

Burden of Tuberculosis Infection in Household Contacts: Evidence from A Northern Kerala District

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ABSTRACT

Background -Household contacts of patients with pulmonary tuberculosis (TB) are at higher risk of tuberculosis infection (TBI) because of repeated and prolonged exposure to infected patients. Early identification of TBI enables timely initiation of tuberculosis preventive treatment (TPT), through IGRA (Interferon-Gamma Release Assay). TPT will reduce the progression to active disease and contribute to national TB elimination strategies.

Methods - A cross-sectional observational study was conducted among household contacts of pulmonary TB patients diagnosed in two tuberculosis unit of northern Kerala between 2024 and 2025. All those aged above 5yrs who are household contacts of Pulmonary TB were enrolled after obtaining informed written consent. All Participants subjected to IGRA (QuantiFERON-TB Gold Plus)testing. IGRA-positive individuals were further evaluated to exclude active TB. Clinical, Sociodemographic, comorbidities, substance abuse, smoking history, , immunosuppression and overcrowding were documented using a semi-structured questionnaire. Data analysis was performed using SPSS software, and associations were assessed using chi-square tests ($p < 0.05$ considered significant).

Results - Of 204 household contacts screened, 93 were IGRA-positive yielding a TBI prevalence of 45.6%. Diabetes mellitus was significantly associated with IGRA positivity (79.3%; $p = 0.023$). No statistically significant associations were observed between IGRA positivity and sex ($p = 0.977$), age group ($p = 0.55$), smoking history ($p = 0.633$), symptom status ($p = 0.458$), comorbidity profile ($p = 0.116$), substance abuse ($p = 0.346$), or overcrowding ($p = 0.88$).

Conclusion - Nearly one in two household contacts of pulmonary TB patients had evidence of tuberculosis infection, more than double that reported in the general Kerala population. Diabetes mellitus was independently associated with higher IGRA positivity. These findings strongly support IGRA-based screening of all household contacts, and prompt TPT initiation, particularly among individuals with diabetes mellitus

INTRODUCTION

Tuberculosis (TB), caused by *Mycobacterium tuberculosis*, remains one of the leading cause of morbidity and mortality worldwide. Despite the advances in diagnosis and treatment, TB continues to be a major public health challenge, especially in high-burden countries like India. Pulmonary tuberculosis primarily transmitted through airborne droplet nuclei generated by individuals with active pulmonary TB. Household contacts of patients with pulmonary TB are at a risk of prolonged and repeated exposure to an infectious source within enclosed domestic environment amplifies infection probability more than the general population. Several studies have demonstrated that the prevalence of tuberculosis infection among household contacts is considerably higher than that observed in the general population. Factors such as overcrowding, inadequate ventilation, prolonged duration of exposure, and high bacillary load in the index case further increase the risk of transmission within households.[1–3]

In order to prevent household transmission and active disease, the WHO and NTEP mandate active screening and Tuberculosis Preventive Treatment (TPT) for high-risk contacts—specifically children, immunocompromised individuals, and people with diabetes[4,]

Among individuals harbouring TBI, approximately 5–10% will progress to active disease over their lifetime, with nearly half of these progressions occurring within the first two years following primary infection.

Kerala has lower incidence of TBI than most of India, but household exposure remains a major driver of transmission. While Kerala's 'Akshaya Keralam' campaign promotes preventive treatment, local data on household infection rates are limited.[5,6] Measuring this risk is essential to improve prevention and reach national elimination goals.[7,8]

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The present study was conducted to determine the prevalence of tuberculosis infection among household contacts of pulmonary TB patients in a northern Kerala district and to identify factors associated with it.

MATERIALS & METHODS

Study Design and Setting

This was a cross-sectional observational study conducted at the Department of Respiratory Medicine, MES Medical College Hospital, Perinthalmanna, Malappuram district, northern Kerala—a centre operating an established NTEP unit. The study period extended from January 2024 to December 2025

Study Population and Eligibility Criteria

The study population included household contacts of microbiologically confirmed pulmonary TB patients registered under the NTEP. Household contact is a person who shared the same enclosed living space with the index patient for one or more nights or for frequent or extended daytime periods during the three months before the start of treatment.

Individuals with a documented prior history of TB disease were excluded.

Data Collection

semi-structured questionnaires were administered to collect data on Clinical, Sociodemographic, household characteristics, smoking history, alcohol, substance use, and comorbid conditions.

Diagnostic Evaluation

All participants underwent Interferon-Gamma Release Assay (IGRA) testing using the QuantiFERON-TB Gold Plus assay for the detection of tuberculosis infection. IGRA-positive individuals were further evaluated including chest radiography and sputum examination to exclude active TB.

Statistical Analysis

Data were entered and analysed using SPSS software. The prevalence of TBI was expressed as a proportion with 95% confidence interval.

A two-tailed p-value of <0.05 was considered statistically significant.

Ethical Considerations

Ethical approval was obtained from the Institutional Ethics Committee of MES Medical College. Written informed consent was obtained from all participants prior to enrolment.

RESULTS

Prevalence of Tuberculosis Infection

A total of 204 household contacts were enrolled during the study period. IGRA testing identified 93 participants (45.6%) as positive for TBI, while 111 participants (54.4%) IGRA-negative results.

