Original Article

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# Risk Factors, Epidemiological and Clinical Outcome of Close Contacts of COVID-19 Cases in a Tertiary Hospital in Southern India

Community Section

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## ABSTRACT

**Introduction:** The knowledge of epidemiologic characteristics and transmission dynamics of a novel pathogen, such as Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) among close contacts can help in planning and development of effective control policies in different parts of the world.

**Aim:** To assess the epidemiological and clinical outcome of close contacts of Coronavirus Disease (COVID-2019) cases admitted in a tertiary COVID hospital and to assess the role of risk factors in predicting the epidemiological outcome of these contacts.

**Materials and Methods:** The current retrospective cohort study was conducted among 1286 close contacts of COVID-19 patients admitted to Government Medical College, Thrissur, Kerala. The data collection was done by a semi-structured telephonic interview by the contact tracing team. The questions included the type of exposure to the index case, symptoms if any, date of last exposure with COVID-19 positive patients, and final COVID-19 status of the contact at the end of 14 days. The association of risk factors of COVID-19 positivity was done using binary logistic regression.

**Results:** Proportion of close contacts of COVID-19 who developed the disease was 24.2% (21.87-26.52%). The mean incubation period was found to be 4.22 days (C.I-3.71-4.65). The serial interval mean was found to be 5.24 days (C.I 4.764-5.716). The proportion of household contacts of COVID-19 cases who developed the disease was found to be 26% (C.I-23%-29%). The majority (52.4%) of infections among contacts were asymptomatic. Most common symptom among the COVID-19 positive was fever (32.8%) followed by cough (16.1%). The most common risk factors of infection among primary close contacts were sharing the same room (adjusted odds ratio-2.394) and common use of fomites (adjusted odds ratio-1.953) while use of a mask was found to be protective (adjusted odds ratio-0.570). Significant factors associated with the type of contact with infection were workplace-related contact (adjusted odds ratio-6.629), household contact (adjusted odds ratio-4.856), and travel-related contact (adjusted odds ratio-2.899).

**Conclusion:** The study concludes important risk factors of transmission among close contacts of COVID-19 as being in a household, workplace and travel related contact where the use of mask was found to be protective. The study also concludes that most of the COVID-19 infections in close contacts are asymptomatic.

**Keywords:** Coronavirus, Disease, Secondary attack rate

## INTRODUCTION

The first case of COVID-19 in India was reported in Kerala on January 30th, 2020 who was a returnee from Wuhan, China [1]. By March 2020, the cases started increasing and the epidemic spread to various parts of the country [2]. As of 28th January 2021, the number of active COVID-19 cases in India was 0.17 million and recovered cases were 10 million as compared to Kerala where it was 72,476 and 8.29 lacs, respectively [3]. In the case of a novel disease like COVID-19, the most important thing is to find out the epidemiological and transmission determinants in each region so that control strategies can be drafted accordingly. As of 28th January 2021, COVID-19 has taken a heavy toll on life with a total of 153,847 deaths in India. Among the different states in India, the highest number of deaths have occurred in Maharashtra (50,894) and Tamil Nadu (12,333) compared to Kerala which had fewer deaths (3,663) [3]. As per the World Health Organisation (WHO), the disease spreads mainly through droplet infection and sometimes in closed spaces with inadequate ventilation through aerosol transmission. The highest risk is when the distance between people is less than 1 metre [4].

As this is a novel virus, the transmission dynamics with different epidemiological exposures and different types of contact have to be explored. As the epidemic of COVID-19 in Kerala is still continuing, stringent measures like cluster identification and cluster containment strategies are needed to slow down the epidemic [5]. Many studies around the world have tried to find out determinants of transmission of COVID-19 to close contacts in multiple settings and have found it be being in household, being spoken by an index case, travelling together etc., [6,7]. Hence, this study was conducted to assess the epidemiological and clinical outcome of close contacts of COVID-19 cases admitted in a tertiary COVID hospital in Kerala and to study the association of risk factors and their role in predicting the epidemiological outcome of these close COVID-19 contacts.

