Journal of Communicable Diseases
Volume 53, Issue 3 - 2021, Pg. No. 51-59
Peer Reviewed & Open Access Journal

Research Article

Secondary Attack Rate among the Contacts of COVID-19 Patients at the Beginning of the Pandemic in Pune City of Western Maharashtra, India

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DOI: https://doi.org/10.24321/0019.5138.202138

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How to cite this article:
Jagdale GR, Parande MA, Borle PS, Tapare VS, Tambe MP, Wavare S, Hatnapure M, Salunke P, Shinde P, Paunikar A. Secondary Attack Rate among the Contacts of COVID-19 Patients at the Beginning of the Pandemic in Pune City of Western Maharashtra, India. J Commun Dis. 2021;53(3):51-59.

Date of Submission: 2021-06-03
Date of Acceptance: 2021-07-26

A B S T R A C T

Introduction: The COVID-19 was the emerging disease caused by SARS-COV 2. Efficient transmission of this disease occurs through droplets and fomites. As COVID-19 has high transmission and hence susceptible household & non-household close contacts are at high risk of developing disease. Study Objectives: 1) To estimate secondary attack rate of COVID-19 among the contacts during the pandemic in Pune city; 2) To identify factors associated with transmission and development of COVID-19 disease.

Material & Methods: This was a retrospective cohort study conducted in the month of June 2020. The sample includes 741 contacts of 119 Laboratory confirmed cases for COVID-19, resides in 15 ward offices areas of Pune Municipal Corporation after written informed consent. A confidential telephonic interview was taken by using a prestructured questionnaire which includes socio demographic data, duration of stay, family background, outcome, type of house, development of symptoms etc.

Results: The overall Secondary Attack Rate estimated to be 32.5%, 33.7% among the high risk contacts while 13.3% among the low risk contacts. In this city, 6 wards (40%) out of 15 wards showed SAR of more than 40%. The characteristics of primary cases associated with spread of disease were presence of symptoms and duration between onset of disease and isolation of primary case. The factors significantly affecting SAR were age, comorbidity, no. of family members, type of family, type of house, overcrowding, no. of rooms, bedroom attached with toilet, type of contact & containment zone.

Conclusion: Higher SAR was seen in the household contacts. It is necessary to adopt rigorous measures to cut the transmission chain in this area of close contact.

Keywords: COVID-19, Maharashtra, SAR, Contacts

Introduction

COVID-19 was an emerging infectious disease caused by SARS-CoV-2. Efficient transmission of this disease occurs through droplets and fomite supplemented by other routes such as aerosol and fecal contamination.[1,2] Household transmission might be responsible for the continued rise in cases even after forceful lockdown. Old age and people having co-morbidities like hypertension, cardiovascular diseases, diabetes and immune compromised individuals are more prone to get severe form of disease like acute respiratory distress syndrome (ARDS) and death. The World Health Organization (WHO) on March 11, 2020, has declared the novel corona virus (COVID-19) outbreak a global pandemic.[3] At the end of 3rd June 2020 this pandemic had around 6.5 million confirmed cases & 3,86,788 deaths.[4] It is very challenging to detect asymptomatic carriers which are suspected as major source of transmission of this disease. It is observed that daily rise in number of new cases per day is more in slums & high population density areas. Recently conducted two systematic reviews studied characteristic features of COVID-19 transmission in household contacts. Both showed that household Secondary Attack Rate (SAR) varies widely among different populations and ranges from 4.6% to 49 %.[5,6]

As of 3rd June 2020, India had crossed 2,00,000 confirmed cases and more than 6000 deaths, of which 74000 cases and 2500 deaths were contributed by the state of Maharashtra alone.[7,8] Mortality rate of the disease in Maharashtra is around 3.5% which is more than the national average.[8] On March 9, 2020, the first confirmed case of novel corona virus in Maharashtra was reported in Pune.[9] Pune is first district in India to cross 2 lakh COVID-19 cases. The mortality rate was also highest in Pune as compare to other cities of India.[10]

Till date around 8035 deaths in Pune city are due to COVID-19 diseases.[11]

An important parameter in the spread of any pandemic disease is their SAR (SAR) i.e. the probability the infection occurring among susceptible persons within a reasonable incubation period following known contact with an infectious person or an infectious source.Increase in SAR might indicate ineffectiveness or failure of current control programmes. As COVID-19 has high transmission and hence susceptible household & non-household close contacts are at high risk of developing disease. This study will help to know average number of people who will contract COVID-19 disease from a person with disease Assessing SAR and its correlates plays a major role in curtailing the disease transmission. Hence, a study was planned with an objective to estimate the SAR of COVID-19 among contacts in city of Pune, Maharashtra.