Table 1. Distribution of IGRA Status Among Study Participants (n = 204)

IGRA Status	Frequency (n)	Percentage (%)
Negative	111	54.4
Positive	93	45.6
Total	204	100.0

The findings indicate a substantial burden of latent tuberculosis infection among household contacts of pulmonary TB patients.

TABLE 2 – Characteristics of study population & proportion of TBI (n=204)

Variables	IGRA Negative n (%)	IGRA Positive n (%)	p-value
Age (years)			0.55
<20	33 (60.0)	22 (40.0)	
21–40	44 (57.1)	33 (42.9)	
41–60	27 (48.2)	29 (51.8)	
61–80	6 (40.0)	9 (60.0)	
>80	1 (100)	0 (0)	
Sex			0.977
Male	51 (54.3)	43 (45.7)	
Female	60 (54.5)	50 (45.5)	

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Variables	IGRA Negative n (%)	IGRA Positive n (%)	p-value
Smoking History			0.633
Non-smoker	99 (55.0)	81 (45.0)	
Smoker	12 (50.0)	12 (50.0)	
Substance Abuse			0.346
None	107 (55.2)	87 (44.8)	
Alcohol use	4 (40.0)	6 (60.0)	
Overcrowding			0.88
Present	43 (53.8)	37 (46.2)	
Absent	68 (54.8)	56 (45.2)	

Sociodemographic and Clinical Characteristics

The distribution of IGRA positivity across all study variables is presented in Table 2. IGRA positivity was broadly distributed across age categories: <20 years (40.0%), 21–40 years (42.9%), 41–60 years (51.8%), and 61–80 years (60.0%), with no statistically significant age gradient ($p = 0.55$). Similarly, IGRA positivity was nearly equivalent between males (45.7%) and females (45.5%), with no significant sex-based difference ($p = 0.977$). Smoking history ($p = 0.633$), substance or alcohol use ($p = 0.346$), household overcrowding ($p = 0.88$), and other comorbidities ($p = 0.116$) were not significantly associated with tuberculosis infection.

Table 3. Association Between Diabetes Mellitus and IGRA Status (n = 204)

Diabetes Mellitus	IGRA Negative n (%)	IGRA Positive n (%)	Total (n)
No	105 (60.0)	70 (40.0)	175
Yes	6 (20.7)	23 (79.3)	29
Total	111 (54.4)	93 (45.6)	204
p = 0.023			

Diabetes mellitus (DM) was the only variable demonstrating a statistically significant association with IGRA positivity (Table 3). Among the 29 diabetic participants, 23 (79.3%) were IGRA-positive compared with 70 of 175 non-diabetic participants (40.0%). This difference was statistically significant ($p = 0.023$). This suggests a significant association between diabetes and increased IGRA positivity in our study population.

DISCUSSION

This cross-sectional study conducted among household contacts of pulmonary tuberculosis (TB) patients at in two tuberculosis unit of northern Kerala demonstrated a high prevalence of tuberculosis infection (TBI), with 45.6% of contacts testing positive by Interferon-Gamma Release Assay (IGRA). This prevalence is substantially higher than the estimated TBI prevalence of 20.5% reported among the general population in Kerala, highlighting the significantly increased risk associated with prolonged household exposure to TB cases.[1] The findings are consistent with previous studies that have elevated rates of TBI among household contacts, indicating the household as a critical site of transmission.

The findings of the present study have important public health implications. Despite Kerala's relatively low annual risk of tuberculosis infection at the population level, Nearly one in every two household contacts had evidence of tuberculosis infection by the time the index case was diagnosed. This observation emphasizes the need for prompt screening, and wider implementation of tuberculosis preventive treatment. The study also supports the actions undertaken through Kerala's "Akshaya Keralam" initiative and the National Tuberculosis Elimination Programme, which prioritize preventive therapy and active screening among high-risk contacts[9,10]

Diabetes mellitus emerged as the only factor significantly associated with IGRA positivity. Nearly four-fifths (79.3%) of diabetic contacts were IGRA positive compared with 40.0% of non-diabetic contacts. Hyperglycaemia impairs innate and adaptive immune responses, including macrophage function and T-cell-mediated immunity, thereby increasing susceptibility to Mycobacterium tuberculosis infection. Considering India's growing burden of diabetes, these findings support integrated TB-diabetes screening strategies and prioritisation of diabetic household contacts for enhanced surveillance and preventive measures[11,12]

In contrast, demographic and behavioural factors such as age, sex, smoking status, alcohol use, overcrowding, other comorbidities were not significantly associated with tuberculosis infection.

Overall, the findings reinforce the importance of strengthening contact investigation strategies within the NTEP, with emphasis on screening of household contacts and prompt implementation of TPT. Enhanced focus on high-risk groups, especially individuals

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with diabetes mellitus, may further contribute to reducing future progression to active TB and support ongoing efforts toward TB elimination in Kerala and India.

CONCLUSION

This study demonstrates a high prevalence of tuberculosis infection among household contacts of pulmonary tuberculosis patients in northern Kerala, with 45.6% of contacts testing IGRA positive. The higher prevalence compared with that reported in the general population highlights the household as an important setting for tuberculosis transmission. Diabetes mellitus was significantly associated with increased risk of tuberculosis infection. These findings strongly support IGRA-based screening of all household contacts, and prompt TPT initiation, particularly among individuals with diabetes mellitus.

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