## MATERIALS AND METHODS

The current retrospective cohort study was conducted in Government Medical College, Thrissur, a tertiary care institution in the southern state of Kerala. The data collection was done between June 2020 to July 2020 and the data analysis was done in September 2020. The study was approved by the Institutional Ethics Committee as per letter B6-155/2019 MCTCR dated 18.06.2020.

As an institutional policy, once a COVID-19 positive patient is admitted to the isolation ward, it is informed to the contact tracing team, which does an extensive search for all possible contacts of the admitted COVID-19 positive patient. Once the contacts are identified they are quarantined and tested as per the state government guidelines.

Close contact is defined as "someone who was within 1 meter (6 feet) of an infected person for a cumulative total of 15 minutes or more over 24 hours starting from two days before illness onset (or, for asymptomatic patients, two days before test specimen collection) until the time the patient is isolated" [8].

**Inclusion criteria:** All close contacts of COVID-19 patients admitted and identified by contact tracing team were included in the study.

**Exclusion criteria:** All contacts who were not willing to use their data for the study were excluded.

**Sample size calculation:** The sample size was calculated using the formula $4pq/d^2$ where 'p' is the proportion of primary contacts of COVID-19 patients who became positive for SARS-CoV-2 infection. The 'p' was taken as 6.6% as per the study conducted by Bi Q et al., [6]. q was taken as 1-p and absolute error was taken as 2%. Thus, the calculated minimum sample size was found to be 1026.

The methodology of the study involved a telephonic interview of all the close contacts of COVID-19 patients identified, by using a semi-structured interview schedule. This contained questions on the type of exposure and contact, symptoms if any, date of last exposure with COVID-19 patient, and final COVID-19 status i.e., COVID-19 positive or negative at the end of 14 days. For the 267 COVID positive (+ve) patients admitted and included in the study, there were 1334 close contacts. All of them were contacted over the phone and instructions on testing and symptoms to watch out for were given. The information was also passed on to the nearest health center for making sure that they were followed-up and tested. They were tested for COVID-19 infection on day eight of their last exposure to a COVID-19 positive patient in asymptomatic contacts. In symptomatic contacts, they were tested irrespective of date from the last contact with a positive case. This was the Government of Kerala Guidelines for COVID testing at that time [9].

Even though there were 1334 contacts, 48 were not willing to give consent to use their data for the study and were excluded. The rest of 1286 were interviewed telephonically twice. The initial interview was done as soon as their details were available and the second one was done on day 14 to know the outcome of the close contacts i.e., to confirm whether they were COVID positive or negative.

## STATISTICAL ANALYSIS

The data thus obtained was coded and entered in Microsoft Excel and further analysis was done using Statistical Package for the Social Sciences (SPSS) software version 16.0. Age and occupation-specific attack rates were calculated as proportions and their confidence intervals. The overall secondary attack rate was calculated as the proportion of close contacts who developed COVID-19 infection during the maximum incubation period of 14 days. The mean duration between the day of last exposure with the COVID positive patient and the day of onset of symptoms or day of sample came positive was considered as the incubation period in this study. The serial interval was calculated as the mean duration between the date of confirmation of COVID among primary COVID positive cases and the date of confirmation among contacts. R-naught (R0) on average, is calculated as the number of people that a single infected person can be expected to transmit that disease [10].

For finding out the risk factors of COVID-19 infection among close contacts, logistic regression was used. Their final COVID status was taken as the dependent variable and the risk factors as independent variables. The results were expressed as adjusted odds ratios and their confidence intervals. A p-value less than 0.05 considered as significant.

