Original Article

Household secondary attack rate amongst the susceptible contacts of COVID-19 cases and its epidemiological profile: A retrospective study from central Gujarat, India

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Abstract

Introduction: Secondary attack rate (SAR) is a proportion of primary contacts developing the diseases within the incubation period upon exposure to a primary case among the total susceptible household contacts. The epidemiological profile and SAR will help in understanding the transmission dynamics of COVID-19 for further strengthening preventive and effective control measures. **Objectives of the Study:** The study was conducted with the primary objective to estimate the household SAR of COVID-19 cases at Mahisagar District, Gujarat, and to study the epidemiological profile of primary and secondary cases of COVID-19. **Methodology:** A retrospective study was conducted to estimate SAR among 245 confirmed cases of COVID-19 and 898 susceptible household contacts in Mahisagar district through telephonic interview and questionnaire by the Investigator team. **Results:** The household SAR was calculated from the current study in Mahisagar district, Gujarat, and was 13.9%. Among primary cases, 74.7% males were affected, and among secondary cases, 52.8% females were affected. The SAR among elderly was 23.9%, and the SAR among children was 3.9%. 74.1% household contacts had developed disease among symptomatic contacts as compared to asymptomatic household contacts. **Conclusion:** The household SAR in Mahisagar district, Gujarat, was found to be 13.9%. In primary cases, more males, and in secondary cases, more females were found to be affected. The household SAR was increased in elderly as compared to the younger age group. The SAR was more among the contacts of symptomatic cases than asymptomatic cases. Overall hospitalization in public hospitals was more than that in private hospitals.

Keywords: COVID-19, Gujarat, secondary attack rate, susceptible contacts

Introduction

The whole world had become a prey to the pandemic of COVID-19, which was initiated from Wuhan, China, in the month of December, 2019. Enormous efforts were directed by all the countries to combat the pandemic. Active search for the cases, quarantine and isolation of affected, and screening of close contacts were the most effective ways for breaking the chain of transmission.[1] Age and co-morbidity played a vital role in the prognosis of the COVID-19 cases.[2] The study has shown that the highest-risk exposure setting of COVID-19 transmission was the household contacts of the infected cases.[3] To reduce secondary cases of COVID-19, contact tracing is one of the key strategies which interrupt the chain of transmission of SARS-CoV-2.[4] The secondary attack rate (SAR) among contacts is a helpful parameter to track the potential of viral transmission.[3] It also guides for control strategies. The SAR

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of SARS-CoV-2 denotes the probability that infection occurs among susceptible contacts within a reasonable incubation period following contact with the infectious person (s) or that of the source.[5] The SAR of SARS-CoV-2 differs from the nature of the setting and that of the symptomatic status of the primary cases.[6] The present study aimed at determining the SAR at one of the districts of Gujarat, India, and study the epidemiological profile of primary and secondary cases. Findings of the study may contribute in developing area-specific prevention and control policies for COVID-19. The findings of the study can guide primary care practitioners in implementing targeted and effective prevention and control strategies, tailored to the specific characteristics of the community, ultimately enhancing their ability to manage and mitigate the impact of a future epidemic or pandemic.

Objectives

The primary objectives were to estimate the household SAR of COVID-19 cases at Mahisagar District, Gujarat, and to study the profile of primary and secondary cases of COVID-19 (demographic, clinical, and socio-economic determinants).

Materials and Method

A retrospective study was conducted among confirmed cases of COVID-19 of Mahisagar district, Gujarat state. Mahisagar district (comprising six talukas) was assigned to the Community Medicine Department of one of the private medical colleges in Ahmedabad, Gujarat, for Regional Monitoring Team/Suppositive Routine Immunization Mentoring area and Rapid Response Team activities for COVID-19. The study was conducted in the month of September to October 2020.

