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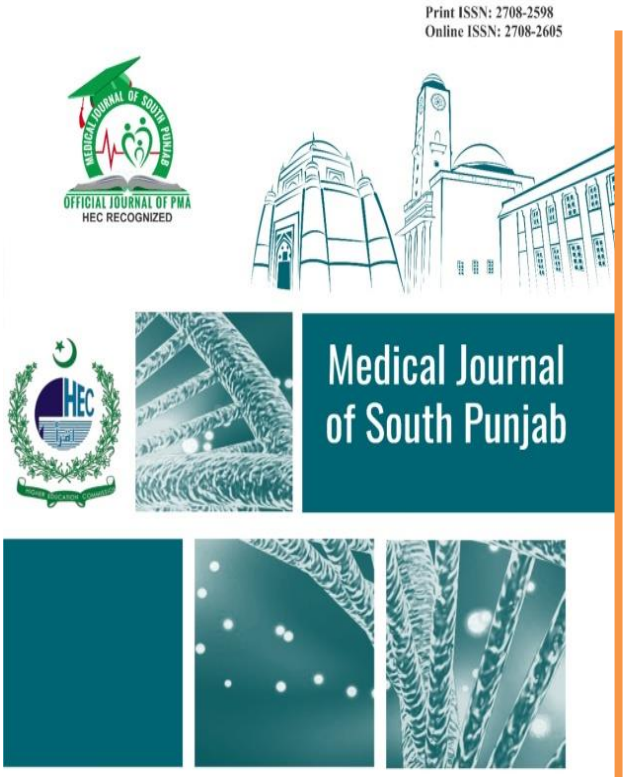

Prevalence of pulmonary tuberculosis in end stage renal disease patients: A single center study

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Original Article

Prevalence of pulmonary tuberculosis in end stage renal disease patients: A single center study

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ABSTRACT

Objective: To determine the prevalence of pulmonary tuberculosis and its associated factors among patients with end-stage renal disease at a single tertiary care center.

Methods: This cross-sectional study included 145 patients diagnosed with ESRD. Demographic data, clinical characteristics, comorbid conditions, and dialysis duration were recorded. Pulmonary tuberculosis was diagnosed based on clinical, radiological, and microbiological criteria. Data were analyzed using appropriate statistical tests, and a p-value ≤0.05 was considered statistically significant.

Results: The mean age of participants was 52.6 ± 13.4 years, with a male predominance (63.4%). The mean body mass index was 23.4 ± 3.2 kg/m². Hypertension was the most common comorbidity (74.5%), followed by diabetes mellitus (46.2%), ischemic heart disease (20%), and hepatitis C infection (15.2%). The overall prevalence of pulmonary tuberculosis among ESRD patients was 12.4%. PTB prevalence was significantly higher in patients undergoing dialysis for more than three years compared to those with a dialysis duration of three years or less (18.8% vs. 8.3%, p = 0.04).

Conclusion: ESRD patients on maintenance dialysis are at substantially increased risk of PTB. In our cohort, the prevalence of 12.4% and the significant association with longer dialysis duration underscore the need for sustained screening and preventive strategies.

Keywords: Pulmonary tuberculosis, ESRD, Prevalence, Dialysis

1. INTRODUCTION

Pulmonary tuberculosis (PTB) remains a major global health concern, affecting millions of people worldwide and posing significant morbidity and mortality, especially among immunocompromised populations[1]. According to the World Health Organization (WHO), an estimated 10.6 million people developed tuberculosis (TB) in 2022, with 1.3 million deaths among HIV-negative individuals and an additional 167,000 among those with HIV infection[2]. Patients with chronic kidney disease (CKD), particularly those with end-stage renal disease (ESRD) requiring dialysis, are at an increased risk of developing active TB compared to the general population[3]. Studies have shown that the incidence of TB in ESRD patients is up to 10 to 25 times higher, with pulmonary involvement being the most frequent manifestation (2,3). This increased susceptibility makes TB a significant contributor to morbidity and mortality among ESRD patients worldwide[4,5].

The pathophysiology underlying the increased risk of tuberculosis in ESRD is multifactorial and largely related to immune system dysfunction. Uremia and its metabolic consequences impair both innate and adaptive immunity, particularly affecting T-cell mediated immune responses that are crucial for containing *Mycobacterium tuberculosis*[6]. Additionally, malnutrition, anemia, oxidative stress, and the accumulation of uremic toxins further compromise host defense mechanisms. Dialysis itself may alter immune homeostasis through complement activation, chronic inflammation, and loss of essential immune mediators during the dialysis process[7]. Consequently, ESRD patients are more prone to both reactivation of latent TB infection and development of new infections after exposure[8].

