Slaughter RE, Paul SM. The revised Piper Fatigue Scale: psychometric evaluation in women with breast cancer. Oncol Nurs Forum. 1998;25(4):677–684.
12. Raj JP, Das S, Kumari R, Muralidharan R. Prevalence of poor sleep and restless legs syndrome among tuberculosis patients. Lung India. 2021;38(1):35–40.
13. Thedthong W, Kamolthip R, Moolwong T. Predictors of fatigue in patients with pulmonary TB. Pac Rim Int J Nurs Res. 2022;26(2):150–163.
14. Marques TR, da Silva Ferreira V, Lima NS. Impact of chronic infection on sleep and energy. Front Psychol. 2023;14:1123412.
15. Irwin MR. Sleep and inflammation: partners in sickness and in health. Nat Rev Immunol. 2019;19(11):702–715.
16. Choudhary S, Gupta R, Singh P. Fatigue in infectious diseases. J Clin Med. 2021;10(9):1914.
17. Moline M, Broch L. Gender differences in sleep and fatigue. J Womens Health (Larchmt). 2020;29(4):453–460.
18. Cohen SP, Vase L, Hooten WM. Autonomic imbalance and fatigue in chronic disease. J Intern Med. 2022;291(5):569–582.
19. Yilmaz F, Kocyigit BF, Cinar HG. Fatigue and sleep quality in patients with pulmonary tuberculosis. BMC Pulm Med. 2022;22(1):135.