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A CROSS-SECTIONAL STUDY OF PREVALENCE AND RISK FACTORS FOR TB INFECTION AND DISEASE AMONG HOUSEHOLD CONTACTS OF TB PATIENTS IN RURAL DISTRICT IN SOUTH INDIA

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Abstract

Background: Early diagnosis, proper and complete treatment, awareness, and minimizing contact transmission are the main factors which help in lowering the burden of the disease.

Objective - study to determine the prevalence of tuberculosis infection and tuberculosis disease among paediatric household contacts aged <18 years of adult tuberculosis patients and to assess the risk factors associated with occurrence of tuberculosis infection and disease.

Materials and Methods: The Present study was a cross sectional study conducted in the Department of Paediatrics at Sri Devaraj Urs Academy of Higher Education and Research, Tamaka, Kolar – 563101 for 1 year. children of less than 18 years who were staying with confirmed TB patients. Face to face interview were conducted of index cases.

Results: The analysis included ninety-four index cases and 248 responses. Out of 248 residence responses, 11.29% were Suggestive of TB, and 46.77% were not tested for tuberculosis. Among the respondents found to be positive for tuberculosis infection (71.05%) were children under five years of age, (2.56%) were children in the age group of 6 to 15 years and (29.41%) were above 15 years of age.

Conclusion: The study concludes that a higher number of children, particularly children under five years of age in contact with adult TB patients, and exposed to smoking developed the infection.

Key words- Tuberculosis, household contacts, children, index cases

Introduction

Tuberculosis (TB) is a chronic infectious disease and its persistent morbidity and mortality burden remains one of the major public health challenges in India.(1) The global TB report published by the World Health Organization (WHO) indicated that in about 10 million

people, fell ill with tuberculosis in the year 2019.(2) By WHO estimates, India accounts for 27% of the global estimated 10 million cases and 25% of the estimated 1.6 million deaths. The global burden of disease analysis estimated the number of incident cases to be 3 million people in the year 2016.(3)

In 1920, Devoto recognized that healthcare workers were at risk of developing tuberculosis; in 1934, Wells described the falling and evaporation times for droplet nuclei; and Riley, in 1961, described the deposition of airborne bacteria in the lung and, in 1960–1962, described aerial dissemination of *M. tuberculosis* in a tuberculosis ward.(4–6) Chapman, in 1964, described the social and other factors associated with tuberculosis transmission in tuberculosis-affected households.(7) Today there is a wealth of evidence to support transmission of drug-susceptible and drug-resistant tuberculosis in households.(8–10) Transmission of tuberculosis to household contacts is most likely to occur when the index case is smear positive and the household contacts are <15 years of age.(8,11)

Studies show indoor air pollution as a significant risk factor for the occurrence of TB. However, the findings of most studies are based on small study populations.(12,13) Existing literature suggests a number of factors associated with TB infection, including demographic, socio-economic and environmental factors, such as age, sex, level of education, marital status, place of residence, wealth, overcrowding, poor housing and household environment factors.(14–17)
Tuberculosis in children continues to pose a pressing public health challenge and remains one of the leading infectious causes of child morbidity and mortality globally. Most paediatric tuberculosis deaths occur in low-income and middle-income countries, predominantly among children younger than 5 years, who often die without being diagnosed with tuberculosis.(18–20)

About 26% of the cases of TB is attributed to Indoor Pollution.(21) The main source of infection in children is infected adults in their surroundings. 40% of children under one year age, 24% of children between one and 10 years of age, 16% of children between 11 and 15 years of age infected with TB, if left untreated, may develop lymphadenopathy or segmental lesions.(22) There is limited evidence on the coverage of these investigations and screening among household contacts of index tuberculosis patients. Early screening among high-risk populations such as household contacts provide a critical and unique window of opportunity for public health program interventions. Therefore, we conducted this study to determine the prevalence of tuberculosis infection and tuberculosis disease among paediatric household contacts aged <18 years of adult tuberculosis patients and to assess the risk factors associated with occurrence of tuberculosis infection and disease

Materials and Methods

The current study was a cross-sectional study conducted in the Department of Paediatrics at Sri Devaraj Urs Academy of Higher Education and Research, Tamaka, Kolar – 563101. The data collection for the study was done between January 2020 to January 2021 for a period of

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12 months. All the eligible children of less than 18 years who were staying with confirmed TB patients and studied in the Department of Paediatrics at Sri Devaraj Urs Medical College were considered as the study population. Children less than 18 years, who are household contacts of adult TB patients, who had been receiving treatment under the NTEP were included in the study. Children who were contacts of temporary residents, unconfirmed cases based on laboratory testing, those who were not registered in NTEP, and those treated at a private hospital or clinic were excluded from the study.

