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Original article

Changing patterns of household transmission of tuberculosis in an eastern state of India: The impact of COVID19 pandemic

Abhijit Dey a, Isita Roy b, Arup Kumar Chakrabarty t, Anuradha Choudhury b, Arista Lahiri d, * 

a World Health Organization, Technical Support Network for National Tuberculosis Elimination Program in India, West Bengal, India
b Joint Effort for Elimination of TB, Maduradaha, Kolkata, West Bengal, India
c Health Vision Research, Jessore Road, Kolkata, West Bengal, India
d Dr. B. C. Roy Multi-Speciality Medical Research Centre, Indian Institute of Technology Kharagpur, West Bengal, India

ABSTRACT

Background: The COVID-19 Pandemic has affected many components of the Tuberculosis (TB) control program. Due to lockdown and restrictions, people, including TB patients, might have spent more time in the household. There might be an increased TB transmission among the household contacts (HHC). The current study was conducted to measure the household transmission of TB and also find out the relationship with several clinico-social factors.

Methods: Contact tracing data of West Bengal, India, was extracted from Nikshay portal of Central TB Division, Government of India. The anonymized data was divided into two parts, firstly before the lockdown initiation in India and secondly during the lockdown. A modified Poisson regression model was developed to determine the statistical association between clinico-social variables and the pandemic with household-level secondary TB cases.

Results: There was a 30% reduction in daily TB case notification, but the proportion of HHC screened was 4% higher during the pandemic than the pre-pandemic period. The secondary attack rate of household TB disease transmission was 34% lower during the pandemic period. Index TB patients aged under ten years, microbiologically positive, Drug-Resistant TB, having three or more HHCs, treatment delay more than seven days, notified from the private sector, and diagnosis during the pre-pandemic period was found to be independently associated with a higher risk of having a secondary TB case at household.

Conclusion: The risk of household TB transmission was significantly lower during the pandemic period compared to the pre-pandemic period, which may be due to better infection prevention and control practices.

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1. Introduction

Tuberculosis (TB) is one of the oldest endemic diseases affecting humanity. It remains the major public health problem of concern even today, with an estimated incidence of 10 million and 1.5 million deaths globally each year.1,2 The world has seen an unprecedented pandemic due to the novel coronavirus disease (COVID-19) at the beginning of 2020, which has impacted every health program, and the TB program is not an exception.3–7 We know from previous epidemics that reduced access to care, medicines, and diagnostics for people with life-threatening conditions, such as TB, can increase deaths from these underlying conditions.3 Historically, significant disruptions such as natural disasters, war, and infectious disease pandemics have compromised TB programs and increased the TB burden.9,10 There are reports of considerable disruption in TB service provisions due to the ongoing pandemic in both primary care and hospital settings.11,12 The pandemic-led disruptions of TB services in India can significantly increase TB morbidity and mortality.13

To prevent household TB transmission, the World Health Organization (WHO) recommended a systematic process of screening intended to identify previously undiagnosed cases of TB among the contacts of an index case, and TB Preventive Therapy (TPT) for the children after ruling out active TB.13 TPT is the treatment offered to individuals who are considered at risk of TB disease in order to reduce that risk. Despite the recommendation and the country’s implementation efforts, it is evident that the contact screening status in India has been suboptimal over the years.15–18 Moreover, due to the COVID19-related lockdown and restrictions on social gatherings, there is reduced access to health services like contact screening and TPT. People, including TB patients, are likely to spend more time in their households for obvious restriction norms. So, there might be an increased TB transmission among the household contacts (HHC) of the TB patients. An HHC is defined as a person who shared the same enclosed living space as the index case for one or more nights or frequent or extended daytime periods during the three months before the start of current treatment.19

Studies have reported the socio-demographic and other associations of the contacts (infector) who eventually become TB patients.20–24 But there is a dearth of studies that have assessed the socio-demographic and other associations of the index TB patients (infector) who eventually produce a secondary case within the household. Also, no such study compared the TB transmission rate among household contacts during this pandemic with the pre-pandemic era to the best of our knowledge. Therefore, we conducted this study to compare the household transmission of TB in West Bengal, India, during the pre-pandemic period and the pandemic. We also determined the associations of different relevant socio-clinical factors of the index TB patient with transmission at the household level.