Line listing of 458 laboratory-confirmed (RT-PCR-positive) COVID-19 cases reported in the months of July and August 2020 was obtained from the district health office, Mahisagar district. Out of that, a total of 300 primary cases were randomly selected from the available line list using the random number table method. The patients who were not contacted or refused to give consent were excluded from the study. Telephonic interviews of selected primary cases and their secondary cases were conducted by the investigator team with help of a pre-validated data collection interview tool. Verbal consent was taken prior to the telephonic interview. Detailed interview was conducted for a total of 245 primary cases and 125 secondary cases. The Investigator team consists of three faculties of the Community Medicine department and trained Interns and Medical Social Workers under the guidance of the Professor and Head of the department. The household contacts included in the present study were defined as individuals sharing the same living address with the positive cases.

A primary case is defined as the index case for the household, and a secondary case will be defined as another household member testing positive for COVID-19 between 2 and 14 days of positivity of the primary case. SAR for COVID-19 was defined as the total number of secondary cases occurring within the range of incubation period (14 days) following exposure to the primary case out of total susceptible persons/household contacts.[7] The study has been approved by the Institutional Ethical Committee of IIPHG as a part of multi-centric study.

Data collection tool

An interview tool includes details of demographics, clinical details, co-morbidity status, household details, secondary case details, and quality of care details, which were collected from both primary and secondary cases.

Data analysis

Data were entered and analyzed in Microsoft Excel 2019, and frequencies and percentages were calculated. Chi-squared test and Chi-squared test for analysis of linear trends were applied for the qualitative data with use of a free statistical software tool, Epi Info version 1.4.3, by Centers for Disease Control and Prevention, Atlanta.

Result

Out of total selected primary cases (300), 245 primary cases were contacted and interviewed for the study and a total of 125 secondary cases were interviewed. The total household contacts identified were 898, and the SAR of Mahisagar district was calculated as 13.9% according to the data reported in the months of July and August 2021 [Table 1].

Around 81% primary cases belonged to the age group of 18–60 years, followed by approximately 16% belonging to >60 years in the study. 74.7% study participants were male, and 25.3% were female. 64.5% primary cases were working. Nearly one-third primary cases had one or more co-morbidities present. Around 75% primary cases had the presence of one or more symptoms.

Out of total interviewed primary cases, 13.1% were hypertensive, 8.6% were diabetic, and 6.5% had both [Table 2].

Table 1: Details of study population and SAR in Mahisagar district

Variable	Frequency
Total Positive cases Line listing (Primary + Secondary + Duplicate entry + Repeat testing)	458
Total number of cases selected for SAR study	300
Patients excluded from study (Not contacted or Refused to give consent)	55
Total primary cases contacted	245
Total Secondary cases	131
Total Secondary cases contacted and interviewed	125
Total household contacts of the primary case	898
Overall SAR	14.6%
SAR (According to contacted Secondary cases)	13.9%

Nearly two-third secondary cases belonged to the age group of 18–60 years. Among study participants, 52.8% were female and 47.2% were male. Total 22.4% secondary cases had one or more co-morbidities present. Around 53% secondary cases had the presence of one or more symptoms. Out of total interviewed secondary cases, 10.4% were hypertensives, 4% were diabetic, and 4.8% had both [Table 2]. The most common relationship of secondary cases with primary cases was found to be either parent (24.8%) or spouse (24.8%) or sibling (12%) and child (24.8%), followed by others (13.6%). Total 94.4% secondary cases were in contact with primary cases within 14 days prior to testing. Out of total secondary cases, 53.6% cases quarantined themselves after positivity of primary cases but prior to testing and 46.4% secondary cases got tested immediately.

Around 29.4% primary cases had one or more secondary cases which were developed within the range of incubation period following the exposer of primary cases [Table 3].

The proportion of primary cases according to type of residence (urban and rural areas) was almost equal (nearly 50%). Around 48.5% primary cases had availability of separate toilet/bathroom facility in their household [Table 4].