Sample size

Sample size for household contacts was calculated based on the one-group precision formula. According to the previous prevalence of TB among household contacts of index TB cases estimated to be 20.3, a type I error of 5%, and a precision of 5%, at least 242 household contacts were required.

All the eligible subjects were recruited into the study consecutively by convenient sampling till the sample size is reached.

Study procedure

The list of index TB cases receiving treatment for at least 6 months was obtained from the district TB registrar, Kolar, and the department of chest disease, SDUMC. The index TB cases and their respective household contacts were then interviewed for background and health-related characteristics through face-to-face/tele interview. In the case of children, parental consent was obtained. After admission to the paediatric ward, contacts were subjected for routine investigation and special investigation to diagnose TB.If the cases are diagnosed TB positive clinically, they were referred to the Department of TB and Chest disease-Kolar, to initiate for further treatment and were followed. The study population was children less than 18 years of age who were house hold contacts of adult TB patients subjected to detailed history taking, physical examination including BCG immunization status, nutritional status, tuberculosis skin test (Mantoux test), X-Ray chest, gastric aspirate for CBNAAT. Information regarding risk factors like age, gender, relation to the index case, BCG status, nutritional status, and socioeconomic status was specifically included while taking history.

Operational definition

Household contacts are children who share the same kitchen, sleeping in the same area for more than 3 months with index adult TB patients, both drug-sensitive and multi-drug resistant TB patients who are taking treatment for TB.

MDR-TB: Was defined as a strain of M. tuberculosis resistant to at least two of the most effective first-line drugs (Isoniazid and rifampicin), the most effectiveness ant-TB drug.

Extensive Drug Resistant-Tuberculosis (XDR-TB): This was defined as TB caused by the strain of M. Tuberculosis resistant to at least two first-line drugs and second-line fluoroquinolone and second-line second-line injectable drugs either (Amikacin, kanamycin, or capreomycin).

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The study was approved by the institutional human ethics committee. Informed written consent was obtained from all the study participants, and only those participants willing to sign the informed consent were included in the study. The risks and benefits involved in the study and the voluntary nature of participation were explained to the participants before obtaining consent. The confidentiality of the study participants was maintained.

STATISTICAL METHODS:

Tuberculosis disease and infection were considered the primary outcome variable. Demographic profile (age, gender, locality, socioeconomic status, etc.) clinical parameters of household contacts was considered as Primary explanatory variables.

Descriptive analysis was carried out by mean and standard deviation for quantitative variables, frequency, and proportion for categorical variables. The Chi-square test was used to test statistical significance. Univariate binary logistic regression analysis was performed to test the association between the explanatory variables and outcome variables along with their 95% CI is presented.

P-value < 0.05 was considered statistically significant. Data were analyzed by using SPSS software.

RESULTS:

94 index cases with 248 household contacts were included in the final analysis.

Table 1: Demographic and baseline characteristics details of the index cases (N=94)

Parameter	Index cases	Percentage
Age Group		
<=20	19	20.21%
21 to 35	39	41.49%
36 to 50	12	12.77%
>50	24	25.53%
Gender		
Male	42	44.68%
Female	52	55.32%
Locality		
Rural	74	78.72%
Urban	20	21.28%
Socioeconomic Status		
Above Poverty Line	13	13.83%
Below Poverty Line	81	86.17%
Type of patient		
New	82	87.23%
Treatment after failure/lost to follow-up/died/cured	12	12.77%
Diagnosis of the index case		
Drug-resistant	9	9.57%
Drug sensitive	85	90.43%

