Pulmonary tuberculosis among contacts of patients with tuberculosis in an urban Indian population

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SUMMARY The study was conducted among 1810 contacts of 50 index “cases”/“suspects” of pulmonary tuberculosis including 312 household and 1498 neighbourhood contacts in the Jhansi city of Uttar Pradesh. The overall prevalence of radiologically active and bacteriologically confirmed tuberculosis was 2.9% and 1.1%. The prevalence rates of radiologically active and bacteriologically confirmed disease, although comparatively high in both the contact groups, were significantly higher in household (5.4% and 2.6%) than in neighbourhood contacts (2.3% and 0.8%). Significant differences in distribution of secondary cases among clusters were observed. Although higher prevalence rates were found in contacts of sputum positive source than in contacts of sputum negative source in both the contact groups, the statistical difference was observed to be insignificant. Case yield among contact symptomatics was 80.0% (30.8% cases and 49.2% suspects).

Various studies conducted among close family contacts have proved that there is a greater risk to those who remain in contact with the patients with pulmonary tuberculosis.¹⁻⁶ Nevertheless, the zone of influence of a case cannot be limited to the family members only. It extends beyond the case households, to neighbourhood households according to the degree of closeness. Moreover, though it is a well established fact that “cases” of pulmonary tuberculosis pose high risk to their contacts, the risk caused by “suspects” cannot be overlooked because some of the genuine cases of pulmonary tuberculosis may not show tubercle bacilli in their sputum at every stage of the disease, even though they are harbouring bacilli.

The present study, a slightly modified evaluation of contact examination limited to only symptomatic contacts for case detection, aims at finding out the prevalence of tuberculosis among the household as well as neighbourhood contacts of those patients with tuberculosis who are registered at the district tuberculosis centre, Jhansi, and the case yield among symptomatic contacts.

Material and methods

STUDY AREA

The study was carried out in the urban and slum localities of Jhansi city in south west Uttar Pradesh

and the headquarters of Jhansi division. The study area is about 7 km from Maharani Laxmi Bai Medical College, Jhansi, and spread over a radius of 5 km. The district tuberculosis centre, situated in the middle of the city, functions as a core of the National Tuberculosis Control Programme covering the urban as well as the rural population (around 900 000) of the district. The district tuberculosis centre has a health team of three medical officers, two x ray technicians, one laboratory technician, two staff nurses, two health visitors, and non-medical staff. The centre is equipped with a miniature x ray unit, a laboratory, 10 indoor beds, and transport facilities. Up to June 1982 about 2000 cases of pulmonary tuberculosis were registered there for domiciliary treatment; of these, about 400 cases were from Jhansi city only. Besides detection of cases among symptomatics attending the outpatient department and providing treatment for them, the centre also gives BCG vaccination to those at risk (0–19 years, undertakes Mantoux test to child contacts, and provides hospital treatment to serious patients.

METHODS

In view of limited resources and time a contact population of 50 cases was considered for the study purpose. Visualising some field difficulties such as non-availability of the respondents, their refusals, and overlapping, 80 cases out of those registered at

the district tuberculosis centre from Jhansi city only were selected after simple random sampling without replacement.⁷ These selected cases were primarily called index cases or index suspects and their families, index case/suspect families. Those having sputum positive for *Mycobacterium tuberculosis* on smear examination were taken as cases and those with negative smear but having suggestive shadows in chest skiagrams were reckoned as suspects for the present purpose.⁸ Furthermore, the term cases has been used in the text, at times, to include cases as well as suspects.

Case clusters were formed on the spot during the survey by enlisting the index case family as a nucleus and five other adjacent families around the index case family as the contact population. When more than one registered case was present in a cluster, the oldest sufferer was considered to be the index case and the rest were taken as contacts. In this way 50 clusters comprising 300 families were studied. The family members of index case families were taken as close family contacts and those from neighbouring families were considered as neighbourhood contacts.

The study started on 17 July 1982 and continued until 16 January 1983. In the survey team were one male and one female social worker besides the investigator (medical). During the survey, after location and confirmation of the index case, particulars of the patient and the family including those with symptoms, if any, were recorded. Similarly other families of the cluster were also contacted and interviewed in order to collect relevant information. The individuals were considered as symptomatics if they had chest symptoms such as cough, continuous fever, chest pain lasting for four weeks or more, or haemoptysis, along with constitutional symptoms such as lassitude, loss of weight, emotional irritability, and insomnia, if any.

An effort was made to contact all the individuals of the family, especially those with symptoms. This, however, required repeated and special visits to some families where symptomatic contacts had not been contacted in previous visits. All symptomatic contacts were motivated to come to the district tuberculosis centre on routine working days for diagnostic investigations such as sputum examination for acid fast bacilli and miniature radiography. The investigations were performed by the investigator himself at the centre on working days from 12 noon to 2 pm.

