Original Article

Household secondary attack rate in mild COVID-19

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Abstract

Background: The coronavirus disease 2019 (COVID-19) pandemic has reached a staggering number of almost 280 million cases worldwide, with over 5.4 million deaths as of 29 December 2021. A further understanding of the factors related to the household spread of the infection might help to bring about specific protocols to curb such transmission. **Objective:** This study aims to find the secondary attack rate (SAR) and factors affecting SAR among the households of mild COVID-19 cases. **Methods:** An observational study was designed where data of patients admitted at All India Institute of Medical Sciences, New Delhi due to mild COVID-19 were collected, and outcome was noted after the discharge of the patient. Index cases who were the first in the household to have a positive infection only were included. Based on these data, the overall household SAR, factors related to the index case and contacts that affected transmissibility were noted. **Results:** A total of 60 index cases having contacts with 184 household members were included in the present study. The household SAR was measured to be 41.85%. At least one positive case was present in 51.67% households. Children below 18 years old had lower odds of getting a secondary infection compared to adults and elderly [odds ratio (OR) = 0.46, 95%CI = 0.22–0.94, p = 0.0383). An exposure period of more than a week was significantly associated with a higher risk of infection (p = 0.029). The rate of transmissibility drastically declined with effective quarantine measures adopted by the index case (OR = 0.13, 95%CI = 0.06–0.26, p < 0.00001). Symptomatic index cases contributed more to the SAR than asymptomatic primaries (OR = 4.74, 95%CI = 1.03–21.82, *P* = 0.045). Healthcare worker index cases had lower rates of spread (OR = 0.29, 95%CI = 0.15–0.58, *P* = 0.0003). **Conclusion:** The high SAR shows the household is a potential high-risk unit for transmissibility of COVID-19. Proper quarantine measures of all those exposed to the index case can mitigate such spread and lead to reduction of risk of COVID-19 within a household.

Keywords: Healthcare, household, Mild COVID-19, quarantine, secondary attack rate, transmission

Introduction

The world is currently facing the coronavirus disease 2019 (COVID-19) pandemic, caused by the novel coronavirus severe acute respiratory syndrome coronavirus 2 (SARS CoV-2), which soon disseminated across the world, including India.[1] By 29 December 2021, a total of around 280,119,931 cases and 5,403,662 deaths have been reported worldwide.[2] Out of this, India has reported a total of 34,799,691 cases and 480,290 deaths.[2]

It is imperative to understand the dynamics of transmission of COVID-19 to be able to curb its rapid spread. Droplet transmission has appeared to be the most significant way for the spread, although small aerosol transmission as a route remains debated upon.[3]

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One significant cluster of transmission that has come to light is the household contacts of primary cases, with the household secondary attack rate (SAR) ranging from a minimum of 4.6% to a maximum of 49.56%.[4] However, there is a lack of data regarding household SAR in urban India. This study aims to determine the household SAR among contacts of mild COVID-19 cases in one such urban area of Northern India and to correlate it with the characteristics related to these contacts, in order to identify factors that cause higher susceptibility of catching the infection following exposure to a positive case.

Objective

As there is not enough literature regarding the SAR among household contacts and factors influencing the same, this study aims to gap this knowledge by understanding the SAR among household contacts of patients infected with COVID-19 and factors influencing the same.

Methodology

An observational study was conducted from the period of 1 September 2020 to 31 October 2020 after obtaining ethical clearance from the Institute Ethics Committee, All India Institute of Medical Sciences (AIIMS), New Delhi. In this study, all the mild COVID-19 cases admitted to isolation ward of AIIMS, New Delhi, India were enrolled to the study and they were followed up telephonically up to 21 days after discharge to see the SAR at their home.

Any patient, aged ≥18 years, admitted under the COVID wing of AIIMS during the study period, diagnosed by SARS CoV-2 Reverse transcriptase- Polymerase chain reaction (RT-PCR) on nasopharyngeal/oropharyngeal swab and having only mild COVID-19 symptoms or being asymptomatic throughout the study period was labelled as an index case.

Household contacts composed of all the people living together with the index case in the same residential apartment or house. Household contacts were members who had been present in the residence with the index case for a minimum of 1 day subsequent to the alleged exposure or onset of symptoms.

Household contacts were excluded if they were exposed to some other potential source of COVID-19 or got infected on the same day as the index case. Households who got COVID-19 infection in the previous 4 months were also excluded. All index cases were admitted to the COVID-19 wing of AIIMS on obtaining a positive RT-PCR result, and remained there until at least 3 continuous days of no fever after at least 10 days from symptom onset (or from positive RT-PCR result in case of asymptomatic cases).[5]

Asymptomatic and mild cases were classified as per national guideline.[6] The SAR was defined as the total number of secondary cases occurring within the duration of one incubation period following exposure to a positive case, as a proportion of the total number of eligible household contacts. The SAR was further calculated based on various characteristics of household contacts like age, comorbidity status, duration of exposure to index case, and so on, as well as factors related to index case like quarantine status, symptomatic status, and health care worker status.

