Original Article

A Cross-sectional Study Assessing Indoor Air Pollution Sources among TB Households in Northern Karnataka

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Background : It is estimated that about 40% of the Indian population is infected with TB bacteria, the vast majority of whom have latent TB rather than TB Disease. Indoor Air Pollution is a recognized risk factor for TB Disease. Providing clean air was a treatment used in the pre-antibiotic era. This is now overlooked. Addressing environmental factors in TB treatment is challenging but a major determinant of the Quality of Life and speedy recovery of TB Patients.

Aims and Objectives : Our study aims to assess Indoor Air Pollution exposure among TB Patients. To assess the prevalence of Indoor Air Pollution sources among TB Households.

Materials and Methods : A cross-sectional study among TB patients of Vijayapura District from May, 2023 to July, 2023. In 119 TB Patients were selected by probability proportional to size sampling method from 5 TUs which was selected by Random sampling method. Data was obtained by house-to-house visits using a semi-structured questionnaire, which was subsequently entered into Excel. Data was analysed using SPSS V.26.

Results : More than 80% of the households belonged to BPL Category. 90% of the study households did not have cross-ventilation and it was statistically associated with level of Education. 63% of the houses did not have separate kitchens with smoke vents and it was statistically associated with Economic class. 58.8% of households had over-crowding and 86.6% had any sources of Indoor Air Pollution in the house.

Conclusion : Indoor Air Pollution is common in TB households and has been identified as a risk factor for TB mortality and morbidity. As the government has attempted to address nutrition through food baskets and the Nikshay Poshan Yojana, we should endeavour to implement measures that address Indoor Air Pollution. We should stimulate research into realistic practical remedies for Indoor Air Pollution among TB patients.

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Key words **: Indoor Air Pollution, TB Households, Environmental Factors.**

Tuberculosis is a leading cause of morbidity and mortality, especially in low-income and middle-income countries. India has the highest burden of Tuberculosis Infection (TBI) globally, with nearly 35-40 crore[1], of which an estimated 26 lakh are likely to develop active TB. It is estimated that about 40% of the Indian population is infected with TB bacteria, most of whom have latent TB rather than TB Disease[2].

Many factors are shown to increase the risk of activation from latent TB infection to clinically manifested active TB and its severity, including host immunity, exposure to smear-positive pulmonary TB patients, malnutrition and socio-economic and environmental exposure and risk behaviour (eg, smoking, alcohol consumption, sexual behaviour)[3].

Air pollution is of particular interest among environmental risk factors, not only because air pollutants, such as Particulate Matter (PM), can serve as carriers of airborne Mycobacterium but also because it affects lung immunity by inducing oxidative stress and inflammation and impairs the host's immunity[4]. Although the mechanism of TB activation from air pollution is not fully understood, it has been proposed that air pollution affects TB activation by altering the lung immunity of the host due to chronic oxidative stress followed by inflammation[5]. Recent literature also shows that air pollution can cause carbon accumulation in the bronchial tree, which increases the risk of TB by inactivating pulmonary macrophages[6].

WHO End Tuberculosis Strategy[7] recommends combining biomedical interventions with policies on social protection and action on other determinants. Indoor Air Pollution is a recognized risk factor for TB

Editor's Comment :

- Indoor Air Pollution presents a major health risk in households affected by TB, particularly in rural areas.
- This study showed that, 90% of the households lacked proper cross ventilation, 87% regularly used mosquito coils, incense sticks, dhoop/camphor and 70% of these households still used wood for cooking and heating water for bathing.
- Raising awareness about these common indoor air pollutants and promoting Ventilation measures need to be focussed as one of the important preventive measure to reduce TB and other airborne diseases transmission.

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Disease and can accelerate the progression of latent TB infections to TB Disease. In the pre-antibiotic age, providing clean air was a treatment[8]. This is now overlooked. Hermann Brehmer was a German physician who opened the first sanatorium specifically dedicated to treating this disease[9]. Addressing environmental factors in TB treatment is challenging but a major determinant of the Quality of Life and speedy recovery of TB Patients.

In this study, we aimed to assess the exposure of sources for Indoor Air Pollution among TB patients. We also aimed to assess the ventilation and overcrowding status of the TB Households.

Materials and Methods

Study Area : Northern Karnataka District.

Study Population: Households of Bacteriologically confirmed Pulmonary TB cases.

Study Period : April, 2023 to July, 2024.