Total household contacts of primary cases were 898, and total secondary cases developed within the range of incubation period of primary cases were 125, so the calculated SAR was 13.9% in this study. SAR was more in the elderly (23.9%) age group, followed by adults (13.6%) and children (3.9%), and it was statistically established with the help of Chi-squared test for analysis of linear trends that as age increases, SAR also increases, showing a linear trend in this study. Total 74.1% household contacts had developed disease among symptomatic contacts (108) following exposure to primary cases as compared to only 5.7% household contacts, who had developed disease among asymptomatic (790). Symptomatic susceptible/household contacts developed disease more as compared to asymptomatic contacts, and it is statistically significant as shown in Table 5.

Most of the positive cases (both primary and secondary) had been admitted in the public hospital as compared to private hospitals [Table 6].

According to multiple responses, the most common/reported symptoms were fever (78.1%), followed by cough (36.6) among primary cases, and among secondary cases, the proportion was 74.2%, followed by 48.5%. Other symptoms were breathlessness, myalgia/body ache, and loss of smell and taste out of all primary cases (n = 182) and secondary cases (n = 81) admitted to public hospitals.

Discussion

A study undertaken at Patan[8] and Gandhinagar[9] districts of Gujarat state found that SAR was 5.6% and 8.8%, which is lower than the SAR found in the current study. A study conducted by Abraham et. al. found SAR of 6%,[10] which was less compared to the current study. However, studies in other countries like China[3,11-14] and South Korea[15] reported SAR from 16.2% to 49.56%, which is more than the SAR reported in the current study. A few studies conducted in USA,[16] Taiwan,[17] and Republic of Korea[18] have reported SAR less than that of the current study in the range of 4.6% to 10.5%. In Indian context, a study conducted by Saraswathy *et al.* in Kerala[19] and Dutta *et al.* in

Table 2: Profile of primary cases and secondary cases

Variable	Primary Cases (*n*=245) *n* (%)	Secondary Cases (*n*=125) *n* (%)
Age in years		
<18 years	06 (2.4)	13 (10.4)
18-60 years	199 (81.2)	87 (69.6)
>60 years	40 (16.3)	25 (20.0)
Mean Age (in years)	45.49±15.0	41.5±18.4
Sex		
Male	183 (74.7)	59 (47.2)
Female	62 (25.3)	66 (52.8)
Working status		
Working	158 (64.5)	79 (63.2)
Not working	87 (35.5)	46 (36.8)
Comorbidity status		
One or more comorbidity (HT/DM/CHD/Lung disease/Cancer/Kidney disease/Others)	71 (29.0)	28 (22.4)
None	174 (71.0)	97 (77.6)
Hypertension and/or Diabetes Mellitus Status of Primary cases		
Only Hypertension	32 (13.1)	13 (10.4)
Only Diabetes	21 (8.6)	5 (4.0)
Hypertension and Diabetes	16 (6.5)	6 (4.8)
Symptoms Status		
One or more Symptoms present	183 (74.7)	66 (52.8)
Asymptomatic	62 (25.3)	59 (47.2)

Rajasthan[20] reported SARs of 5.8% and 22.6%, respectively, while Areekal *et al.*[21] reported 24.2% in Thrissur. A systematic review conducted by Shah K *et al.*[22] found that SAR varies widely across countries between 4.6% and 49.56%.

The most number of cases was found in the earning age group of 18–60 years in the current study. This would have been due to their contact with other individuals at work places and also their active involvement in procuring household materials. The study conducted at Patan[8] showed similar results; that is, 18–<60 years age group reported a greater number of primary cases. In the present study, males were more as the primary case, which is in line to the study conducted at Patan[8] and Gandhinagar,[9] while the study done in China[12] showed both males and females to be equally infected at 50% each. The presence of one or more co-morbidities amongst primary cases in the current study is almost equal to that reported in the study conducted at Patan[8] and Gandhinagar[9] at 34% and 29.8%, respectively. Total 64.5% primary cases were working outside the home in the current study, while 67.6% in Gandhinagar[9] by Shah *et al.* It was found that only 5.7% primary cases had three or more secondary cases in households, whereas 8.1% was reported by Shah *et al.*[9] in Gandhinagar.