Spot collection of sputum from symptomatic contacts was done in waxed cartons under supervision after proper instruction. When sputum was not present, a laryngeal swab was taken. Smears were made after careful selection of necrotic material and stained by Ziehl Neelsen's technique.⁹ Stained

smears were examined thoroughly under oil immersion for 5–10 minutes before they were declared negative.

Each symptomatic contact had a 70 mm miniature radiograph of the chest (posteroanterior view) taken in the miniature x ray unit. Both the investigator and the district tuberculosis officer read the films, first separately and then together before coming to a final conclusion. Diagnostic standards given by the Tuberculosis Association of India¹⁰ were followed for diagnosis. Whenever the miniature x ray findings seemed doubtful, the diagnosis was decided with the help of a full size x ray film paid for by the patient.

Results

The studied contact population of 1810 individuals included 312 household contacts from 50 index families and 1498 neighbourhood contacts from 250 neighbouring families. Out of 1810 contacts, 72 had symptoms. Attempts were made to investigate them all in order to arrive at a definitive diagnosis. Three of them, however, did not cooperate. Furthermore, four had only lymphadenitis, but this diagnosis could not be confirmed owing to lack of appropriate facilities at the centre. The analysis, therefore, after ignoring these seven was limited to 65 symptomatics only.

The prevalence rates of radiologically active as well as bacteriologically confirmed pulmonary tuberculosis were worked out for household and neighbourhood contacts separately. All the acid fast bacilli positive cases were also radiologically positive. Overall prevalence rates of radiologically active and bacteriologically confirmed pulmonary tuberculosis were 2.9% and 1.1% (table 1). The prevalence rates of x ray positive tuberculosis in household contacts and neighbourhood contacts were 5.4% and 2.3%, with statistically significant differences ($p < 0.01$). Prevalence rate of acid fast bacilli positive tuberculosis was 2.6% in household and 0.8% in neighbourhood contacts (table 1). The difference in this case was also statistically significant ($p < 0.01$).

Increasing trend in age wise prevalence of the disease was observed in both the contact groups with statistically significant differences ($p < 0.001$) between the two, although slight fluctuations were present in all three categories (table 1). Prevalence rates of the disease were also studied for the two sexes separately (table 2). The overall prevalence of x ray positive and acid fast bacilli positive pulmonary tuberculosis was 1.8% and 0.9% in men and women respectively. The difference was significant ($p < 0.05$). Moreover, prevalence rates based on radiologically active and bacteriologically confirmed cases were higher in women than men in both contact groups, household as well as neighbourhood (table

Table 1 Age specific prevalence rates of pulmonary tuberculosis based on radiologically active and bacteriologically confirmed cases among contacts

Confirmed cases among contacts												
Age group (y)	Household					Neighbourhood					Overall prevalence rate (%)	
	x ray positive			AFB positive		x ray positive			AFB positive			
	Contact population	No of cases	Prevalence	No of cases	Prevalence	Contact population	No of cases	Prevalence	No of cases	Prevalence	x ray positive	AFB positive
			rate (%)		rate (%)			rate (%)		rate (%)		
0-4	142	5	3.2	Nil	Nil	586	5	0.9	1	0.2	1.4	0.1
15-44	130	10	7.7	4	3.1	695	22	3.2	9	1.3	3.9	1.1
≥45	40	2	5.0	4	10.0	217	8	3.7	2	0.9	3.9	0.8
Total	312	17	5.4	8	2.6	1498	35	2.3	12	0.8	2.9	1.1

Statistical significance:

(a) Overall prevalence: (a) x ray positive, $\chi^2 = 9.90$, df = 2, $p < 0.01$.

(b) AFB positive, $\chi^2 = 35.04$, df = 2, $p < 0.0001$.

(b) Type of contacts: (a) x ray positive, $t = 3.01$, $p < 0.01$,

(b) AFB positive, $t = 2.80$, $p < 0.01$.

AFB = Acid fast bacilli.

Table 2 Sex specific prevalence rates of pulmonary tuberculosis based on radiologically active and bacteriologically confirmed cases among contacts

Sex	Household					Neighbourhood					Overall prevalence rate (%)	
	x ray positive			AFB positive		x ray positive			AFB positive		x ray positive	AFB positive
	Contact population	No of cases	Prevalence rate (%)	No of cases	Prevalence rate (%)	Contact population	No of cases	Prevalence rate (%)	No of cases	Prevalence rate (%)		
Male	164	5	3.0	3	1.8	793	12	1.5	6	0.7	1.8	0.9
Female	148	12	8.1	5	3.4	705	23	3.3	6	0.8	4.1	1.3
Total	312	17	5.4	8	2.6	1498	35	2.3	12	0.8	2.9	1.1

Statistical significance of overall rates between sexes for:

(a) x ray positive: $\chi^2 = 8.50$, df = 1, $p < 0.005$,

(b) AFB positive: $\chi^2 = 6.48$, df = 1, $p > 0.05$.