Site of disease		
Extra pulmonary	32	34.04%
Pulmonary	62	65.96%
Case Definition		
Clinically diagnosed	16	17.02%
Microbiologically confirmed	78	47.87%
Diabetic	16	17.02%
HIV (reactive)	11	11.70%
Smoking	18	19.15%
Number of children <18 years of age in the family of index case residence		
1	20	21.28%
2	36	38.30%
3	17	18.09%
4	12	12.77%
5	3	3.19%
7	6	6.38%

The mean age was 35.29 ± 15.7 years. Majority of 39 (41.49%) participants were aged between 21 to 35 years, and 24 (25.53%) were aged 50 years and above. Out of 94 index cases, 42 (44.68%) were male, and 52 (55.32%) were female. Among the index cases, 74 (78.72%) participants were living in a rural area, and 20 (21.28%) participants were living in an urban area, 13 (13.83%) participants were above the poverty line and 81 (86.17) participants were below the poverty line. Out of 94 index cases, 82 (87.23%) were new patients, and 12 (12.77%) were treatment after failure. Majority of 85 (90.43%) are drug sensitive. Out of 94 index cases, 32 (34.04%) participants had extra pulmonary, and 62 (65.96%) had Pulmonary. Among the index cases, 16 (17.02%) participants were reported clinically diagnosed, 45 (47.87%) were reported as Microbiologically confirmed, and 78 (82.98%). Out of 94 index cases, 16 (17.02%) had diabetic, 11 (11.70%) were reported reactive HIV and 18 (19.15%) were smokers.

Table 2: Demographic details among household contacts (N=248)

Demographic variables	household contacts	Percentages
Children Age Group		
<= 5 years	114	45.97%
6 to 15 years	117	47.18%
>15 years	17	6.85%
Gender		
Male	116	46.77%
Female	132	53.23%
Locality		
Rural	207	83.47%

Urban	41	16.53%
Socioeconomic Status		
Above Poverty Line	32	12.90%
Below Poverty Line	216	87.10%
Duration of contact with the index case		
<3 month	135	55.10%
3 to 6 months	88	35.92%
>6 months to 2 years	22	8.98%
Relationship with index case		
Parents	116	46.77%
Others	132	53.23%
Household contact sleeping in the same bedroom of index case >3 days per week	185	74.60%
Exposure to cigarette smoking	59	23.79%
BCG Vaccination Done	248	100%
BCG scar Present	248	100%

Among the house hold contacts, majority of, 117 (47.18%) were aged between 6 to 15 years and 114 (45.97%) participants were aged <=5 years. Out of 248 house hold cases 116 (46.77%) were male and 132 (53.23%) were female, 207 (83.47%) participants were living in rural area and 41 (16.53%) participants were living in urban area. Among the house hold contacts, 32 (12.90%) participants were above poverty line and 216 (87.10%) participants were below poverty line. Out of 248 house hold contacts with Duration of contact with the index case, majority of 135 (55.10%) were <3 months and 88 (35.92%) were 3 to 6 months. Among the house hold contacts, 116 (46.77%) were relationship with parents and 132 (53.23%) were relationship with others. Out of 248 house hold contacts, 59 (23.79%) were exposure to cigarette and smoking. All of them 100% house hold contacts were done vaccination and scar present. (Table 2)

Table 3: Descriptive analysis of clinical profile among household contacts (N=248)

Symptoms	household contacts	Percentage
Present	59	23.79%
Absent	189	76.20%
Fever (Persistent/ Unexplained for >2 weeks)	26	10.48%
Cough (unremitting/ intermittent for >2 weeks)	22	8.87%

Failure to thrive/ loss of weight (>5% weight loss in the past 3 months?	50	20.16%
Swelling/lumps on your neck/arms/pits/groin?	12	4.84%
Symptoms of Meningitis during the illness?	8	3.23%
Loss of appetite?	61	24.60%

Out of 248 household contacts, 75 (30.24%) had symptoms, 26 (10.48%) had a fever, 22 (6.45%) had a cough, 50 (20.16%) were reported failure to thrive/ loss of weight, 12 (4.84%) were reported Swelling/lumps on your neck/arms/pits/groin, 8 (3.23%) participants had meningitis and 61 (24.60%) were reported loss of appetite. (Table 3)