Secondary cases similar to primary cases were more common in the present study in the age group of 18–60 years, while in gender, a greater number of secondary cases were among females, which are different from primary cases. The results of the present study in cases of age and gender are in line with the study done in Gandhinagar[9] and China.[12] The mean age of primary cases was more than that of secondary cases, which is similar to results drawn from the study conducted at Gandhinagar.[9] The co-morbidity in secondary cases was less compared to primary cases. Here, we can assume that compromised immunity due to the presence of co-morbidity may be the reason for more number of primary cases. The presence of co-morbidity in secondary cases in the current study is in line with the results of the study conducted at Patan[8] and Gandhinagar.[9] Also, the proportion of asymptomatic secondary cases was more than asymptomatic primary cases in the current study, which is in line with the study conducted at Patan.[8] A possible explanation to this would be that in most occasions, only a symptomatic primary case would undergo testing, and if found positive, then close contacts would be tested. The most common relationship of secondary cases with primary cases was found to be either parent or spouse, which was also reported by Shah K *et al.*, Fung *et al.*, and Koh *et al.*[22-24]

Residents of both urban and rural areas were equally susceptible in the current study, while it was 59% in the urban area at Patan. Availability of separate toilet–bathroom facility at homes of primary cases was almost equal. The results of the current study

Table 3: Primary case distribution as per the secondary transmission (*n*=245)

Number of Primary cases with secondary cases	*n* (%)
0 secondary case	173 (70.6)
1 secondary case	43 (17.6)
2 secondary cases	15 (6.1)
3 secondary cases	8 (3.3)
>4 secondary cases	6 (2.4)

Table 4: Household-related characteristic features of primary cases (*n*=245)

Household Charecterisitcs	*n* (%)
Type of Area	
Urban	121 (49.4)
Rural	124 (50.6)
Availability of Separate toilets/bathrooms facility	
Yes	119 (48.5%)
No	126 (51.5%)
Average rooms in each household	2.5
Average contacts per Households	3.5

Table 5: Distribution of Susceptible household contacts (*n*=898)

Groups	Household contacts Frequency (%)	Positive cases Frequency (%)	SAR (%)	95% Confidence Interval (CI)	Odds ratio
Children (<12 years)	101 (11.2)	4 (3.2)	3.9	1.27-9.27	1.0
Adult (12-60 years)	680 (75.7)	93 (74.4)	13.6	11.25-16.42	8.8
Elderly (>60 years)	117 (13.1)	28 (22.4)	23.9	16.86-32.28	7.6
Total	898 (100.0)	125 (100.0)	SAR=13.9% (95% CI: 11.7-16.3)		
Chi-squared test for analysis of linear trend χ^2=18.1 P<0.001					
Symptomatic household contacts	108	80	χ^2=370.7, P<0.001		

Table 6: Distribution of cases according to admission in the type of hospital

Type of Hospital	Primary Cases (*n*=245)	Secondary Cases (*n*=125)
Public hospital (Government, Govt bed in Private Hospital, Non-hospital - Isolation facility)	182 (74.3)	81 (64.8)
Private Hospital	19 (7.8)	7 (5.6)
Isolation at home	44 (18.0)	37 (29.6)
Total	245	125

differ from results drawn from the study conducted at Patan,[8] where almost 75% of primary cases had separate toilet–bathroom facility at home compared to 48.5% in the current study.

A statistically significant relation was established between age and SAR. As age increased, risk of SAR also increased, and similar results were found in Patan study.[8] The household SAR was higher among the contacts of symptomatic cases than asymptomatic cases, and similar results were found in rapid review by Fung *et al.*, Koh *et al.*, and Madewell *et al.*[23-25]

Both varieties of cases, that is, primary and secondary cases, preferred public hospitals over private hospitals. Preference of patients is similar to preference shown by study participants in Patan[8] and Gandhinagar[9] study.