Study Objectives

- To estimate SAR (SAR) of COVID-19 among the contacts during the pandemic in Pune city.
- To identify factors associated with transmission and development of COVID-19 disease.

Materials and Methods

A community based retrospective cohort study was conducted in Pune city in the month of June 2020 after obtaining Ethics Committee clearance. The data of laboratory confirmed cases of COVID-19 diagnosed between 1st April to 15th May, 2020, living in different 15 ward offices area of Pune city was collected from local health authority as Pune Municipal Corporation. In case the study subject is less than 18 years, informed consent was taken from the parents/guardian and assent was taken from the subject. Considering SAR to be 13.8% among the household contacts from a study in Guangzhou China,[12] the minimum sample size of contacts to be covered was calculated to be 625, relative precision of 20%, and rounded off to 700 with a non-response rate of 10%. On an average COVID-19 positive patients are having 8-10 contacts. PMC, Pune has 15 wards. The contacts of 119 laboratory confirmed COVID-19 cases that resides in 15 ward offices areas are included in this study; so around 7 to 8 cases from each ward were selected randomly to meet sample size of 700 contacts.

The household contacts included in the present study are defined as individuals sharing the same living address with the positive cases.

The confidential interviews of 119 cases and their 741 contacts was carried out with the help of structured questionnaire predesigned proforma telephonically by the trained staff of department of Community Medicine after taking their verbal informed consent. It consist of the information about socio demographic characteristics like age, sex, occupation, address, containment zone, history of contact and or history of travel, development of symptoms, COVID-19 testing status, type of quarantine either home/facility or institution, comorbidities, type of house and duration of stay, family background, outcome, other relevant environmental history has been taken. The full contact history was elicited from patient and contacts list was prepared. All laboratory confirmed COVID-19 cases from area outside Pune city & those who not willing for participation were excluded. The primary contacts that turned RT-PCR positive on throat swab within 14 days of contact (irrespective of symptoms) with the confirmed case were counted in for estimating SAR.

Definition of Contact

A Contact in this study had been defined as a person living

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202138

with a case of COVID-19 positive case and had direct contact with the COVID positive case, his or her infectious secretions without wearing personal protective equipments or a person, who was in close environment with the patient or was had face to face contact with the positive case at a distance of 1 meter including air travel.[13,14]

High-risk Contact[13,14]

- Touched body fluids of the patient (respiratory tract secretions, blood, vomit, saliva, urine, faeces)
- Had direct physical contact with the body of the patient including physical examination without PPE
- Touched or cleaned the linens, clothes, or dishes of the patient
- Lives in the same household as the patient
- Anyone in close proximity (within 1 meter) of the confirmed case without precautions
- Passenger in close proximity (within 1 meter) of a conveyance with a symptomatic person who later tested positive for COVID-19 for more than 6 hours

Low-risk Contact[13,14]

- Shared the same space (same class for school/worked in same room/similar) and not having a high-risk exposure to confirmed case of COVID-19
- Travelled in same environment (bus/train/flight/any mode of transit) but not having a high-risk exposure
- Primary case refers to the first case of a communicable disease introduced into the population unit being studied
- Index case refers to the first case to come to the attention of the investigator; it is not always the primary case[15]
- SAR is defined as "the number of exposed persons developing the disease within the range of the incubation period, following exposure to the primary case"[13]

It is given by the formula:15

SAR = Number of exposed persons developing the disease within the range of the incubation period (i.e. within 14 days of exposure)/ Total number of exposed/susceptible contacts x 100.

Ethical Considerations

Permission of Institute Ethical Committee (IEC) was taken. A written informed consent was obtained from all participants by sending it through email. Study participants, whose age is less than 18 years, assent was taken from the study participants. Full confidentiality of respondent's information was kept and information was used only for research purpose.