Table 4: Summary of investigation parameters among household contacts (N=248)

Parameters	household contacts	Percentage
Mantoux Test Result (Positive)	37	14.91%
Chest X-Ray		
Radiological signs present	40	16.13%
Normal	208	83.87%
CBC and ESR		
ESR normal	2	0.81%
Leukopenia	3	1.21%
ESR raised	5	2.02%
Anaemia	6	2.42%
Leukocytosis	6	2.42%
Normal	88	35.48%
Not done	138	55.65%
Zn Smear (Induced Sputum/Gastric Aspirate)	17	6.85%
CB NAAT/Gene Expert	42	16.94%
Culture/MGIT	17	6.85%
Line Probe Assay	1	0.40%
Tuberculosis	89	35.89%
INH Prophylaxis Received	30	12.09%

Out of 248 household contacts, 30 (12.10%) had Mantoux positive. Out of 248 house hold contacts, 40 (16.13%) were reported chest x-ray lesions present. Out of 248 household contacts, 6 (2.42%) participants had Leucocytosis and Anaemia for each, respectively. ESR raised was 5 (2.02%), and 2 (0.81%) were reported ESR normal. Out of 248 household contacts 17 (6.85%) had Zn smear (induced sputum/gastric aspirate) positive. 42 (16.94%) had CB NAAT/gene expert positive, 17 (6.85%) had culture/MGIT positive. 89 (35.89%) had positive tuberculosis.14 (5.65%) had INH prophylaxis received. (Table 4)

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Table 5: Univariate analysis of risk factors associates with tuberculosis status (N=248)

Factors	Tuberculosis		Odds ratio (95% CI)	P value
	Positive	Negative		
Children age group				
<= 5 Years (N=114)	81 (71.05%)	33 (28.95%)	5.9 (1.93 to18.04)	0.002
6 To 15 Years (N=117)	3 (2.56%)	114 (97.44%)	0.07 (0.02 to 0.3)	<0.001
>15 Years (N=17)	5 (29.41%)	12 (70.59%)	(Baseline)	
Gender				
Male (N=116)	35 (30.17%)	81 (69.83%)	(Baseline)	
Female (N=132)	54 (40.91%)	78 (59.09%)	1.062 (0.946 to 2.713)	0.079
Locality				
Rural (N=207)	83 (40.1%)	124 (59.9%)	3.91 (1.58 to9.7)	0.003
Urban (N=41)	6 (14.63%)	35 (85.37%)	(Baseline)	
Socioeconomic Status				
APL (N=32)	3 (9.38%)	29 (90.63%)	(Baseline)	
BPL (N=216)	86 (39.81%)	130 (60.19%)	6.4 (1.89 to21.65)	0.003
Duration of contact with index case (N=245)				
<3 Month (N=135)	51 (37.78%)	84 (62.22%)	2.07 (0.72 to5.94)	0.179
3 To 6 Months (N=88)	33 (37.5%)	55 (62.5%)	2.04 (0.69 to6.05)	0.198
>6 Months (N=22)	5 (22.73%)	17 (77.27%)	(Baseline)	
Mantoux test result (N=86)				
Positive (N=30)	37 (100%)	0 (0%)	4353567855	0.998
Negative (N=218)	55 (27.06%)	156(72.94%)	(Baseline)	
Chest X-Ray				
Lesions Present (N=40)	40 (100%)	0 (0%)	5424051091	0.997
Normal (N=208)	49 (23.56%)	159 (76.44%)	(Baseline)	
Relationship with the index case				
Parents (N=116)	47 (40.52%)	69 (59.48%)	1.460 (0.867 to 2.458)	0.155
Others (N=132)	42 (31.82%)	90 (68.18%)	(Baseline)	
Household contact sleeping in the same bedroom of index case >3 days per week				
Yes (N=185)	84 (45.41%)	101 (54.59%)	9.648 (3.70 to 25.15)	<0.001
No (N=63)	5 (7.94%)	58 (92.06%)	(Baseline)	

The univariate logistic regression analysis had shown a statistically significant association with tuberculosis with many explanatory factors as presented in table 5.