Index cases and their household contacts were explained about the study in detail and appropriate consent was taken.

Statistical analysis

The obtained data were presented in the form of mean (SD)/median (IQR) for continuous covariates and number (percentage) for categorical covariates. The SAR for houses and individuals was analysed in relation to covariates measured using Chi-square test or Fisher's exact test for categorical variables and t-tests or Wilcoxon test for continuous variables. To find out the factors associated with secondary attack, logistic regression analysis procedure was used and results were presented in the form of odds ratio (OR) (95% confidence interval). All the analyses were performed using STATA-SE (Version 14.2). A *P* value of less than 0.05 was considered as statistically significant.

Results

A total of 60 index cases covering 185 household contacts were included in the present study. The general demographic profile is shown in Table 1.

Out of the 184 total household contacts, 77 turned out to be positive as diagnosed by RT-PCR. Factors associated with secondary cases are shown in Table 2.

Whether the index case quarantined after alleged exposure or development of symptoms influenced greatly the risk of secondary transmission, with quarantined cases having

Table 1: Characteristics of primary cases and household contacts

Characteristics	Index case (*n*=60)	Household contacts (*n*=184)
Mean age (years), SD	39.85 (11.15)	32.88 (19.99)
Age range (years)	23-67	1-75
Age category (years)		
0-17	0	46 (25%)
18-59	57 (95%)	113 (61.4%)
≥60	3 (5%)	25 (13.6%)
Gender		
Male	24 (40%)	91 (49.45%)
Female	36 (60%)	94 (50.08%)
Index case		
HCW	66 (35.87%)	76 (39.17%)
Non-HCW	118 (64.13%)	118 (6.83%)

Table 2: Factors associated with secondary cases

	Total	Positive	Negative	Odds ratio	95%CI	*P*
Overall	184	77 (41.85%)	107 (58.15%)			
Age overall		34.4 (17.8)	31.8 (21.5)	1.01	0.99-1.02	
Age category						
<18	46	13 (28.26%)	33 (71.74%)	1	1.89-5.23	0.016
18-60	113	56 (49.56%)	57 (50.44%)	2.49	0.41-3.44	0.742
>60	25	8 (32%)	17 (68%)	1.19		
Sex						
Males	91	35 (38.46%)	56 (61.54%)	1.318	0.73-2.37	0.38
Females	93	42 (44.68%)	51 (55.32%)			
Comorbidity status						
Present	48	22 (45.83%)	26 (54.17%)	1.25	0.64-2.42	0.61
Absent	136	55 (40.44%)	81 (59.56%)			
Duration of exposure with day 7						
≤7	180	73 (40.56%)	107 (59.44)	*	*	0.029
>7	4	4 (100%)	0 (0%)			
Index case quarantined						
Yes	72	11 (15.28%)	61 (84.72%)	0.13	0.06-0.26	<0.0001
No	112	66 (58.93%)	46 (41.07%)			
Index case Symptomatic						
Yes	170	75 (44.12%)	95 (55.88%)	4.74	1.03-21.82	0.045
No	14	2 (14.29%)	12 (85.71)			
Type of symptom in index case						
Resp	80	32 (40%)	48 (60%)	1	0.75-2.52	0.309
Non-resp	90	43 (47.78%)	47 (52.22%)	1.37	0.05-1.19	0.082
Asymptomatic	14	2 (14.29%)	12 (85.71%)	0.25		
Rooms						
1/person	159	67 (42.14%)	92 (57.86%)	1.0924	0.46-2.58	1.00
<1 per person	25	10 (40%)	15 (60%)			
Occupation of index case						
HCW	66	16 (24.24%)	50 (75.76%)	0.2990	0.15-0.58	0.0003
Non-HCW	118	61 (51.69%)	57 (48.31%)			

*As all the contacts in group which has exposure for more than 7 days developed COVID-19 infection odds ratio cannot be calculated

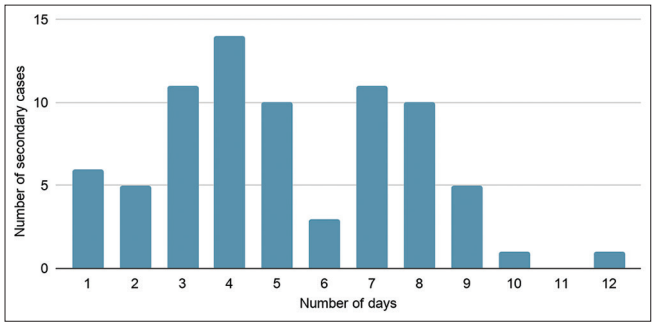

Figure 1: Distribution of durations of days between disease in index case and secondary case