The most common symptoms in both primary and secondary cases were fever followed by cough, similarly reported by Areekal *et al.*[21]

Limitation

This study has taken selected primary cases of 2 months only and that too from one district. The same study can be conducted with a larger sample size involving more districts with more scientific methodology for generalisability purposes. Generalisability of the findings needs to be validated before recommending any policy decisions in the different populations in different settings/countries.

Conclusion

SAR drawn from the current study in Mahisagar district, Gujarat, was 13.9%. In primary cases, more males were affected, while more females were found to be affected in secondary cases. The household SAR was increased in elderly as compared to the younger age group, which was more among the contacts of symptomatic cases than asymptomatic cases. Nearly all the secondary cases were in contact with primary cases within 14 days prior to testing. Approximately half of the secondary cases quarantined themselves after positivity of primary cases but prior to testing, and nearly half of the secondary cases got tested immediately. Only 48.5% primary cases had availability of separate toilet/bathroom facility in their household. Overall hospitalisation in public hospitals was more than that in private hospitals.

Recommendations

The preventive strategy should be directed with more focus to elderly and co-morbid status of the cases. The health staffs have to ensure that all secondary cases should be tested immediately after the positivity of primary cases. As around half of primary cases had the facility of separate toilets/bathrooms in their household, all the primary cases should be shifted to identified facilities like COVID Care Corner to avoid further contacts. The quality services provided at public hospitals should be continued and maintained to attract the large number of patients for adequate utilisation of public services.

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Conflicts of interest

There are no conflicts of interest.

References

1. COVID Containment and Surveillance Manual for Supervisors in containment zones. Ministry of Health and Family Welfare, India. August 2020.COVID19 Inter-ministerial Notifications. Available from: https://covid19.india.gov.in/. [Last accessed on 2023 Feb 20].
2. D'ascanio M, Innammorato M, Pasquariello L, Pizzirusso D, Guerrieri G, Castelli S, *et al.* Age is not the only risk factor in COVID-19: The role of comorbidities and of long staying in residential care homes. BMC Geriatr 2021;21:63.
3. Li W, Zhang B, Lu J, Liu S, Chang Z, Peng C, *et al.* Characteristics of household transmission of COVID-19. Clin Infect Dis 2020;71:1943-6.
4. Guidelines for Contact Tracing of Covid-19 Cases in Community Settings. Integrated Disease Surveillance Programme, National Centre for Disease Control, India. 2020. Available from: https://ncdc.gov.in/. [Last accessed on 2023 Feb 20].
5. Halloran ME. Secondary attack rate. In: Peter A, Theodore C, editors. Encyclopedia of Biostatistics. New York: John Wiley and Sons Ltd; 2005.
6. Thompson HA, Mousa A, Dighe A, Fu H, Arnedo-Pena A, Barrett P, *et al.* Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) setting-specific transmission rates: A systematic review and meta-analysis. Clin Infect Dis 2021;73:e754-64.
7. K Park. Park'sTextbook of Preventive and Social Medicine. 25th ed. Jabalpur, India: Bhanot Publisher; 2019.
8. Sharma P, Solanki N, Ninama R. Secondary attack rate and epidemiological determinants of secondary high- risk contacts of SARS COV-2; Lessons to learn: A study from north Gujarat. Natl J Community Med 2020;11:376-9.
9. Shah K, Desai N, Saxena D, Mavalankar D, Mishra U, Patel GC. Household secondary attack rate in Gandhinagar district of Gujarat state from Western India. medRxiv 2020. doi: 10.1101/2020.09.03.20187336.
10. Abraham P, Aggarwal N, Babu GR, Barani S, Bhargava B, Bhatnagar T, *et al.* Laboratory surveillance for SARS-CoV-2 in India: Performance of testing & descriptive epidemiology of detected COVID-19, January 22 - April 30, 2020. Indian J Med Res 2020;151:424-37.
11. Jing QL, Li YG, Ma MM, Gu YZ, Li K, Ma Y, *et al.* [Contagiousness and secondary attack rate of 2019 novel coronavirus based on cluster epidemics of COVID-19 in Guangzhou]. Zhonghua Liu Xing Bing Xue Za Zhi 2020;41:1623-6. Chinese.
12. Jing QL, Liu MJ, Zhang Z Bin, Fang LQ, Yuan J, Zhang AR, *et al.* Household secondary attack rate of COVID-19 and associated determinants in Guangzhou, China: A retrospective cohort study. Lancet Infect Dis 2020;20:1141-50.
13. Liu Y, Eggo RM, Kucharski AJ. Secondary attack rate and superspreading events for SARS-CoV-2. Lancet