2. Materials and methods

2.1. Study design

We conducted a secondary data analysis using the contact tracing data of West Bengal available from the Nikshay portal.25 All notified TB patients (the index cases) were retrospectively followed up as per the data available to see the household incidence of secondary TB cases. The relevant contact tracing data is available from the database of the Nikshay portal. We retrieved these data from January 1, 2019, to June 30, 2021 (910 days). India declared the first lockdown & banned public gatherings and recommended Infection Prevention & Control (IPC) practices from March 25, 2020.26 So, the duration is divided into two parts – Pre-Covid (January 1, 2019, to March 24, 2020, i.e., 448 days) & Covid (March 25, 2020, to June 30, 2021, i.e., 462 days). Comparisons were made based on these two time periods.

2.2. Study population

West Bengal, a major state in the Eastern part of India, is the fourth most populous state. Our analysis considered all the 2,34,657 TB patients diagnosed in West Bengal and notified in the Nikshay portal from January 1, 2019, to June 30, 2021. In the first stage of analysis, all these patients were included. Among the notified TB patients, we found index TB patients who do not have any HHC and several index TB patients where none of the HHCs were screened for TB symptoms. These cases were excluded during the second stage of analysis. Among the remaining TB patients, there were cases where some of the HHCs have been put on TPT. We also excluded these patients from our analysis to eliminate the heterogeneity of risk. Thus, the final sample size was 1,22,385 TB patients with at least one HHC with all HHCs screened and no HHC given TPT. The flow of participant selection is depicted in Fig. 1.

2.3. Data access and variables

The first author (AD) extracted the required data from the contact tracing register from January 2019 to June 2021 by accessing the Nikshay portal for records from West Bengal.25 In the anonymized dataset “Episode ID” was used as unique identifier during the data curation & analysis process. The date of diagnosis, the basis of diagnosis, date of treatment initiation, age, gender, site of disease, type of TB, type of notification, number of above six years old & under six years old HHC, number of HHC screened for TB, number of HHC diagnosed with TB, and the number of beneficiaries put on TPT were the key variables extracted from the database. The socio-demographic information of the index TB patients was also extracted. For the purpose of our analysis, we considered the phase (pre-pandemic or during pandemic) of TB notification of the index patient as a predictor variable. We considered age, gender, site of disease, basis of diagnosis, type of notification, duration from diagnosis till treatment initiation, TB treatment regimen, and the number of household contacts as other variables in our study.

2.4. Data analysis

The data were analyzed using STATA 14.2 (StataCorp LP, College Station, TX, USA). At the first stage, the TB diagnosis and notification indicators were calculated. To calculate the mean number of HHCs per index TB patient, we took the ratio of the total number of HHCs notified and the total number of
index TB patients with at least one HHC. Socio-demographic and clinical characteristics were assessed separately for any statistical difference during the pandemic and pre-pandemic periods for all index TB patients and index TB patients with at least one secondary infection in the household. Chi-squared tests determined the bivariate statistical associations. In the second stage of our analysis, we tested for the factors contributing to household TB transmission. The bivariate association between the factors and diagnosis of a secondary case were assessed separately with negative binomial regression models. For multivariate analysis, a modified Poisson regression model with robust standard errors was used to evaluate the independent associations of the socio-demographic and clinical characteristics of index TB patients with the diagnosis of a secondary case in the household and calculate the adjusted relative risk (aRR) with 95% confidence interval (95% CI).

2.5 Ethics

The current study was a secondary data analysis of the data available from the government database. The analysis involved review of the anonymized patient records extracted (i.e., the program-level data). Therefore, the need for ethical clearance was waived. We maintained confidentiality during the handling and analysis of the dataset extracted.
3. Results

3.1 Notification of cases and contacts

Among the total 234,657 TB patients, 136,451 patients were notified during the Pre-pandemic phase at an average of 305 cases per day. On the other hand, 98,206 patients were notified during the pandemic at an average of 213 cases per day. The proportion of reduction in notification was 30%. Total HHCs identified were 723,687, of which 87% were screened for TB symptoms. Proportion HHC screened during the pre-pandemic period was 86%, whereas 90% during the pandemic. Overall, Secondary Attack Rate (SAR) was 4.15 (95% CI: 4.13–4.16) per thousand HHC. SAR was 4.77 (95% CI: 4.76–4.79) before the pandemic, whereas it was 3.14 (95% CI: 3.12–3.16) during the pandemic. The details regarding TB cases notification and contact identification are provided in Table 1.