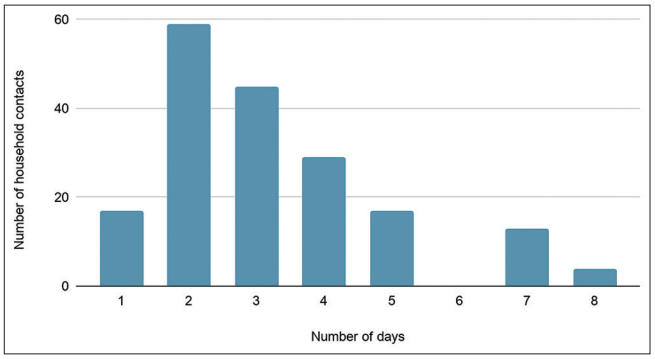

Figure 2: Distribution of durations of exposure in household contacts

significantly lower rate of passing on the disease [odds ratio (OR) = 0.1257, 95%CI: 0.0597–0.2645] ($p < 0.001$). Symptomatic primaries were more likely to pass on the disease (OR = 4.7368, 95%CI: 1.0285–21.8162, $P = 0.045$) than asymptomatic cases. 44.12% of contacts of symptomatic patients got the infection while 14.29% of contacts of asymptomatic cases got infected.

Another factor that decreased risk of secondary infections in households was if the primary was a health care worker, with significant values observed (OR = 0.299, 95%CI: 0.1532–0.5837) (p = 0.0003). 100% of the families which had a healthcare worker index case who quarantined remained secondary infection free.

Discussion

The overall SAR for household contacts of mild confirmed cases of the COVID-19 infection admitted under the COVID wing of AIIMS, New Delhi, came out to be 41.85%.

Most studies, to the best of our knowledge, have demonstrated a lower SAR compared to our study, especially studies done in

India. For instance, a study done in rural Gujarat estimated a household SAR of 5.6%,[7] whereas another study done in rural Western India measured it to be 8.8%.[8] Another study which was done in Kerala has reported a household SAR of 5.88%.[9] Similarly, a study in China which determined a SAR of 16.3%.[10]

However, there exist studies that demonstrate higher rates of household SAR for COVID-19. A study conducted in Tennessee found a high household SAR of 53%.[6] Another meta-analysis which included 43 studies conducted by Koh *et al.* in July 2020 found a pooled household SAR of 18.1% with a range of 3.9–54.9%.[11]

In our study, age of the household contacts played an important role in the susceptibility to the infection, with adults and elderly showing higher SAR of 49.56% and 32%, respectively, compared to children and teenagers having a SAR of 28.26%. This is consistent with other studies.[11] Our study also showed that the mean duration between disease onset in index cases and secondary cases was 5.16 days [Figure 1], which is lower than the overall mean duration of 14.3 days reported by an Indian counsel of medical research (ICMR) study.[12]

Out of 184 household contacts, the SAR in those with a duration of exposure of less than a week was 40.56%, whereas it was 100% for those exposed to the index case for a week or more (p = 0.029) [Figure 2]. This shows that chances of secondary infection increase with exposure longer than a week.[8]

Symptom status of the index case proved to be a major indicator of risk of secondary transmission, with household contacts more likely to be positive if exposed to a symptomatic primary case compared to an asymptomatic (OR = 4.74, 95%CI: 1.03–21.82, $P = 0.045$). This is in accordance with other studies.[13]

The most significant factor to decrease transmission to household contacts in our study was the quarantine status of the index case. Household contacts of primaries who had quarantined following proper guidelines[14] had a much lower rate of secondary infections compared to those that did not quarantine (OR = 0.13, 95%CI = 0.06–0.26, $P < 0.0001$). This is concurrent with most studies as it decreases the effective exposure.[10]

A new aspect that we undertook to investigate in this study was to determine the incidence of secondary household infections depending on whether the index case is a healthcare worker. We found that secondary contacts had a lower chance of contracting a secondary COVID-19 infection if the index case was a healthcare worker, compared to a non-healthcare worker index case (OR = 0.3, 95%CI = 0.15–0.58, $P = 0.0003$).

Our study had a few limitations. As SAR was determined only in symptomatic households, our study could have missed some secondary cases. The sample size was also not powered enough to equate association between parameters like comorbidities and secondary infection. A study with better sample size can be planned in this aspect.

With the high household SAR as has been found in this study in an urban setting in India despite a low average duration of exposure, we can conclude that a household is a high-risk unit for spread of the infection. Children below 18 years old were less susceptible to secondary infection compared to the adults and the elderly. However, proper quarantine measures if strictly followed lowered the rate of transmission significantly and remain one of the most effective measures of decreasing secondary spread. Our study also found that healthcare worker primaries were associated with a lower rate of transmission.

Future perspective

As this study was done in the pre-vaccination time and has analysed the SAR among households, in future a similarly conducted study can be used to compare the real-world effectiveness of vaccines in preventing secondary attacks in mild cases.

Conclusion

The high SAR shows the household is a potential high-risk unit for transmissibility of COVID-19. Proper quarantine measures of all those exposed to the index case can mitigate such spread and lead to reduction of risk of COVID-19 within a household. Healthcare workers have less chance of spreading infection to their household contacts.

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Conflicts of interest

There are no conflicts of interest.

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