## RESULTS

The current study was conducted among 1286 close contacts of 267 COVID positive patients admitted to the study institute. The baseline characteristics of the study participants are depicted in [Table/Fig-1]. The age group with the maximum number of people was 31-45 years (31.6%) followed by 16-30 years (26.1%) and 46-60 (19.6%).

| Age group (Years) | Gender | | Total Number (%) |
|---|---|---|---|
| | Males Number (%) | Females Number (%) | |
| 0-15 | 81 (11.1) | 103 (18.7) | 184 (14.3) |
| 16-30 | 208 (28.4) | 127 (23) | 335 (26.1) |
| 31-45 | 260 (35.4) | 146 (26.4) | 406 (31.6) |
| 46-60 | 129 (17.6) | 123 (22.2) | 252 (19.6) |
| 61-75 | 45 (6.1) | 39 (7.1) | 84 (6.5) |
| 76 and above | 10 (1.4) | 15 (2.7) | 25 (1.9) |
| Total | 733 | 553 | 1286 |

**[Table/Fig-1]:** Age and gender distribution of the study participants.

In [Table/Fig-2] the overall secondary attack rate was (N=311) 24.2% (21.87-26.52%). Among the different age groups, the highest attack rates were among children aged 0-15 years. For occupation based attack rates, highest was found for businessmen followed by drivers. The attack rate of health care workers was the lowest.

| Age category (Years) | Age specific attack rate-N (%) | 95% CI |
|---|---|---|
| 0-15 (n=184) | 60 (32.6) | 28.02-37.2 |
| 16-30 (n=335) | 83 (24.8) | 20.6-29 |
| 31-45 (n=406) | 86 (21.2) | 17.2-25.2 |
| 46-60 (n=252) | 59 (23.4) | 19.2-27.5 |
| Above 61 (n=109) | 23 (21.2) | 17.5-25.2 |
| Total (1286) | 311 (24.2) | 21.87-26.52 |
| **Occupation** | **Occupation specific attack rate-N (%)** | **95% CI** |
| Unemployed (n=102) | 20 (19.6) | 15.7-23.5 |
| Driver (n=42) | 13 (31) | 26.5-35.5 |
| Health care worker (n=107) | 10 (9.3) | 6.5-12.1 |
| House wife (n=271) | 68 (25.1) | 20.9-29.3 |
| Student (n=226) | 60 (26.5) | 22.2-30.8 |
| Business (n=38) | 19 (50) | 42.5-52.3 |
| Daily wage workers (n=75) | 18 (25.3) | 21.1-29.5 |
| Others (n=425)* | 103 (24.2) | 20-28.38 |
| Total (n=1286) | 311 (24.2) | 21.87-26.52 |

**[Table/Fig-2]:** Age and occupation-specific attack rates among close contacts (N=1286).
*Teachers/Police/Other professionals/private employment etc., CI: Confidence interval

As far as the symptom profile of COVID +ve close contacts are concerned, majority (52.4%) of them were asymptomatic. Most common symptom among the COVID +ve was fever followed by cough, rhinitis, anosmia and sore throat [Table/Fig-3].

| Symptom | Number (%) |
|---|---|
| Fever | 102 (32.8) |
| Cough | 50 (16.1) |
| Rhinitis | 48 (15.4) |
| Anosmia | 36 (11.6) |
| Sore throat | 33 (10.6) |
| Headache | 16 (5.1) |
| Altered taste | 13 (4.2) |
| Diarrhea | 10 (3.2) |
| Asymptomatic | 163 (52.4) |

**[Table/Fig-3]:** Symptom profile among the COIVD +ve close contacts (n=311).

Other epidemiological findings from the study:

**Incubation period:** The minimum incubation period found was one day and the maximum 14 days. The mean incubation period as per the current study definition was found to be 4.22 (CI-3.71-4.65).

**Serial interval:** Mean was found to be 5.24 (C.I 4.764-5.716) (Time gap between).

**Secondary attack rate:** As explained earlier, the overall secondary attack rate was found to be 24.2% (21.87-26.52%). But the clinical secondary attack rate i.e. the rate of secondary cases with clinical symptoms was found to be 11.51 (9.82-13.38%) showing the importance of screening among contacts without symptoms. The household secondary attack rate i.e., contacts in the household who developed disease was found to be 26% (23%-29%).

R naught (**R0)** is the average number of people that a single infected person is expected to transmit the disease. In the present study, there were 267 COVID-19 +ve patients admitted in the hospital. Out 1286 close contacts of the above patients, 311 developed the disease. Thus average number of people infected by a single COVID-19 +ve case is 311/267=1.16. Thus, the R0 (R naught) as per the current study is 1.16.