3.2 Socio-demographic and clinical characteristics

The mean age of the index TB Patients was 39.7 (±17.5) years, and 67.8% were males. 78.1% were Pulmonary TB & 73.0% were microbiologically confirmed. The proportion of Private notification was 17.9% & drug-resistant TB was 4.5%. The mean duration from diagnosis to Treatment initiation was 2.4 (±0.9) days, and the mean number of HHC was 5.1 (±1.5) per index TB patient. 67.5% of such patients were notified before lockdown. Of the 122,385 index TB patients identified, 1417 (95% CI: 1.16%–1.18%) patients had at least one HHC infected with TB. The socio-demographic & clinical profile of the Index TB Patients & the TB patients who have at least one secondary TB patient before & during the pandemic has been compared and summarized in Table 2.

3.3 Factors associated with household transmission of TB

Table 3 shows the factors associated with having a secondary TB patient in the household. Preschool age [aRR (CI) = 3.15 (1.89–5.26)], Childhood [aRR (CI) = 2.05 (1.22–3.42)], Microbiological confirmation [aRR (CI) = 1.53 (1.3–1.79)], Private notification [aRR (CI) = 1.17 (1.01–1.37)], DR-TB [aRR (CI) = 1.36 (1.05–1.77)], Treatment delay by more than 7 days [aRR (CI) = 1.28 (1.05–1.55)], having 3–4 HHCs [aRR (CI) = 1.25 (1.07–1.45)], and having 5 or more HHCs [aRR (CI) = 1.7 (1.46–1.98)], were independently associated with having a secondary TB patient in the same household. Index case diagnosed during pre-pandemic period has been found as an independent risk factor of a secondary TB infection in household [aRR (CI) = 1.27 (1.13–1.41)].

4. Discussion

4.1 What is already known and what this study adds

The findings from our study represent the scenario of a large state in India and are relevant from the policy perspective also. It was observed that there was a 30% reduction in daily TB case notification during the pandemic period. Similar findings reported by many studies & can be explained by less health-seeking behavior of people or deterioration of routine health service during the pandemic.5–7,27–29 Despite the devastating impact of COVID-19, the contact tracing effort in West Bengal was found to be higher during the pandemic compared to the pre-pandemic period, as reflected by a 4% increase in the proportion of HHC screened for TB.

The secondary attack rate (SAR) of household TB transmission was 4.15 (95%CI; 4.13–4.16) per 1000 HHC, which is lower, compared to a recent study from a province of Iran done on all smear-positive patients (SAR: 8.14 per 1000 contacts, 95% CI: 3.4–12.8).30 As we included all types of TB cases, e.g., pulmonary, extra-pulmonary, microbiologically positive, and microbiologically negative, lower SAR was expected. SAR was 34% lower during the pandemic period when compared with the pre-pandemic period. Widespread use of masks, sanitizer, social distancing & other IPC practices might have contributed to lower SAR during the pandemic.

The preschool age & childhood age of the index TB patient was found to be independently associated with having a secondary case at household. The findings are supported by the results of Khazaei et al.30 This can be explained by less use of mask by the under ten years old and longer duration of stay inside house in comparison of adolescent & adult. This may also be due to atypical case presentation in the younger age group & thereby, HHC might be unknowingly exposed well before diagnosis of the Index case. In this context, literature

| Table 1 – Screening of HHC & screening yield before and during the Covid-19 pandemic in West Bengal, India. |
|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|
| Period                                           | Index TB Patients notified (a)                  | Avg. TB notification per day (b = a/no. Of days) | Total HHC (c)                                   | Number Screened for TB (e)                         | % Screened (95% CI) (f = e*100/c)                | Total TB Diagnosed (g)                        | SAR Per 1000 HHC (95% CI) (i = g*100/e)       |
|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|
| Total (910 days)                                 | 234,657                                        | 258                                             | 723,687                                        | 632,707                                          | 87.4 (87.4–87.5)                                | 2623                                           | 4.15 (4.13–4.16)                              |
| Pre-Pandemic (448 days)                          | 136,451                                        | 305                                             | 451,413                                        | 388,737                                          | 86.1 (86.0–86.2)                                | 1857                                           | 4.77 (4.76–4.79)                              |
| Pandemic (462 days)                              | 98,206                                         | 213                                             | 272,274                                        | 243,970                                          | 89.6 (89.5–89.7)                                | 766                                            | 3.14 (3.12–3.16)                              |