AFB = Acid fast bacilli.

2). The differences in rates between the two sexes were significant for x ray positive cases ($p < 0.05$) but insignificant for acid fast bacilli positives ($p > 0.05$).

Prevalence of pulmonary tuberculosis was also assessed according to the bacteriological status of the source. Although it varied in the two contact groups, it did not differ significantly among the contacts of sputum positive and sputum negative sources. The overall prevalence rates and also the prevalence rates of the disease in the two contact groups were a little higher among the contacts having a sputum positive source than those having a sputum negative source (table 3). There was, however, no association between prevalence rates and nature of source in both the contact groups ($p > 0.05$).

Analysis showed that some of the case clusters had accumulation of cases. Out of 50 case clusters studied, 18 clusters (36.0%) were with only index case or suspect, 19 clusters (38.0%), however, were with one case, eight clusters (16.0%) with two cases,

and five clusters (10.0%) with three or more cases as well as the index case or suspect. The statistical difference in distribution of secondary cases among clusters was significant ($p < 0.01$). The study sample of 50 clusters included 20 case clusters and 30 suspect clusters. Table 4 shows distribution of secondary cases in both types of clusters. Secondary cases of tuberculosis were distributed in index case clusters and index suspect clusters without any significant statistical difference ($p > 0.05$).

Case yield was found to be remarkably high among those with symptoms. Analysis, in depth, showed that overall case/suspect yield among symptomatics was 80-94.4% in household and 74.4% in neighbourhood contact symptomatics, including 38.8% cases and 49.2% suspects (table 5). Analysis showed that case yield was considerably high in household symptomatic contacts. Differences in rates between two types of contacts, worked out separately, for cases and overall cases/suspects were statistically insignificant ($p > 0.05$).

Table 3 Index cases and prevalence rates of pulmonary tuberculosis by bacteriological status of the source

Bacteriological status of source	Index cases*		Household			Neighbourhood			Overall prevalence rate (%)
	No	%	Contact population	No of cases	Prevalence rate (%)	Contact population	No of cases	Prevalence rate (%)	
Sputum AFB positive	20	40.0	129	10	7.8	600	17	2.8	3.7
Sputum AFB negative†	30	60.0	183	7	3.8	898	18	2.0	2.3
Total	50	100.0	312	17	5.4	1498	35	2.3	2.9

*Includes index cases as well as suspects.

†x ray positives.

Statistical significance of:

(a) Overall prevalence rate by bacteriological status of the source: $\chi^2 = 3.06$, df = 1, $p > 0.05$.

(b) Association of rates by bacteriological status of source and type of contact population: $\chi^2 = 3.67$, df = 2, $p > 0.05$.

AFB = Acid fast bacilli.

Table 4 Index case/suspect clusters showing distribution of secondary cases (sputum positive as well as x ray positive). (Figures in parentheses represent percentages).

Clusters	Without secondary case		With HH secondary case		With NBHD secondary case		With HH & NBHD secondary case		Total	
	No	%	No	%	No	%	No	%	No	%
Index case clusters	7 (35.0)	38.9	3 (15.0)	50.0	6 (30.0)	30.0	4 (20.0)	66.6	20 (100.0)	40.0
Index suspect clusters	11 (36.7)	61.1	3 (10.0)	50.0	14 (46.7)	70.0	2 (6.6)	33.4	30 (100.0)	60.0
Total	18 (36.0)	100.0	6 (12.0)	100.0	20 (40.0)	100.0	6 (12.0)	100.0	50 (100.0)	100.0

HH = Household.

NBHD = Neighbourhood.

Statistical significance of distribution of secondary cases by: Type of clusters: $\chi^2 = 0.14$, df = 1, $p > 0.05$.

Table 5 Case yield among symptomatic contacts by type of contact population

Contact group	Symptomatics studied		Secondary cases/suspects					Overall cases suspects per 100 symptomatics
	No of cases	%	No of cases	Cases per 100 symptomatics	No of suspects	Suspects per 100 symptomatics	Total No of cases/suspects	
Household	18	27.7	8	44.5	9	50.0	17	94.4
Neighbourhood	47	72.3	12	25.5	23	48.9	35	74.4
Total	65	100.0	20	30.8	35	49.2	52	80.0

Statistical significance of:

(a) Overall cases/suspects yield by type of contacts: $t = 1.76$, $p > 0.05$.

(b) Case yield by type of contacts: $t = 1.45$, $p > 0.05$.