Study Design : Cross-sectional survey.

Study Technique :

A cross-sectional survey using a semi-structured questionnaire was conducted through in-person interviews in the households of bacteriologically confirmed pulmonary TB cases after acquiring ethical clearance from the Institutional Ethics Committee. All questionaries were made in English and then translated into the local language (Kannada) and administered after pilot testing. The questionnaire included Socio-demographic variables of the Household (HH) and variables to assess sources of Indoor Air Pollution. The head of the household or any adult male/ female in the household was interviewed after taking informed consent (Table 1).

Sample size :

With the anticipated proportion of burning incense of 76%[10], the study would require a sample size of 110 (Minimum) TB patients with a 95% level of confidence and 8% absolute precision.

Formula used :

$$n = \frac{z^2\, p^*q}{d^2}$$

Where Z = Z statistic at α level of significance

d^2 = Absolute error

P = Proportion rate

q = 100-p

Dropout rate of 5% = 110+6=116

Sampling Technique:

Out of the 10 TB units in the district, five (5) units was selected using a simple random sampling method (lottery method). TB patients (Bacteriologically confirmed Pulmonary TB) was selected from sampled TB units using the probability proportional to size sampling method to get a good representation till the estimated sample size is reached.

Table 1 — *Socio-demographic Characteristics*

Variables	Categories	Value (%) N=119
Sex	Male	56 (47)
	Female	63 (53)
Age Group	18-39	52 (43.7)
	40-59	42 (35.3)
	60-89	25 (21.0)
Educational Level	Never Attended	47 (39.5)
	Pre/Primary	29 (24.4)
	High School	21 (17.6)
	PUC/Diploma	14 (11.8)
	Degree and above	8 (6.7)
Religion	Hindu	93 (78.2)
	Muslim	26 (21.8)
Caste	SC	22 (18.5)
	ST	13 (10.9)
	OBC	76 (63.9)
	General	8 (6.7)
Type of Family	Nuclear	57 (47.9)
	Joint	44 (37.0)
	3 Generation	18 (15.1)
Size of Family	0-4	56 (47.1)
	5-9	49 (41.2)
	10-14	10 (8.4)
	15+	4 (3.4)
Socio-economic Class (Modified B G Prasad Classification 2022)	Class 1	32 (26.9)
	Class 2	21 (17.6)
	Class 3	34 (28.6)
	Class 4	30 (25.2)
	Class 5	2 (1.7)

Inclusion Criteria :

- All Households of Bacteriologically confirmed Pulmonary TB cases registered in the previous six months (Table 2).

Exclusion Criteria :

- All HHCs of MDR TB cases and HHs where no consent is given.

Operational Definition :

Bacteriologically confirmed Pulmonary TB case: TB diagnosed in a biological specimen by smear microscopy, culture, or a WHO-endorsed rapid molecular test and adopted by NTEP such as expert MTB/RIF®/TrueNat®.

Statistical Analysis :

(1) The data obtained was entered into a Microsoft Excel sheet and statistical analysis was performed using SPSS V.26.

(2) Association between Categorical variables will be compared using the Chi-square test.

(3) $P<0.05$ was considered statistically significant. All statistical tests were performed two-tailed.

Table 2 — *Household Characteristics*

Variables	Categories	Value (%) N=119
Ownership	Own	104 (87.4)
	Rent	15 (12.6)
Type of House	Kutcha	18 (15.1)
	Pucca	51 (42.9)
	Mixed	50 (42)
	60-89	25 (21.0)
Number of Rooms (Excluding Kitchen)	0	10 (8.4)
	1	41 (34.5)
	2	29 (24.4)
	3	18 (15.1)
	4	12 (10.1)
	5	7 (5.9)
Toilet Facility	No	62 (52.1)
	Yes	57 (47.9)
Ration Card	AAY	7 (5.9)
	BPL	96 (80.7)
	APL	4 (3.4)
	Not Available	12 (10.1)
Disposal of Household Waste	Vehicle	46
	Throw Outside	73

Results

A total of 119 TB Patients were recruited and enrolled in the study. 52 % of the study participants were among the 18-39 age group. 78.2% of them were Hindu by Religion and 63.9% belonged to OBC Caste. More than 50% of the participants belonged to class 3 or less according to modified B G Prasad Scale 2022.