Data Analysis

Microsoft excel was used for data entry. The data was tabulated and analyzed using SPSS version 23. Chi-square test has been used to test the significance of the proportion of secondary cases in association with various sociodemographic factors. A p-value less than 0.05 considered as significant.

Results

In this study, 119 laboratory confirmed primary cases residing in 15 different wards of City and their 741 contacts were interviewed telephonically. Among 741 contacts, 241 (32.5%) were RTPCR positive and 500 (67.5%) were RTPCR negative (Figure 1).

The 241 positive secondary cases among all contacts give rise to overall SAR as 32.5% (Figure 2). Out of 741 contacts, 696 (93.9%) were high risk contacts, while 45 (6.1%) were low risk contacts. Among the high risk contacts, 235 were RTPCR positive giving SAR of 33.7% and among low risk contacts, 6 were RTPCR positive giving SAR of 13.3%.

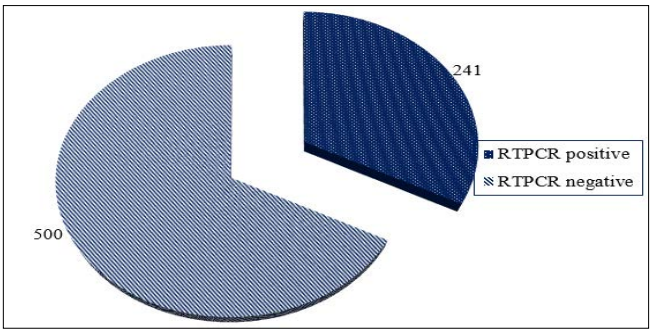

Figure 1.Proportion of RTPCR Positive among the Contacts

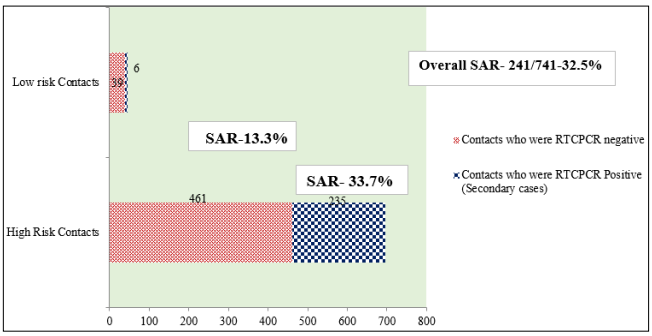

Figure 2.SAR among the Contacts

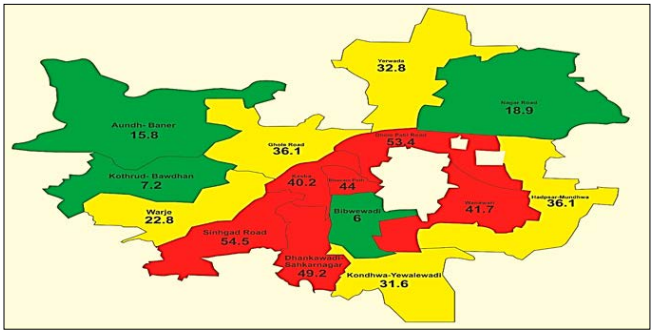

Figure 3.Ward-wise SAR Pune City

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202138

The geographical variation of COVID-19 was studied and it showed that there was a variation in ward-wise distribution of secondary cases; hence SAR also varies from ward to ward. The categorization of the wards were done depending on the SAR into 3 groups as follows:

i) < 20%, ii) 20 to 40% and iii) > 40.

Among 15 wards of city, 4 wards showed SAR as less than 20%. Five wards had SAR in between 20 to 40% and six wards of central part of city were showing SAR above 40%.

In this study, the majority 103(85.5%) of primary cases were between 16-60 years of age with mean age of 38.7 ± 16.2 years. Among 119 primary cases, 65 (54.6%) cases were female and 54 (45.4%) cases were male. Symptoms were present among 81 (68.1%) cases and rest 38 (31.9) were asymptomatic, 35 (29.4%) had co-morbid condition. The fatality rate in was 5.9% in the study period (Table 1). Majority of primary cases 38 (31.9%) were isolated on same day of symptoms followed by Day 3 and above 29 (24.4%).