Discussion

High prevalence rates of radiologically active as well as bacillary tuberculosis among family contacts varying from 3.3% to 10.0% and 1.3% to 4.2% have been reported from different parts of the world including India.^{2-4,6} The discrepancies as shown from reviewed findings largely reflect the different criteria and methods adopted by different workers and, to some extent, are due to varied epidemiological situations. The present study showed more or less similar prevalence of active (5.4%) and bacillary (2.6%) tuberculosis among the household contacts. The present prevalence rates might be rather lower than the actual ones because in the present study only symptomatic contacts were investigated. Furthermore, even some cases without symptoms might have escaped the examination. Nevertheless, most of the similar other contact studies, on the other hand, have screened all the contact population by radiography, culture, and repeated sputum examination. Hence, it is easy to believe that the case yield in these studies is considerably higher than the present one.

The present study showed a considerably higher prevalence of active (5.4%) and bacillary (2.6%) tuberculosis among household contacts than in the general population; the prevalence rates in the general population often vary from 0.8% to 2.1% and from 0.2% to 0.8% in different parts of the country.¹¹⁻¹⁶ The above two types of prevalence rates of tuberculosis (2.3% and 0.8%) among neighbourhood contacts have been found to be close to the upper limits of rates in the general population. On the basis of infection rates among child contacts, Nair *et al* reported that the influence of cases of tuberculosis in the neighbourhood, though it may extend up to several households, usually remains highest in the first neighbourhood on either side of the case household.¹⁷ The present study gave a fairly high prevalence of active (2.3%) and bacillary (0.8%) tuberculosis among contacts of the first household.

Various authors have reported varying prevalence rates of pulmonary tuberculosis by age in contacts of patients with tuberculosis.^{1-4,6} We also found this variability in prevalence of tuberculosis for different age groups. The disease was more prevalent in the middle aged and elderly than in children. It appears therefore that tuberculosis, although highly prevalent in different age groups, especially in household contacts, is more prevalent in the middle aged and elderly who might have been infected many years ago. We believe that continuous superinfection in the host already having a tuberculosis infection

often precipitates the adult type of tuberculosis in those who remain in the vicinity of the case.

Some of the studies conducted among family contacts have reported significantly higher prevalence of disease in women.^{2,3} In contrast, however, Ramkrishnan *et al* in their investigation observed a higher prevalence of disease in men.⁴ In the present study the overall prevalence rates based on radiologically active (4.8%) and bacillary (1.5%) tuberculosis were much higher in female contacts than male contacts (1.8% and 0.9%). The prevalence rates in both contact groups were significantly higher in women than in men ($p < 0.05$). On the contrary, in the general population different longitudinal studies have reported higher prevalence rates in men than women.¹¹⁻¹³

Although, in both the contact groups, household and neighbourhood, the prevalence of the disease was higher among the contacts of smear positive sources (7.8% and 2.8%) than in contacts of smear negative sources (3.8% and 2.0%), the statistical analysis failed to show any significant relation between prevalence rates by type of contacts and bacteriological status of source ($p > 0.05$). Thus on the basis of the findings of the study, it may be concluded that though the sputum positive patients pose a great problem to their contacts, the risk caused by smear negative patients cannot be overlooked and that the examination of contacts of smear negative patients is also essential simultaneously with those of smear positive patients. Our findings further suggest that the influence of a case is not limited to households only but extends to the neighbourhood also. Therefore, case detection among the people in the close surroundings of the case may be beneficial. Health programmes need to pay special attention to the higher risk caused by index cases to their contacts residing in close vicinity, although in overcrowded localities the possibility of getting infection from other places besides the index case may prevail.

The clustering of cases in certain pockets of the community is quite a usual finding. In the studied population out of 50 case clusters 32 (64.0%) had multiple cases. The distribution of clusters according to number of secondary cases present was statistically significant ($p < 0.01$). Distribution of secondary cases in the index case and suspect clusters was however, not so ($p > 0.05$). Various other epidemiological surveys have opined that quite a large number of bacillary cases are missed on examination of only one spot specimen. Furthermore about 30.0% genuine tuberculosis cases may be diagnosed, 10.0% by second spot sputum examination and 20.0% by culture examination.¹⁸ In the light of the present findings it may be pointed out that case detection among the contacts of index suspects cannot be

ignored, especially where facilities for sputum culture are not available to differentiate further their bacteriological status.

A higher case yield (80.0%) among symptomatic contacts has been observed in the present study as against other population groups¹⁹—general population (0.8–2.1%), cluster contacts (2.8%), and symptomatic contacts attending tuberculosis centres (20.6–54.1%). Whereas the possibility of overdiagnosis by x ray cannot be excluded, the yield of a high proportion (30.8%) of bacteriologically confirmed cases (44.5% among household and 25.5% amongst neighbourhood) symptomatic contacts may be taken as remarkable observations.

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