2020;395:e47. doi: 10.1016/S0140-6736 (20) 30462-1.

14. Sun WW, Ling F, Pan JR, Cai J, Miao ZP, Liu SL, *et al.* Epidemiological characteristics of 2019 novel coronavirus family clustering in Zhejiang province. Zhonghua Yu Fang Yi Xue Za Zhi 2020;54:E027.
15. Park SY, Kim YM, Yi S, Lee S, Na BJ, Kim CB, *et al.* Coronavirus disease outbreak in call center, South Korea. Emerg Infect Dis 2020;26:1666-70.
16. Burke RM, Midgley CM, Dratch A, Fenstersheib M, Haupt T, Holshue M, *et al.* Active monitoring of persons exposed to patients with confirmed COVID-19-United States, January-February 2020. MMWR Morb Mortal Wkly Rep 2020;69:245-6.
17. Cheng HY, Jian SW, Liu DP, Ng TC, Huang WT, Lin HH*et al.* Contact tracing assessment of COVID-19 transmission dynamics in Taiwan and risk at different exposure periods before and after symptom onset. JAMA Intern Med 2020;180:1156-63.
18. COVID-19 National Emergency Response Center, Epidemiology and Case Management Team, Korea Centers for Disease Control and Prevention. Coronavirus Disease-19: Summary of 2,370 contact investigations of the first 30 cases in the Republic of Korea. Osong Public Health Res Perspect 2020;11:81-4.
19. Saraswathy AS, Sanya R, Kumaran JA. Secondary attack rate of COVID-19; analysis of contacts of COVID-19 cases admitted in a tertiary care centre, Northern District of Kerala: A cross-sectional study. Int J Community Med Public Health 2020;7:5111-4.
20. Dutta S, Kaur RJ, Bhardwaj P, Charan J, Bist SKS, Detha MD, *et al.* Household Transmission of COVID-19: A Cross-Sectional Study. Infect Drug Resist 2020;13:4637-42.
21. Areekal B, Vijayan SM, Suseela MS, Andrews MA, RAVI RK, SUKUMARAN ST, *et al.* Risk factors, epidemiological and clinical outcome of close contacts of COVID-19 cases in a tertiary hospital in southern India. J Clin Diagn Res 2021;15:34-7.
22. Shah K, Saxena D, Mavalankar D. Secondary attack rate of COVID-19 in household contacts: A systematic review. QJM 2020;113:841-50.
23. Fung HF, Martinez L, Alarid-Escudero F, Salomon JA, Studdert DM, Andrews JR, *et al.* The household secondary attack rate of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2): A rapid review. Clin Infect Dis 2021;73(Suppl 2):S138-45.
24. Koh WC, Naing L, Chaw L, Rosledzana MA, Alikhan MF, Jamaludin SA, *et al.* What do we know about SARS-CoV-2 transmission? A systematic review and meta-analysis of the secondary attack rate and associated risk factors. PLoS One 2020;15:e0240205. doi: 10.1371/journal.pone.0240205.
25. Madewell ZJ, Yang Y, Longini IM, Halloran ME, Dean NE. Household transmission of SARS-CoV-2: A systematic review and meta-analysis. JAMA Netw Open 2020;3:e2031756. doi: 10.1001/jamanetworkopen.2020.31756.