Total study period = 910 days (January 1, 2019–June 30, 2021). Lockdown started in India on March 25, 2020, so we divided the study period into Pre-pandemic (448 days, i.e., January 1, 2019–March 24, 2020) & Pandemic (462 days, i.e., March 25, 2020–June 30, 2021). HHC = Household contact, TB = Tuberculosis, CI = Confidence Interval, SAR = Secondary Attack Rate.
indeed mentions that infected children are a reservoir from which many adult cases will arise if proper measures are not taken. Contact tracing, including reverse contact tracing on a priority basis, immediately upon notification of all under ten years old TB patients, should be done by the program. It is also found that there is no significant difference for different gender (Male, female, or transgender) or site of lesion (may it be pulmonary or extra-pulmonary), in the risk of having a secondary case among the HHC. This may be explained by an undiagnosed pulmonary component in the EPTB or maybe the presence of a common hidden source. Whatever may be the reason, the findings strongly suggest that TPT should be extended to HHC of EPTB patients.

Microbiological confirmation, having three or more HHC, and treatment delay of more than seven days was found to be associated with having a secondary case at household. These are quite expected findings as Microbiologically confirmed pulmonary TB patients usually have higher bacillary load per ml sputum & have a higher number of infected droplets produced with coughing or sneezing. More HHC means a more significant number of susceptible hosts. So, more chance of having a secondary case. The infectiousness of TB patients diminishes rapidly once effective treatment is initiated. If there is a delay in the initiation of treatment, there will be a chance of spreading infection among HHC. In the case of the DRTB, the pre-treatment evaluation process usually causes a delay in treatment initiation. Districts & States should arrange all tests & evaluations of the DRTB cases in a synchronized way within a few working days, preferably in a single institution. During this pre-treatment evaluation phase, patients should be given masks & proper counseling so that they don’t infect others. Preferably they should be kept isolated in an isolation ward of the hospital (DR-TB Ward/TB Sanatorium) during this period. National TB Program (NTP) should ensure treatment is initiated in all types of TB patients as early as possible & within seven days of diagnosis. DR-TB patients were found to be associated with a 36% higher risk of having a secondary case. This could be explained by the longer

Table 2 – Socio-Demographic & Clinical profile of the Index TB Patients (N) & TB patients who have at least one secondary TB patient (n) during Jan’19–June’21 in West Bengal. N = 122,385; n = 1417.