The clinical presentation of tuberculosis in ESRD patients often differs from that seen in immunocompetent individuals. While pulmonary TB remains the predominant form, extrapulmonary involvement is also relatively common, and the symptoms may be atypical or masked by overlapping uremic features such as fatigue, weight loss, and anorexia[9]. Radiological findings may also be non-specific, leading to delays in diagnosis and initiation of treatment. This diagnostic challenge further contributes to the high morbidity and mortality associated with TB in this population[10].

From a public health perspective, the coexistence of ESRD and TB represents a dual burden on healthcare systems, especially in developing countries where both conditions are highly prevalent. The growing incidence of ESRD, largely driven by diabetes mellitus and hypertension, increases the at-risk population for TB[11].

Given the significant impact of pulmonary tuberculosis on the clinical outcomes of ESRD patients, understanding its prevalence and associated risk factors is crucial for improving patient care. This study aims to determine the prevalence of pulmonary tuberculosis among patients with end-stage renal disease, thereby contributing to local data and guiding early screening and preventive strategies to reduce TB-related morbidity and mortality in this vulnerable group.

2. METHODOLOGY

This descriptive cross-sectional study was conducted at the Multan Institute of Kidney Diseases, Multan, to determine the prevalence of pulmonary tuberculosis among patients with end-stage renal disease (ESRD). The study duration was six months, from 5 December 2024 to 4 June 2025. The sample size was determined using the WHO sample size calculator based on a reported TB prevalence of 10.5% in ESRD patients from previous literature, with a 5% margin of error

and a 95% confidence level. The estimated sample size was 145[12].

All patients diagnosed with ESRD and undergoing maintenance hemodialysis for at least three months were considered eligible for inclusion. Patients aged 18 years and above who provided written informed consent were enrolled, while those with acute kidney injury, patients already on anti-tuberculous therapy, or those with incomplete data were excluded from the study.

Data were collected using a structured questionnaire that included demographic information such as age, sex, duration of dialysis, and comorbid conditions like diabetes mellitus and hypertension. Patients were assessed for symptoms suggestive of pulmonary tuberculosis, including chronic cough, fever, weight loss, and night sweats. All participants underwent a chest X-ray, and sputum samples were examined for acid-fast bacilli (AFB) using Ziehl–Neelsen staining. In cases with negative sputum smears but high clinical or radiological suspicion, further diagnostic tests such as GeneXpert MTB/RIF assay and high-resolution computed tomography (HRCT) of the chest were performed. The diagnosis of pulmonary tuberculosis was made according to the World Health Organization (WHO) and National TB Control Program (NTP) criteria.

End-stage renal disease was defined as chronic kidney disease stage V with a glomerular filtration rate (GFR) below 15 mL/min/1.73 m² requiring maintenance dialysis, while pulmonary tuberculosis was defined as the presence of *Mycobacterium tuberculosis* confirmed through sputum microscopy, GeneXpert positivity, or characteristic radiological findings in symptomatic patients.

Data were entered and analyzed using the Statistical Package for the Social Sciences (SPSS) version 26.0. Quantitative variables such as age and duration of dialysis were presented as mean ± standard deviation, while qualitative variables such as gender, comorbidities, and tuberculosis status were expressed as frequencies and percentages. The prevalence of pulmonary tuberculosis was calculated, and associations between TB and various clinical factors were evaluated using the Chi-square test, considering a *p*-value of less than 0.05 as statistically significant. Ethical approval was obtained from the Institutional Ethical Review Committee of the Multan Institute of Kidney Diseases, and written informed consent was obtained from all participants prior to data collection.

3. RESULTS

A total of 145 patients with end-stage renal disease were included in the study, with a mean age of 52.6 ± 13.4 years. The majority were male (63.4%), and the mean BMI was 23.4 ± 3.2 kg/m². Hypertension was the most prevalent comorbidity (74.5%), followed by diabetes mellitus (46.2%), ischemic heart disease (20%), and hepatitis C infection (15.2%). The overall prevalence of pulmonary tuberculosis (PTB) among ESRD patients was 12.4% (Table 1).

Patients undergoing dialysis for more than three years had a higher PTB prevalence (18.8%) compared to those on dialysis for three years or less (8.3%), with a *p*-value of 0.04. Although PTB was more frequent among diabetic patients (16.4%) than non-diabetic patients (9.0%), this difference did not reach statistical significance ($p = 0.12$) (Table 2).

Among hypertensive patients, 13.0% had TB compared to 10.8% of non-hypertensive patients ($p = 0.57$). Likewise, the prevalence of PTB was slightly higher in patients with hepatitis C infection (18.2%) compared to those without infection (11.4%), but this difference was statistically non-significant ($p = 0.28$) (Table 3).