When age factor of primary cases and of contacts was studied, it was found that spread of disease was not significantly associated with age of primary case (p=0.42) and among the contacts of primary cases, positivity rate i.e. secondary cases were significantly higher in age group more than 60 years as 38.1% while percentage of secondary cases was less in children age group (< 15 years) as 22.7% i.e. as age increases positivity rate significantly increased (p< 0.011). The spread of disease was more when female was a primary case (p=0.33) and number of secondary cases were slightly higher in males (53.9%) compared to females but it was not statistical significant (p=0.95). In this study, very high statistical significant difference was found among the spread of disease and symptomatic nature of primary case (p < 0.0001). There was a highly significant association between the day of isolation from start of symptoms or RTPCR result (in case of asymptomatic primary cases); higher spread was seen when the gap was Day 3 or more (p < 0.0001). There was a significant association between number of family members, type of family, presence of comorbidity among the contacts and spread of disease. Among 741 contacts of primary cases, 66 were with one or more comorbidity. In this 66 contacts, 34/66 (51.5%) were RTPCR positive and there was very high association of Comorbidity with number of secondary cases among contacts (p < 0.0001). There was also no association found between education, occupation, & spread of disease in contacts (Table 2).

The families living in Pakka house showed significantly more positivity of contacts than those living in Kachha house (p=0.031). The number of secondary positive cases was significantly higher in families having 1 and 2 rooms than 3 and above rooms (p < 0.0001). In overcrowding positivity rate was significantly higher than non-overcrowding (p=0.027). The houses with no facility of bedroom with attached toilet showed higher positivity rate then bedroom attached with toilet facility (p=0.029). Ventilation and cross ventilation of house was not associated with spread of disease. Household contact was significantly more positivity rate than other types of contact (p=0.007). Containment zone had significantly more positivity rate than non-contentment zone (p < 0.0001) (Table 3).

Table 1.Characteristics of Primary Cases

Parameters		Primary cases [n=119 (%)]
Age (Years)	<15	7 (5.9)
	16 - 60	103 (85.5)
	>60	9 (7.6)
Gender	Male	54 (45.4)
	Female	65 (54.6)
Symptoms	Present	81 (68.1)
	Absent	38 (31.9)
Co-morbidity	Present	35 (29.4)
	Absent	84 (70.6)
Outcome	Death	7 (5.9)
	Survived	112 (94.1)
Duration of contact with index case	Isolated on same day	38 (31.9)
	Isolated on day 1	27 (22.7)
	Isolated on day 2	25 (21.0)
	Isolated on day 3 and above	29 (24.4)

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202138

Table 2.Sociodemographic and Other Factors Affecting SAR

Parameters		Contacts		Chi-square	P value
		Positive n=241 (%)	Negative n=500 (%)		
Characteristics of primary cases					
Age (Years)	<15	9 (3.7)	20 (4.0)	1.72	0.42
	16 – 60	219 (90.9)	440 (88.0)		
	>60	13 (5.4)	40 (8.0)		
Gender	Male	120 (49.8)	268 (53.6)	0.94	0.33
	Female	121 (50.2)	232 (46.4)		
Symptoms	Present	158 (65.6)	166 (33.2)	69.2	<0.0001
	Absent	83 (34.4)	334 (66.8)		
Duration of contact with index case	Isolated on same day	41 (17.0)	139 (27.8)	18.1	0.0001
	Isolated on day1	52 (21.6)	131 (26.2)		
	Isolated on day 2	68 (28.2)	119 (23.8)		
	Isolated on day 3 and above	80 (33.2)	111 (22.2)		
Characteristics of contacts					
Age (Years)	<15	36 (22.7)	122 (77.2)	8.93	0.011
	16 – 60	184 (34.8)	344 (65.1)		
	>60	21 (38.1)	34 (61.8)		
Gender	Male	130 (53.9)	271 (54.2)	0.004	0.95
	Female	111 (46.1)	229 (45.8)		
Education	Professional	9 (3.7)	36 (7.2)	9.18	0.16
	Graduate/ PG	29 (12)	66 (13.2)		
	Intermediate/ diploma	65 (27)	106 (21.2)		
	High school	66 (27.4)	114 (22.8)		
	Middle school	32 (13.3)	71 (14.2)		
	Primary	21 (8.7)	54 (10.8)		
	Illiterate	19 (7.9)	53 (10.6)		
Occupation	Profession	8 (3.3)	22 (4.4)	7.69	0.26
	Semi profession	10 (4.1)	20 (4)		
	Clerical/ shop owner	25 (10.4)	65 (13)		
	Skilled worker	16 (6.6)	19 (3.8)		
	Semi-skilled worker	20 (8.3)	25 (5)		
	Unskilled	7 (2.9)	11 (2.2)		
	Unemployed	155 (64.3)	338 (67.6)		
No. of family members	Up to 6	164 (68.0)	375 (75.0)	3.96	0.04
	Above 6	77 (32.0)	125 (25.0)		
Type of family	Joint	122 (50.7)	324 (64.8)	13.64	<0.0001
	Nuclear	119 (49.3)	176 (35.2)		
Comorbidity	Yes	34 (14.1)	32 (6.4)	10.98	<0.0001
	No	207 (85.9)	468 (93.6)		