87.4% of TB Patients lived in their own houses and 42% had mixed type of housing. More than 80% of the households belonged to BPL Category. 90% of the study households did not have cross-ventilation and it was statistically associated with level of Education. 63% of the houses did not have separate kitchens with smoke vents and it was statistically associated with Economic class. 58.8% of households had over-crowding.

LPG and Wood were the only types of cooking fuel among 30% and 17.6% respectively. All others used wood along with LPG. Kerosene was not at all used among the study households. Only 4 (3.4%) households reported smoking inside the House.

86.6% had a history of daily usage of Mosquito Coils, Incense Sticks, Camphor etc. The presence of any one among them was considered positive. 30.3% of the houses had dampness and 90.8% of them reported that they do not burn waste near their house (Tables 3&4).

Table 3 — *Sources of IAP*

Variables	Categories	Value (%) N=119
Type of Cooking Fuel	LPG Gas	36 (30.3)
	Wood	21 (17.6)
	Both	62 (52.1)
Does Anyone Smoke Inside House?	No	115 (96.6)
	Yes	4 (3.4)
Sources of IAP Inside House by Burning Mosquito Coil, Incense Stick, Camphor Etc*	No	16 (13.4)
	Yes	103 (86.6)
Dampness	No	83 (69.7)
	Yes	36 (30.3)
Burns Waste Near House	No	108 (90.8)
	Yes	11 (9.2)

*Presence of any one of the sources was considered as 'Yes'

Discussion

More than 50% of the participants belonging to Socio-economic class 3 or less have shown that India still faces the issue of TB among the Poor Socio-economic class. Previous studies have shown a higher prevalence of Tuberculosis among the multidimensional poor compared to the multi-dimensional non-poor in most of the states in India[11].

A study done in Pune discovered a link between kerosene use and tuberculosis[10]. In our study we had not found any households using kerosene as a cooking fuel. They responded by saying we are not getting any kerosene from the public distribution system anymore. The Government's Ujjwala program has significantly changed the type of cooking fuel. The 'Pradhan Mantri Ujjwala Yojana' (PMUY) is a flagship scheme with the objective to make clean

Table 4 — *Statistical Association*

Level of Education *versus* Cross-Ventilation						
		Cross-Ventilation			Chi-square	P value
		No	Yes	Total		
Level of Education	Never Attended	45	2	47		
	Pre/Primary	28	1	29		
	High School	20	1	21	16.906	0.002*
	PUC/Diploma	10	4	14		
	Degree and above	5	3	8		
	Total	**108**	**11**	**119**		
Socio-Economic class *versus* Separate Kitchen						
		Separate Kitchen with smoke vent			Chi-square	P value
		No	Yes	Total		
Socio-Economic Class	Class 1	15	17	32		
	Class 2	12	9	21		
	Class 3	19	15	34	15.179	0.004*
	Class 4	27	3	30		
	Class 5	2	0	2		
	Total	**75**	**44**	**119**		

*Statistically Significant

cooking fuel such as LPG available to the rural and deprived households which were otherwise using traditional cooking fuels such as firewood, coal, cow-dung cakes etc[12]. Most of our study households used wood along with LPG citing high cost of LPG.

Indoor air pollution is common in TB households and has been identified as a risk factor for TB mortality and morbidity[13]. In 90% of the houses in our survey lacked cross ventilation, and 58.8% of the households were crowded. In addition to this, 86.6% of people reported using a Mosquito coil, an incense stick, camphor or another indoor pollution source on a daily basis. All of them causes Indoor Air Pollution, which is a significant factor in TB mortality and morbidity[14].

As the Government has attempted to address nutrition through food baskets and the Nikshay Poshan Yojana, we should endeavour to implement measures that address Indoor Air Pollution. We should stimulate research into realistic practical remedies for Indoor Air Pollution among TB Patients. We should also try to bring a discussion on re-instating Sanatoriums which was the Worldwide accepted management technique in the pre-antibiotic era[15].

Limitations: We could have measured the pm 2.5 levels to assess the Indoor air pollution more precisely.

Conclusion

The poorest populations, who are most at risk, should be the focus of TB control initiatives and significant disease determinant like Indoor Air Pollution should be addressed.

Although the Ujjwala program has indicated a change in the type of cooking fuel used, Government should take action to encourage LPG usage by making more of it available and keeping LPG pricing under control.

Those who have been diagnosed with TB should get Health Education about Indoor Air Pollution, which should include general guidance on optimal ventilation and removing sources of IAP.

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