Table 1: Demographic and Clinical Characteristics of ESRD Patients (n = 145)

Variable	Mean ± SD / Frequency	Percentage (%)
Age (years)	52.6 ± 13.4	—
Gender		
Male	92	63.4
Female	53	36.6
Body Mass Index (BMI) (kg/m²)	23.4 ± 3.2	—
Duration of Dialysis (years)	2.8 ± 1.6	—
Hypertension	108	74.5
Diabetes Mellitus	67	46.2

Ischemic Heart Disease	29	20.0
Hepatitis C Infection	22	15.2
Pulmonary Tuberculosis (PTB)	18	12.4

Table 2: Comparison between pulmonary tuberculosis and duration of dialysis / diabetes mellitus

Variable	Category	TB Positive (n)	TB Negative (n)	p
Duration of Dialysis	≤ 3 years	8 (8.3%)	89 (91.7%)	**0.04**
	> 3 years	9 (18.8%)	39 (81.2%)	
Diabetes Mellitus	Present	11 (16.4%)	56 (83.6%)	0.12
	Absent	7 (9.0%)	71 (91.0%)	

Table 3: Comparison between pulmonary tuberculosis and hypertension / hepatitis C infection

Variable	Category	TB Positive (n)	TB Negative (n)	p
Hypertension	Present	14 (13.0%)	94 (87.0%)	0.57
	Absent	4 (10.8%)	33 (89.2%)	
Hepatitis C Infection	Present	4 (18.2%)	18 (81.8%)	0.28
	Absent	14 (11.4%)	109 (88.6%)	

4. DISCUSSION

In our study of 145 patients with end-stage renal disease (ESRD) undergoing maintenance hemodialysis, the prevalence of pulmonary tuberculosis (PTB) was 12.4%. This compares to the 8.3% found by Tanwani et al[13] in Karachi, and the much higher 27% reported by Beyene et al[14] in Addis Ababa. These differences likely reflect variations in TB endemicity, dialysis infrastructure, duration of exposure, and comorbidity profiles of patients.

Min et al[15] in a Korean study observed an adjusted hazard ratio of 4.39 (95% CI 3.60-5.37) for active TB in dialysis patients versus matched controls. Okada et al[16] indicated incidence rates 6-25-fold higher in ESRD patients, and higher mortality during treatment.

In our cohort, duration of dialysis >3 years was significantly associated with PTB (18.8% vs 8.3% for ≤3 years, $p = 0.04$). By contrast, our results suggest that longer dialysis vintage may carry increased risk in our setting, which may reflect cumulative immune suppression, repeated hospital exposures, malnutrition, or latent TB activation over time. Pavan et al[17] in India reported an incidence of 12% among 200 HD patients, noting early years of dialysis as a risk factor and a high proportion of extrapulmonary TB (87.5%).

Regarding comorbidities, although we found a higher PTB prevalence among diabetic patients (16.4% vs 9.0%), the difference did not reach statistical significance ($p = 0.12$). In contrast, our findings align with Tanwani et al[13] who in a Karachi study found diabetes to be significantly more prevalent among TB patients (18.3% vs 2.1%, $p<0.001$) albeit in a smaller sample size. This suggests that the interplay between diabetes, ESRD, and TB may vary by population and endemicity, and may require larger studies to detect significance in our setting.

Hypertension and hepatitis C infection were not significantly associated with PTB in our cohort ($p = 0.57$ and $p = 0.28$ respectively). Comparable to this, Chitnis et al[18] noted that while ESRD dramatically increases TB risk, traditional cardiovascular comorbidities were less consistent as independent risk factors. South Africa's Ndamase et al[19] reported an incidence rate of 4 505 per 100 000 patient-years among dialysis patients at a tertiary centre, and identified informal housing and hospitalisation history, rather than hypertension or hepatitis C, as significant contributory factors.

The greater vulnerability of ESRD patients to TB can be explained through multiple mechanisms: immune dysfunction due to uraemia (impaired T-cell and macrophage function), malnutrition, repeated healthcare exposures, and often atypical presentations leading to diagnostic delay. High prevalence of latent TB infection (LTBI) among dialysis patients has been reported by Lee et al[20] where QFT-G positivity was 40% (95% CI 22.7-59.4) and active TB incidence 3.53 per 100 person-years among ESRD patients. These findings reinforce the importance of screening for LTBI and

considering TB preventive therapy in high-risk dialysis populations.

5. CONCLUSION

ESRD patients on maintenance dialysis are at substantially increased risk of PTB. In our cohort, the prevalence of 12.4% and the significant association with longer dialysis duration underscore the need for sustained screening and preventive strategies.

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