It was found that sharing the same room was a statistically significant risk factor of COVID-19 among primary close contacts with an adjusted odds ratio of 2.394. A common use of fomites was also found as a risk factor (Adjusted odds-1.953). The use of a mask was found to be protective with an adjusted odds ratio of 0.570 [Table/Fig-4].

| Exposure factor | COVID-19 +ve (N=311) | COVID-19 -ve (N=975) | p-value | Adjusted OR | 95% CI |
|---|---|---|---|---|---|
| **Body fluid exposure** | | | | | |
| Yes (n=36) | 16 (44.4) | 20 (55.6) | 0.287 | 1.479 | 0.719-3.040 |
| No (n=1250) | 295 (23.6) | 955 (76.4) | | | |
| **Physical contact** | | | | | |
| Yes (n=473) | 168 (35.5) | 305 (64.5) | 0.414 | 0.850 | 0.576-1.255 |
| No (n=813) | 143 (17.6) | 670 (82.4) | | | |
| **Exposure to linen** | | | | | |
| Yes (n=358) | 141 (39.4) | 217 (60.6) | 0.335 | 1.213 | 0.819-1.795 |
| No (n=928) | 170 (18.3) | 758 (81.7) | | | |
| **Shared same room** | | | | | |
| Yes (n=555) | 208 (37.5) | 347 (62.5) | 0.001 | 2.394 | 1.707-3.358 |
| No (n=731) | 103 (14.1) | 628 (85.9) | | | |
| **Mask use** | | | | | |
| Nil (n=766) | 254 (33.2) | 512 (66.8) | 0.001 | 0.570 | 0.461-0.704 |
| Cloth mask (n=268) | 29 (10.8) | 239 (89.2) | | | |
| Surgical mask (n=200) | 28 (14) | 172 (86) | | | |
| N 95 mask (n=52) | 0 | 52 (100) | | | |
| **Common use of fomites** | | | | | |
| Yes (n=845) | 265 (31.4) | 580 (68.6) | 0.001 | 1.953 | 1.335-2.856 |
| No (n=441) | 46 (10.4) | 395 (86.6) | | | |

**[Table/Fig-4]:** Risk factors of COVID-19 among close contacts based on the type of exposure.
*Binary logistic regression; OR: Odds ratio; CI: Confidence interval; p-value less than 0.05 significant

The risk of COVID-19 among secondary cases based on the type of contact was also assessed using binary logistic regression. Among the factors assessed it was found that statistically, significant risk factors were workplace-related contact (Adjusted odds-6.629), Household contact (Adjusted odds-4.856) and travel-related contact (Adjusted odds-2.899) [Table/Fig-5].

| Type of contact | COVID-19 +ve (N=311) | COVID-19 -ve (N=975 | p-value | Adjusted OR | 95% CI |
|---|---|---|---|---|---|
| **Household** | | | | | |
| Yes (n=849) | 221 (26.0%) | 628 (74.0%) | 0.001 | 4.856 | 1.934-12.193 |
| No (n=437) | 90 (20.6%) | 347 (79.4%) | | | |
| **Travel related contact** | | | | | |
| Yes (n=144) | 25 (17.4%) | 119 (82.6%) | 0.038 | 2.899 | 1.061-7.920 |
| No (n=1142) | 286 (25%) | 856 (75%) | | | |
| **Healthcare related** | | | | | |
| Yes (n=68) | 11 (16.2%) | 57 (83.8%) | 0.085 | 2.663 | 0.874-8.112 |
| No (n=1218) | 300 (24.6%) | 918 (75.4%) | | | |
| **Workplace related contact** | | | | | |
| Yes (n=151) | 49 (32.5%) | 102 (67.5%) | 0.001 | 6.629 | 2.514-17.480 |
| No (n=1135) | 262 (23.1%) | 873 (76.9%) | | | |
| **Community contact** | | | | | |
| Yes (n=923) | 226 (24.5%) | 697 (75.5%) | 0.766 | 1.120 | 0.531-2.362 |
| No (n=363) | 85 (23.4%) | 278 (76.6%) | | | |

