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Tracing the potential extra-household contacts of TB patients: findings from a personal social network survey in a high TB burden setting in India

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Background: Evidence on the extra-household contacts of TB patients who drive disease transmission is scarce.

Methods: We conducted a cross-sectional personal social network survey among 300 newly diagnosed index pulmonary TB patients to identify their first-degree extra-household contacts.

Results: A significantly higher proportion of neighbourhood (3.5; 95% CI 1.3 to 7.5), occupational (3.2; 95% CI 1.3 to 9.2) and friendship contacts (2.2; 95% CI 0.8 to 4.5) developed TB within 1 y of the index patient's diagnosis than their household contacts (0.7; 95% CI 0.3 to 1.3). Similarly, a higher proportion of extra-household contacts had TB at different time points before the index patient was diagnosed.

Conclusion: Extra-household contacts of TB patients could be a potential source of TB or could be at increased risk of TB.

Keywords: contact tracing, extra-household, neighbourhoods, social networks, TB

Introduction

A systematic review on studies pertaining to household TB transmission highlighted that <20% of infections could be attributed to household exposure and that the remaining infections could be attributed to community transmission.[1] There is a need to systematically trace contacts occurring outside the households of TB patients.[2] We undertook a study among newly diagnosed pulmonary TB patients to estimate the proportion of their extra-household contacts with TB compared with their household contacts with the disease.

Methods

From February 2018 to June 2019, we enrolled 300 consecutive adult pulmonary (drug-sensitive) TB patients who were newly diagnosed at 24 designated microscopy centres in Chennai, a south Indian metropolitan city, for a cross-sectional personal social network survey (Supplementary Methods). Patients who resided for at least 1 y in the sample catchment area and who were willing to share their complete social network and socialisation information were considered eligible for the study. A semistructured questionnaire was used to probe and list the first-degree social network contacts of the index patients as per standard.[3] Network contacts were classified into household and extra-household contacts, which included 'extended family and relatives', 'friends', 'neighbours' and 'occupational' contacts.[4] A sample size of 300 was used in consideration of the sample sizes of published network studies in countries with a high TB burden. The following definitions were used:

Index patients: The enrolled 'newly diagnosed pulmonary TB patients' were defined as index TB patients.

First-degree social network contacts or contacts: Individuals with whom the index TB patients had consistent social relations (lived, socialised, worked) during their prediagnostic and postdiagnostic periods.

Consistent social relation: Lived, socialised or worked together for ≥3 d a week for at least 2–4 h.

The diagnostic definition used for index TB patients and their contacts with TB was taken from the National TB Elimination Program India.[5] TB status of first-degree contacts was reported by index patients and was further tracked and validated through

Table 1. Validated TB status of the first-degree contacts of index patients at different time points

First-degree contact type	Contacts with a validated TB status*									
	Within previous 5 to 1 y after index diagnosis		Within 2 y of index diagnosis		1 y before index diagnosis		Within 6 mo leading up to index diagnosis		Within 1 y after index diagnosis	
(N)	N (%)#	(95% CI)	N (%)	(95% CI)	N (%)	(95% CI)	N (%)	(95% CI)	N (%)	(95% CI)^
Household/family (1140)	36 (3.1)	(2.2 to 4.3)	27 (2.3)	(1.5 to 3.4)	19 (1.6)	(1.0 to 2.5)	14 (1.2)	(0.6 to 2.0)	8 (0.7)	(0.3 to 1.3)
Relatives/extended family (796)	34 (4.2)	(2.9 to 5.9)	20 (2.5)	(1.5 to 3.8)	15 (1.8)	(1.0 to 3.0)	11 (1.3)	(0.6 to 2.4)	4 (0.5)	(0.1 to 1.2)
Friends (316)	43 (13.6)	(10.1 to 17.8)	29 (9.1)	(6.2 to 12.9)	24 (7.5)	(4.9 to 11.))	21 (6.6)	(4.1 to 9.9)	7 (2.2)	(0.8 to 4.5)
Neighbours (169)	57 (33.7)	(26.6 to 41.3)	45 (26.6)	(20.1 to 33.9)	34 (20.1)	(14.3 to 26.9)	25 (14.7)	(9.8 to 21.0)	6 (3.5)	(1.3 to 7.5)
Occupational (123)	12 (9.7)	(5.1 to 16.4)	10 (8.1)	(3.9 to 14.4)	7 (5.6)	(2.3 to 11.3)	5 (4.0)	(1.3 to 9.2)	4 (3.2)	(1.3 to 9.2)
Total (2544)	182^ (7.1)	(6.1 to 8.2)	131 (5.1)	(4.3 to 6.0)	99 (3.8)	(3.1 to 4.7)	76 (2.9)	(2.3 to 3.7)	29 (1.1)	(0.7 to 1.6)
p	<0.05		<0.05		<0.05		<0.05		<0.05	