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202138

Table 3.Household Environmental Factors Affecting SAR

Household environmental factors		Contact		Chi-square	P value
		Positive n=241 (%)	Negative n=500 (%)		
Type of house	Kachha	80 (33.1)	128 (25.6)	4.65	0.031
	Pakka	161 (66.9)	372 (74.4)		
No. of rooms	1	55 (22.8)	12 (2.4)	18.98	<0.0001
	2	131 (54.3)	245 (49)		
	3	36 (15)	74 (14.8)		
	More than 3	19 (7.9)	169 (33.8)		
Overcrowding	Yes	163 (67.7)	296 (59.2)	4.91	0.027
	No	78 (32.3)	204 (40.8)		
Bedroom with attached toilet	Yes	89 (37)	273 (54.6)	4.77	0.029
	No	152 (63)	227 (45.4)		
Ventilation of house	Adequate	87 (36)	177 (35.5)	0.04	0.85
	Inadequate	154 (64)	323 (64.5)		
Cross ventilation	Yes	27 (11.2)	59 (11.9)	0.06	0.81
	No	214 (88.8)	441 (88.1)		
Type of contact	Household	198 (82.1)	367 (73.4)	12.26	0.007
	Neighbor	34 (14.1)	96 (19.2)		
	Workplace	9 (3.7)	20 (4.0)		
	Other	0 (0)	17 (3.4)		
Containment zone	Yes	212 (88.0)	344 (68.8)	31.89	<0.0001
	No	29 (12)	156 (31.2)		

Discussion

The spread of any epidemic depends on the infectivity of the pathogen and the available susceptible population. SAR is a marker of the susceptibility of spread from a primary source of infection to other specific groups, say within a household, within close contacts, within professional contacts, etc. and helps to understand how specific factors and interactions may be a key to the transmission of the infection. Maharashtra was a hotspot that accounts for nearly one-third of the total cases in India as well as about 40% of all deaths. On 13 March 2020, the Government of Maharashtra declared the outbreak an epidemic in the cities of Mumbai, Navi Mumbai, Pune (PMC & PCMC limits) and Nagpur, and invoked provisions of Epidemic Diseases Act, 1897 which enabled it to forcibly hospitalize anyone with suspected symptoms. All schools, Colleges, gardens, religious places and Commercial establishments were shut across the state as a precaution. A ban on all public gatherings and functions to contain the spread of the virus. In this study, the overall SAR among the contacts of persons with COVID-19 was 32.5%; out of which 33.7% among high risk contacts while among low risk contacts it was 13.3%. Similar observations of high SAR among the high risk contacts was observed by various studies.[5,16-20] The SAR of COVID-19 in this study was higher than SAR reported from other districts in India. The SAR of 5.6% was observed in a study from North Gujarat.[19] The study done by ICMR COVID Study Group reported SAR with a national average of 6% with the highest SAR in Chandigarh (11.5%) and Maharashtra (10.6%).[18] In a systematic review of SAR of COVID-19 among household contacts by Shah et al it was observed that SAR among household contacts was 6% in India.[5] The same systematic review study found that SAR ranges between 4.6% to 49.56% among the different countries and was unaffected by the factors like population of the country, lockdown status in the country and country's geographical location.[5]

The high SAR among this study could be due to the factors like the primary cases were more among the central part of this city which was epicenter of COVID-19 in India. The emergence of Pune as the city with the highest number of cases is somewhat intriguing, although not entirely a surprise since it was always among the five worst affected cities. This might be due to the fact that the testing in this

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202138

city of Maharashtra was much more as compared to other cities. Pune was also one of the cities in the country which recorded the initial cases of Coronavirus which might explain the widespread of the disease in a large number of people; higher the risk of exposure, more chances of transmission of this infectious disease was there.