| Characteristics               | Index TB patients, N (%) | Pre-pandemic | During pandemic | P-value | TB patients who had at least one secondary case in the household, n (%) | Pre-pandemic | During pandemic | P-value |
|-------------------------------|--------------------------|--------------|----------------|---------|---------------------------------------------------------------------|--------------|----------------|---------|
| Total                         | 75,448                   | 46,937       | 0.000          | 956     | 461                                                                | 0.819        | 0.132          | 0.324   |
| Age in years                  |                          |              |                |         |                                                                     |              |                |         |
| 0-4 (Pre-School)              | 383 (0.51)               | 191 (0.41)   | 8 (0.84)       | 11 (1.15)| 5 (1.08)                                                            |              |                |         |
| 5-9 (Childhood)               | 561 (0.74)               | 282 (0.6)    | 110 (11.51)    | 194 (20.29)| 97 (21.04)                                                          |              |                |         |
| 10-19 (Adolescent)            | 8377 (11.1)              | 5473 (11.66) | 225 (23.54)    | 251 (26.26)| 116 (25.16)                                                        |              |                |         |
| 20-29 (Young Adult)           | 16,031 (21.25)           | 9956 (21.21) | 140 (14.64)    | 17 (1.78) | 10 (2.17)                                                           |              |                |         |
| 30-44 (Mature Adult)          | 18,936 (25.1)            | 11,946 (25.45)| 140 (14.64)    | 10 (2.17) |                                                                     |              |                |         |
| 45-59 (Middle Age)            | 18,822 (24.95)           | 11,770 (25.08)| 140 (14.64)    | 10 (2.17) |                                                                     |              |                |         |
| 60-74 (Pre-Old)               | 10,705 (14.19)           | 6432 (13.7)  | 140 (14.64)    | 10 (2.17) |                                                                     |              |                |         |
| 75 & Above (Old)              | 1633 (2.16)              | 887 (1.89)   | 140 (14.64)    | 10 (2.17) |                                                                     |              |                |         |
| Gender                        |                          |              |                |         |                                                                     |              |                |         |
| Male                          | 51,871 (68.75)           | 31,973 (68.12)| 663 (69.35)    | 297 (64.43)| 0.132                                                              |              |                |         |
| Female                        | 23,537 (31.2)            | 14,954 (31.86)| 292 (30.54)    | 164 (35.57)|                                                                     |              |                |         |
| Transgender                   | 40 (0.05)                | 10 (0.20)    | 1 (0.1)        | 0 (0)     |                                                                     |              |                |         |
| Site of Disease               |                          |              |                |         |                                                                     |              |                |         |
| Pulmonary TB                  | 54,221 (71.87)           | 34,012 (72.46)| 753 (78.77)    | 354 (76.79)| 0.399                                                              |              |                |         |
| Extra-Pulmonary TB            | 21,227 (28.13)           | 12,925 (27.54)| 203 (21.23)    | 107 (23.21)|                                                                     |              |                |         |
| Basis of Diagnosis            |                          |              |                |         |                                                                     |              |                |         |
| Microbiologically Confirmed   | 48,912 (64.83)           | 30,831 (65.69)| 706 (73.85)    | 329 (71.37)| 0.324                                                              |              |                |         |
| Clinically Diagnosed          | 26,536 (35.17)           | 16,106 (34.31)| 250 (26.15)    | 132 (28.63)|                                                                     |              |                |         |
| Type of Notification          |                          |              |                |         |                                                                     |              |                |         |
| Public                        | 61,293 (81.24)           | 36,774 (78.35)| 805 (84.21)    | 359 (77.87)| 0.004                                                              |              |                |         |
| Private                       | 14,155 (18.76)           | 10,163 (21.65)| 151 (15.79)    | 102 (22.13)|                                                                     |              |                |         |
| Type of Regimen               |                          |              |                |         |                                                                     |              |                |         |
| Drug Susceptible TB           | 73,441 (97.34)           | 45,647 (97.25)| 903 (94.46)    | 451 (97.83)| 0.004                                                              |              |                |         |
| Drug Resistant TB             | 2007 (2.66)              | 1290 (2.75)  | 53 (5.54)      | 10 (2.17) |                                                                     |              |                |         |
| Diagnosis to Treatment initiation|                      |              |                |         |                                                                     |              |                |         |
| Same day                      | 6829 (9.05)              | 6521 (13.89) | 70 (7.32)      | 63 (13.67)| 0.000                                                              |              |                |         |
| >7 days                       | 46,135 (61.15)           | 29,570 (63)  | 547 (75.22)    | 293 (63.56)|                                                                     |              |                |         |
| Number of HHC                 |                          |              |                |         |                                                                     |              |                |         |
| 1-2 HHC                       | 16,507 (21.88)           | 10,495 (22.36)| 162 (16.95)    | 73 (15.84)| 0.637                                                              |              |                |         |
| 3-4 HHC                       | 33,314 (44.15)           | 21,556 (45.93)| 400 (41.84)    | 186 (40.35)|                                                                     |              |                |         |
| 5 or more HHC                 | 25,627 (33.97)           | 14,886 (31.71)| 394 (41.21)    | 202 (43.82)|                                                                     |              |                |         |

Notes: *- Column percentage. Proportion & measures of association with p-value calculated with Chi-square test. "n" is a subset of “N”. All other numbers within the parentheses from the subsequent rows indicate column percentages for each category. TB = Tuberculosis, HHC= House hold contact, TPT = TB Preventive Treatment.
duration of DR-TB treatment & the longer time it took to become non-infectious. NTP should take care of the HHC of DR-TB index cases for this extra risk. WHO released a consolidated guideline on TPT for the HHC, including HHC of DR-TB patients\(^2\); countries should adopt & implement it as early as possible.