Table 5: Comparison of CXR, Mantoux chest, and CBNAAT test result (N=248)

CXR	Mantoux Test	CBNAAT	Results
Lesions present	Positive	Positive	3
Normal	Positive	Negative	4
Normal	Negative	Positive	9

There were 3 people who reported as lesions present according to CXR, Mantoux positive and CBNAT positive, in normal CXR people who reported Mantoux test as positive and CB as negative were 4, where Mantoux test negative and CBNAT positive were 9. (Table 5)

Table 6: Analysis of Active cases and latent TB cases in household contacts (N=248)

Parameter	Symptom's present	CB NAAT Positive	Mantoux test positive
Total TB disease	59	39	7
	No symptoms	**CB NAAT Negative**	**Mantoux test positive**
Total Latent TB cases	189	38	30

Among 59 TB diseased cases who reported as symptomatic only 39 were positive as per CBNAAT among these 39 cases 7 only positive according to Mantoux test. In asymptomatic latent cases 189, CBNAAT negative were 38 and among these 30 reported positive Mantoux test results. (Table 6)

Discussion

The results of the present study focused on the demographic as well as socioeconomic background of the index cases. Findings revealed that the majority of the index cases belong to age group of 21 to 35 years. Study by Srivastava G et al., found that age of the index cases ranged between 18 and 65 years.(23) these findings show younger generation affected majorly than compared to older. This builds up an association of living conditions and external environment for the rapid transmission of TB. We found females were seen more affected than males. Our results were contradictory to results of where they found 18 212 were male (53.14%).(24).

In our study majority of the household contacts were TB positive and were children less than 5 years of age and females were seen more affected. study by Geetika Srivastava. et al., in which the prevalence of TB at recruitment was 1.76 times higher (29.1%) in children aged < 6 years compared to children between 6 and 14 years (16.5%).(23) We can say that in most of the cases females remain deprived of treatment and hence remain undiagnosed. . However, today, TB is the leading cause of death for women globally.(25)

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In the present research majority of index cases and household were belonging to rural area and below poverty line. People with lower socioeconomic status (SES) have a higher likelihood of being exposed to crowded, less ventilated places and have limited safe cooking practicing facilities. Marginalized populations including prisoners have a higher chance of getting infected with TB.(26)

In the present study majority of the household contacts did not show considerable symptoms. Our results were not completely matching with study by as About 29.6% of diagnosed cases did not present any clinical symptoms.(27) we observed that house hold contacts were exposed to smoking. Similarly Singh SK et al., observed that family members who were regularly (daily) exposed to smoke (second-hand smoke) inside the house were more prone to getting tuberculosis (OR = 1.49; CI = 1.39-1.61) as compared with households where people do not smoke inside the house.(28) . Singh M et al., reported exposure to tobacco smoke as significant predictors for TB infection among children of respective age.(29)

The index cases of the TB positive children were majorly their parents. Similarly Singh J et al., on screening found that the contact relationship status with index patients, 52 (62.7%) were first-degree relatives.(30) In the study there were considerable number of TB positive children who slept with index cases in the same room. This can be due to less education and unawareness regarding modes of TB transmission. Krishnamoorthy Y et al., concluded that sharing the same bed with the index case (aIRR = 1.2, 95% CI: 1.1–1.3, *p* value: 0.04) was independent determinant of latent tuberculosis infection (LTBI) among the HHC.(31)

LIMITATIONS:

This study included very small sample size, and hence generalization of results requires support from other similar large studies. The burden of TB infection reported in child contacts in the study might be higher than that reported because some children were not tested for TB, and there was no follow-up screening. Due to COVID 19 pandemic and country lockdown, face to face interviews were not possible for some cases.This study recommends screening of all household child contacts of adult TB patients and initiation of isoniazid prophylaxis for prevention of development of TB infection in children.

Conclusion

This study concludes that a higher number of children, particularly children under five years of age in contact with adult TB patients, living in a rural area below the poverty line, sharing the same bedroom, exposed to smoking developed the infection which shows the importance of child contact identification, screening, and initiation of prophylaxis treatment. Child contact management helps in controlling pediatric TB to a great extent.

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