The wards which were centrally located, having high population density, with more slum area and where major markets of city were located showed highest SAR as more than 40%. Four out of fifteen wards showed SAR less than 20%; the population density and housing index is less in this wards as compared to rest, was might be reason of low SAR.

The primary cases were more in adult age as compared to old age or children. The outdoor activities or frequency of exposure might play important role in occurrence of infection in this age group. Similar type of findings was observed in a study conducted from North Gujarat.[19] Data suggests children have not played a substantive role in household transmission of SARS-CoV-2.[21]

The first characteristic of primary case significantly associated with spread of disease was symptomatic nature. Asymptomatic primary case also transmits the disease but there may be low infectiousness or a shorter duration of infectiousness. In another systematic review, it's found that cases with asymptomatic infection have a shorter duration of RNA shedding than symptomatic individuals.[22] Asymptomatic patients may therefore be contagious but for a shorter duration. The second one was duration of contact with the primary case; more the time of contact i.e. from the symptom onset to isolation, more was the spread. Right from the initial outbreak of the COVID-19, epidemiologists and public health experts undoubtedly recommended quarantining and isolation of the positive cases as one of the most effective preventive strategy.[5] The other factors of primary case like age and sex were not significantly related to the spread in this study.

The socio-demographic factors of contacts were also important in transmission and spread of COVID-19. The factors significantly associated with transmission were age of contacts, presence of co-morbidity, type of family and total members in the family. Age was the most examined covariate, with most studies reporting significantly lower secondary transmission of SARS-CoV-2 to children contacts than adult contacts.[12,23,24] The individuals aged > 60 years were most susceptible to SARS-CoV-2 infection. Till date it was known that elderly and patients with comorbid conditions are most vulnerable population for infection and poorer outcome.[5] It is known that old age and comorbid conditions are independent risk factors of COVID-19 infections and hence it explains higher transmission rate in elderly in household SAR as well.[5] In type of family, occurrence of secondary cases in joint family was significantly more than nuclear type of family and family having members above.[6] There is evidence that individuals living in more crowded housing units are more likely to contract the virus; so more the number of individuals more is the risk. The household environmental factors and its infrastructure plays crucial role in spread and transmission of infectious diseases. The household environmental factors associated significantly with transmission were type of house, no. of rooms in the house, presence of overcrowding, bedroom with attached toilet, type of contact and presence of residence in containment zone.

The risks of getting COVID-19 are higher in crowded and inadequately ventilated spaces where infected people spend long periods of time together in close proximity. Ideally, for isolation, a bedroom with window(s) and an attached toilet is the choice. Definitely if a primary or index case had been isolated in such room there was less chance of transmission and we had similar type of findings. There were more chances of local transmission going on in containment zone. The household and family contacts are at higher risk than other types of contacts. Due to frequency of contacts between family members of the households, reduced or no usage of personal protective equipment, shared living and or eating environment, presence of SARS-CoV 2 virus on the different surfaces and potential fecal shedding of virus in shared toiles might be favorable for more transmission in the household.[25]

Conclusion

The overall SAR estimated to be 32.5%, 33.7% among the high risk contacts, while 13.3% among the low risk contacts. In this city, 6 wards (40%) out of 15 wards showed SAR of more than 40%. The characteristics of primary cases associated with spread of disease were presence of symptoms and duration between onset of disease and isolation of primary case. It showed that the disease is infectious in nature and hence adequate precautions must be taken to prevent secondary transmission with iimmediate isolation of primary case, especially when symptoms are present. The SAR is elevated among household contacts, with old age, co-morbidity, household with more than 6 members, presence of overcrowding, absence of bedroom attached with toilet. Knowing the SARs can help align the local public health response with transmission dynamics with the goal of minimizing the morbidity and mortality due to COVID-19.

Acknowledgement

The authors are thankful to the Health department of Pune Municipal Corporation, Pune for sharing the data of COVID-19 patients from PMC, Pune area.

Source(s) of Support in the Form of Grants, Equipment, Drugs, or All of these: None.

Conflicts of Interest: None

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