**[Table/Fig-5]:** Risk of COVID-19 among close contacts based on the type of contact.
*Binary logistic regression; OR: Odds ratio; CI: Confidence interval; p-value less than 0.05 significant

## DISCUSSION

The present study among close contacts of COVID-19 +ve patients reports a secondary attack rate of 24.2%. Secondary attack rate can provide an indication of how social interactions relate to transmission risk. As per the study conducted by Saraswathy AS et al., in Kerala among 255 primary contacts of COVID positive patients, the population developing infection among all contacts was found to be 5.88%, which is much lower than the current study [11]. The difference could be because of the lower sample size used in the study and that the study had taken both primary and secondary contacts. In another study by Laxminarayan R et al., from Tamil Nadu and Andhra Pradesh, the secondary attack rate in close contacts was found to be 10.3% [12]. As per the study conducted by Jing QL et al., in China, the household secondary attack rate was found to be 17.1% (95% CI: 15.5-23.9%) where the definition of household contacts was taken as those who were residing in the same residential address [13].

As per the present study, highest age-specific attack rate was among children below the age of 15 years (32.6%). This shows the higher probability of transmission to children from COVID-19 infected people. Similar findings have been echoed by a study conducted in China [14]. COVID-19 infections in children are mostly asymptomatic which makes it difficult to diagnose unless tested. This, combined with higher probability of transmission, could be an important factor in the control of the disease [15]. Even though the current study shows high attack rates among children but their role in the transmission of disease is yet to be fully ascertained [16].

As far as occupation-specific attack rates were concerned it was found that those doing business had the highest attack rates (50%) in the present study. As per the report of the European Centre for Disease Prevention and Control, Stockholm those occupations which need people to work in close proximity particularly when working in indoor settings are more exposed to and at higher risk of COVID-19 in the absence of mitigation [17]. The lowest attack rates were found out for health care workers (9.3%) in the current study. But as per the study conducted by Lan FY et al., in China among 103 possible work-related cases, 22% were among health care workers [18]. Compared to this study, the rates were much lower here. It could be because of higher adherence to infection control practices both in the health care setting and outside by health care workers.

As far as the symptom profile of close contacts who became COVID +ve, majority (52.4%) of them were asymptomatic. This could one of the biggest barriers in controlling the COVID-19 pandemic. Importance of asymptomatic and pre-symptomatic cases in transmission of COVID-19 has been shown in multiple studies [19,20]. As a result of this, Centers for Disease Control and Prevention (CDC) Atlanta has recommended testing of significant numbers of asymptomatic "healthy people" when there is significant

spread of the virus in the community, in order to help stop the spread of the virus [21].

Household contact and sharing of fomites were found to be significant risk factors associated with COVID-19, as per the current study. Sharing the same room and sharing of fomites is very difficult to differentiate between the two as one can lead to the other. Family members have a high probability of contact with each other with a longer duration as well as chances of sharing articles. This added to the fact that masks are not used inside the house, could have been the factors associated with higher chances of infection among household contacts As per the study conducted by Bi Q et al., in China, household contacts and those traveling with a COVID-19 case were at higher risk of infection (odds ratio 6.27 for household contacts and 7.06 for those traveling with a case) than other close contacts [6]. This was similar to the current study except the highest odds ratio was obtained for work-related exposures compared to other household contacts.

### Limitation(s)

The data collection was done by telephonic interview could have resulted in some information bias. It also could have brought in some level of recall bias.

## CONCLUSION(S)

The study found that 24.2% of close contacts of a COVID-19 positive case became infected. The study also throws light into the risk factors associated with COVID-19 positive patients. Workplace related contact was found to be an important risk factor followed by household contact and travel related contact. The use of mask was found to be protective. The study recommends infection control practices both in the household and outside with quarantine of close contacts to control the epidemic. As most of the infections were asymptomatic, the study also recommends testing of all close contacts.

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