*Validated TB status of contacts included: having concurrent TB or cured of TB or died of TB or TB cured and died or having presumptive TB and tested positive. It included both drug-sensitive and drug-resistant TB.
% is obtained by using contact numbers (N) as denominators.
^ Binomial exact CI.

a systematic process that involved (i) documentation verification, (ii) house visits and interviews with contacts or their families, and (iii) interviews with healthcare providers. Validation of contact TB status was limited to a 5 y period before index diagnosis and 12 mo after index diagnosis. Data quality standards used for network surveys were followed.[3] Validated TB status of contacts was expressed in percentages with 95% CIs. The χ^2 test was used to assess differences in the proportion of validated TB status between different types of contacts. A geographic positioning system was used to measure the distance (in metres) between the residences, socialisation or working spots of the index patients and their TB contacts and was expressed as the median and IQR. Analysis was conducted using STAT Ver. 16.0.Stata Corp., USA, and STROBE guidelines were followed (Supplementary Table S4).

Results

A total of 713 consecutive and newly diagnosed pulmonary TB patients were screened, and 300 were found eligible. The attributes and network characteristics of the 300 indices and their 2544 first-degree contacts are provided in Supplementary Table S1. On average, one index had 10 first-degree contacts (Supplementary Table S1). Of the 300 index patients, 205 (68.3%) reported that 455 (17.89%) of their first-degree contacts had TB in the past or currently (Supplementary Table S2). Of the total reported contacts with TB status (n=455), cumulative validation was possible for 182 (40%) in the prescribed time frame of 5 y before to 1 y after index diagnosis. Of these 182 contacts, 131, 99 and 76 statuses were validated as 2 y after, 1 y after and 6 mo before the index diagnosis, respectively, and 29 statuses were validated within 1 y after the index diagnosis. Of the 182 contacts, 79.8% were first-degree validation, that is, gold standard (Supplementary Table S1 and Supplementary Figure S1).

Table 1 shows that, of the contacts who developed TB within 1 y of the index patient's diagnosis, a significantly high proportion were extra-household contacts: neighbours (3.5; 95% CI 1.3 to 7.5), occupational contacts (3.2; 95% CI 1.3 to 9.2) and friends (2.2; 95% CI 0.8 to 4.5) compared with household contacts (0.7; 95% CI 0.3 to 1.3; p=0.00). Of the contacts who developed TB in the 6 mo before the index diagnosis, a significantly higher proportion were neighbours (14.7%; 95% CI 9.8 to 21.0), friends (6.6%; 95% CI: 4.1 to 9.9) and occupational contacts (4%; 95% CI 1.3 to 9.2) compared with household contacts (1.2; 95% CI: 0.6 to 2.0). Similar trends highlighting a significantly high proportion of extra-household contacts with TB were observed at 1, 2 and 5 y before index diagnosis. The median distance between the residences of index patients and their extended family contacts with TB was 20 m, 60 m from neighbours, 88 m from friends and 224 m from occupational contacts (Supplementary Table S3).

Discussion

Our results highlight that a significant proportion of extra-household contacts, especially neighbours and friends of index patients, had TB in the past or developed TB within 1 y of index patients' diagnoses compared with the patients' household contacts. Almost half of the contacts who developed TB after the index patients' diagnoses were neighbours and friends. The greater chance of contracting TB among neighbours is due to living in close proximity to the index patient's residence.[6] Such a spatial perimeter could be of use for the contact tracers to prioritise contacts who are both socially and spatially closer to index patients. Thus, close geographical proximity and social

relationships could hold significant potential in driving disease transmission outside households.[6,7] Our findings have some limitations. This study was conducted in a high TB prevalence setting and may not be generalised to low prevalence settings. While we used robust validation steps to confirm the contact TB status reported by index patients (Supplementary Methods), respondent bias may still exist.

Supplementary data

Supplementary data are available at *Transactions* online.

Authors' contributions: conceptualisation: KN and MM; methodology: KN and MM; data collection and implementation: BP and SS; analysis: KN and MM; draft preparation: KN, MM, SS and BP; review and editing: KN, MM, BP and SS.

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Data availability: The data underlying this article cannot be shared publicly due to the privacy and confidentiality of individuals that participated in the study.

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