Index TB patients notified from the private sector were associated with a 17% higher risk of having a secondary case at household with a 27% extra-risk compared to the TB patient notified during the pandemic period. Widespread use of masks, sanitizer, social distancing & other IPC practices might have contributed to lower risk during the pandemic. Due to the COVID19 pandemic, the barriers associated with face mask use have waned off significantly. The TB patients, as a result, are now consistently wearing the mask, which was not consistent before the pandemic due to the self-perceived stigma.\(^3\) This might be leading to less impact of COVID-19 on household TB transmission empirically. Our study utilized data obtained under programmatic

### 4.2. Strengths and limitations

This study is one of the first studies in India to assess the impact of COVID-19 on household TB transmission empirically. Our study utilized data obtained under programmatic

| Table 3 – Socio-demographic & clinical factors of the index TB patients associated with a secondary case within the household in West Bengal, India, during January 1, 2019- June 30, 2021. |
| Variable | Total index TB Patient, [N] | Index TB Patients with TB among the HHC [n (%)]* | Unadjusted RR (95% CI)* | Adjusted RR (95% CI)§ |
| --- | --- | --- | --- | --- |
| **Total** | 122,385 | 1417 (1.2) | | |
| **Age in years** | | | | |
| 0-4 (Pre-School) | 574 | 16 (2.8) | 2.49 (1.5–4.14) | 3.15 (1.89–5.26) |
| 5-9 (Childhood) | 843 | 16 (1.9) | 1.7 (1.02–2.82) | 2.05 (1.22–3.42) |
| 10-19 (Adolescent) | 13,850 | 155 (1.1) | 1 (base) | 1 (base) |
| 20-29 (Young Adult) | 25,987 | 291 (1.1) | 1 (0.82–1.21) | 1.01 (0.83–1.23) |
| 30-44 (Mature Adult) | 30,882 | 335 (1.1) | 0.97 (0.8–1.17) | 1 (0.83–1.21) |
| 45-59 (Middle Age) | 30,592 | 367 (1.2) | 1.07 (0.89–1.29) | 1.11 (0.91–1.34) |
| 60-74 (Pre-Old) | 17,137 | 210 (1.2) | 1.09 (0.89–1.35) | 1.1 (0.89–1.36) |
| 75 & Above (Old) | 2520 | 27 (1.3) | 0.96 (0.64–1.44) | 0.95 (0.63–1.44) |
| **Gender** | | | | |
| Male | 83,844 | 960 (1.1) | 1 (base) | 1 (base) |
| Female | 38,541 | 456 (1.2) | 1.03 (0.93–1.16) | 1.09 (0.97–1.23) |
| Transgender | 50 | 1 (2) | 1.75 (0.25–12.17) | 1.54 (0.22–10.62) |
| **Site of Disease** | | | | |
| Pulmonary TB | 88,233 | 1107 (1.3) | 1.38 (1.22–1.57) | 1.12 (0.94–1.33) |
| Extra-Pulmonary TB | 34,152 | 382 (0.9) | 1 (base) | 1 (base) |
| **Basis of Diagnosis** | | | | |
| Microbiologically Confirmed | 79,743 | 1035 (1.3) | 1.45 (1.29–1.63) | 1.53 (1.3–1.79) |
| Clinically Diagnosed | 42,642 | 310 (0.9) | 1 (base) | 1 (base) |
| **Type of Notification** | | | | |
| Public | 98,067 | 1164 (1.2) | 1 (base) | 1 (base) |
| Private | 24,318 | 253 (1) | 0.88 (0.77–1) | 1.17 (1.01–1.37) |
| **Type of Regimen** | | | | |
| Drug Susceptible TB | 119,088 | 1354 (1.1) | 1 (base) | 1 (base) |
| Drug Resistant TB | 3297 | 63 (1.9) | 1.68 (1.31–2.16) | 1.36 (1.05–1.77) |
| **Duration from diagnosis till treatment initiation** | | | | |
| Same day | 13,350 | 133 (1) | 1 (base) | 1 (base) |
| 1–7 days | 75,705 | 840 (1.1) | 1.11 (0.93–1.34) | 1.04 (0.87–1.25) |
| >7 days | 33,330 | 444 (1.3) | 1.34 (1.1–1.62) | 1.28 (1.05–1.55) |
| **Number of HHC** | | | | |
| 1-2 HHC | 27,002 | 235 (0.9) | 1 (base) | 1 (base) |
| 3-4 HHC | 54,870 | 586 (1.1) | 1.23 (1.06–1.43) | 1.25 (1.07–1.45) |
| 5 or more HHC | 40,513 | 596 (1.5) | 1.69 (1.45–1.96) | 1.7 (1.46–1.98) |
| **Time of diagnosis of the Index Case** | | | | |
| Pre-Pandemic period | 75,448 | 956 (1.3) | 1.29 (1.16–1.44) | 1.27 (1.13–1.41) |
| Pandemic period | 46,937 | 461 (1) | 1 (base) | 1 (base) |

TB: Tuberculosis; HHC: Household Contact; RR: Relative Risk; aRR: Adjusted Relative Risk; CI: Confidence Interval.

* Row percentage, # Binomial regression model (unadjusted), § Adjusted generalized linear (Poisson) model. Statistically significant findings are highlighted with bold font.
settings and reflects the field realities. The study has a relatively large sample size and reflects the whole State of West Bengal scenario during the referenced period. Fourth, the robust study design to measure the strength of association. To minimize heterogeneity in risk measurements, we excluded TB patients who did not have HHC or had HHHC put on TPT or HHC not screened for TB. We have used data from Nikshay, which is believed to be very trusted data as it is being validated at different stages of the data cycle, starting from entry to archiving. But being a secondary data analysis, it does not provide any information regarding the quality of the contact tracing process and the portal. Since the routine data collected did not include potential confounders like socioeconomic status, overcrowding, malnourishment or other comorbidities, household pollution, distance from the health facility, education level of the index TB patients, we could not adjust our model for their effects. We assumed that the HHCs have equal exposure and from only one Index TB patient, which though computationally efficient, but maybe different in reality. We have considered the occurrence of TB disease (active TB disease) among HHC to measure TB transmission within the household & we could not detect the TB infection (erstwhile Latent TB Infection), which could have been a perhaps better indicator to measure actual TB transmission. Thus, the factors associated with having a secondary case in the household have to be interpreted with caution.

4.3. Implications & recommendations

Based on the study findings, we came up with specific action points for effective contact management under the NTP and further containing the spread of TB in the community. Rigorous contact screening & reverse contact tracing in the case of the under ten-year-old index TB patients is a strategy that can be incorporated into the current national strategy. Early treatment initiation of all TB patients within seven days of diagnosis should be enforced. NTP should give priority to private-sector TB patients for public health action, especially treatment adherence, comorbidity screening & contact tracing. Our findings unequivocally advocate that all diagnosed TB patients be provided with an Airborne Infection Control Kit (AIC-Kit) having masks, spittoon, phenol & handkerchief instead of the current practice of providing AIC-kit only to the DRTB Patients. The study also recommends that all TB patients & their caregivers should be counseled & monitored on AIC practices. Serial sputum testing based on fortnightly (or at least monthly) after diagnosis until sputum conversion can be a way forward. Supports like provision of masks, supervisory home visits, additional nutritional support, provision of paid leave or work from home (wherever applicable) should be extended until the sputum conversion, thus limiting further spread.

5. Conclusions

The risk of TB transmission among the household contacts was significantly lower during the pandemic period compared to the pre-pandemic period. Due to Covid, the stigma associated with mask-wearing has diminished significantly. Widespread use of masks, sanitizer, social distancing & other IPC practices might have contributed to the lower risk of TB transmission during the pandemic. As childhood TB is associated with a greater number of secondary cases within the household, aggressive control measures are necessary for childhood TB. Early treatment initiation for all patients and a focus on implementing the WHO consolidated guideline on TPT, including the TPT provision for HHC of DRTB & EPTB without any further delay, are a must in the current circumstances. Further studies should be done to assess the associations after adjusting socio-demographic and clinical factors of the HHC, measure transmission by measuring TB infection among the HHC & measure the impact of Covid in household TB transmission in the long run.

Data accessability

The raw data utilized in the study, and the relevant analytical codes are accessible upon formal request to the corresponding author.

Author contributions

Conceptualization- IR, AD, AL. Data collection and entry — AD, AKC, IR, AC. Data curation- AL, IR, AC. Formal analysis- AD, AL, AKC. Methodology- AD, AL. Software- AD, IR. Supervision- AKC, AL. Validation- IR, AC, AD. Visualization- AKC, AD, AL. Writing — original draft- AD, IR. Writing — review & editing- AL, AC, AKC.

Conflicts of interest

The authors have none to declare.

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