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Original Research Article

Secondary attack rate among high-risk contacts of COVID-19 paediatric index cases: a study at the beginning of the pandemic in Pune city of Western Maharashtra, India

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ABSTRACT

Background: The COVID-19 was the emerging disease caused by SARS-COV2. Efficient transmission of this disease occurs through droplets and fomites. The susceptibility of children to coronavirus disease-19 (COVID-19) and transmission of COVID-19 from children to others is a relatively unexplored area. The aim of this study was to understand the transmission dynamics of severe acute respiratory syndrome coronavirus 2 in children. Study objectives were to estimate secondary attack rate of COVID-19 from paediatric index case during the early phase of pandemic in Pune city and to identify factors associated with transmission and development of the COVID-19 disease.

Methods: This was a retrospective cohort study conducted in the month of June 2020. The sample includes 58 contacts of 11 laboratory confirmed pediatric index cases of COVID-19 from Pune municipal corporation after written informed consent. A confidential telephonic interview of parents was taken by using a prestructured questionnaire which includes socio-demographic data, family background, type of house, development of symptoms, outcome etc.

Results: The mean age of primary pediatric case was 12.7±5.1 years. All of them were symptomatic. The SAR estimated was 55.2%. The factors significantly affecting SAR were comorbidity, no. of family members, type of family, overcrowding, no. of rooms, bedroom attached with toilet.

Conclusions: The household SAR from paediatric patients is high and is closely associated with family size and other household characteristics. Hence, home quarantine should be advocated in smaller families with appropriate isolation facilities; more emphasis is given to co-morbid individuals.

Keywords: COVID -19, Maharashtra**,** Pediatrics, Secondary attack rate

INTRODUCTION

On March 9, 2020, the first confirmed case of novel corona virus in Maharashtra was reported in Pune.[1,2] 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.[3] The number of cases of coronavirus disease-19 (COVID-19) was showing a rising trend globally and in India. Similar trends have been noticed in the number of publications on COVID-19. However, most of these literatures involve the adult population. Studies have shown that the percentage of children amongst total COVID-19 positive individuals is less than the 5%.[4-6]

Whether this low number is due to decreased susceptibility of children to infection or decreased rates of exposure is a matter of debate.[4] Since there is a very high percentage of asymptomatic disease in children, a question can be raised whether transmission from children, in general, will be lesser. Similar to elderly, this population is also vulnerable and often depends on their caretakers for basics of their needs. This makes it extremely important to study disease transmission when index case is from paediatric age group. Studies have reported the role of children in transmitting COVID-19 in close contacts. Hence current cross-sectional study was planned with the aim to understand the transmission dynamics of SARS-CoV-2 in children.

Study objectives

The study objectives were to estimate SAR (SAR) of COVID-19 among the contacts of paediatric index cases during the pandemic in Pune city and to identify factors associated with transmission and development of COVID-19 disease from pediatric index case.

METHODS

A large community based retrospective cohort study was conducted by department of community medicine, BJGMC, Pune in Pune city area in the month of June 2020 to estimate secondary attack rate among the contacts of COVID-19. This current study was a part of this big survey; in this 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 this study data of 119 primary cases and 741 contacts was collected. Out of this, 11 index cases were below 18 years of age (Paediatric age group); these cases had 58 contacts and were included in final analysis.

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

The confidential interviews of 11 pediatric cases and their 58 contacts were carried out with the help of predesigned structured questionnaire telephonically by the trained staff of department of community medicine. It consists 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. The 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.

Inclusion criteria

COVID positive index case by RT PCR who were below 18 years of age (Paediatric age group) and their household and neighbourhood contacts residing in Pune city area were included in the study.

Exclusion criteria

Low risk contacts of paediatric index cases, COVID positive index case who were above 18 years of age and residing in rural area of Pune were excluded from the study.

A contact in the context of COVID-19 is:[7,8] A person living in the same household as a COVID-19 case; a person having had direct physical contact with a COVID-19 case or his/her infectious secretions without recommended personal protective equipment (PPE) or with a possible breach of PPE and a person who was in a closed environment or had face to face contact with a COVID-19 case at a distance of within1metre including air travel.

High-risk contact[7,8]

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 and passenger in close proximity (within 1 meter) of a conveyance with a symptomatic person who later tested positive for COVID-19 for more than the 6 hours.

Low-risk contact[7,8]

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.[9] 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".[9]

It is given by the formula:[9]

SAR=(number of the 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) ×100

Ethical considerations

Permission of institute ethical committee (IEC) was taken. A verbal informed consent was obtained from the parents of the index cases and assent was obtained from the cases telephonically. 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 $p<0.05$ considered as significant.

RESULTS

In this study, 11 laboratory confirmed primary cases residing in 7 different wards of city and their 58 contacts were interviewed telephonically. Among 58 contacts, 32 (55.2%) were RTPCR positive and 26 (44.8%) were RTPCR negative (Figure 1).

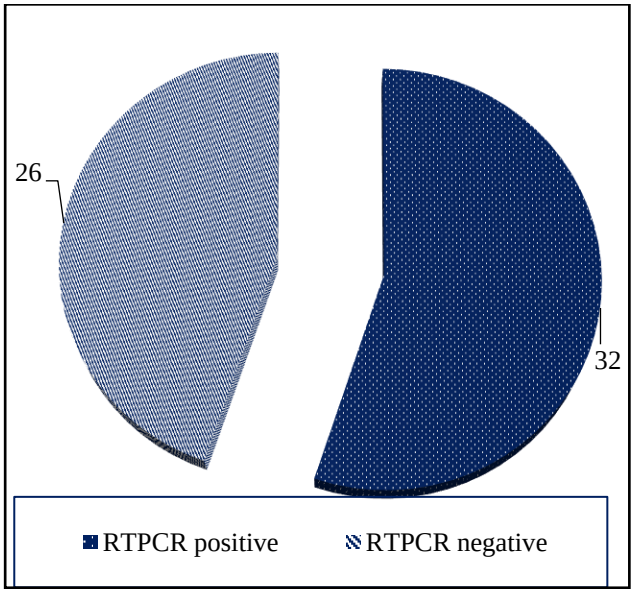

Figure 1: Proportion of RTPCR positive from pediatric index case among the contacts.

The 32 positive secondary cases among all contacts give rise to overall SAR as 55.2%. All the contacts were high risk type.

The mean age of primary pediatric case was 12.7±5.1 years. Among 11 primary cases, 5 (45.5%) cases were male and 6 (45.4%) cases were female. All of them were symptomatic. The fatality was not observed among these pediatric primary cases during the study period Majority of primary cases 5 (45.4%) were isolated on day 3 and above (Table 1).

When factors affecting positivity of contacts was studied, it was found that spread of disease was not significantly associated with age of primary case (p=0.24) as well as age of contacts (p=0.69). The spread of disease was more when female was a primary case (p=0.26) and number of secondary cases were also higher in females (59.4%) compared to males but it was not statistically significant (p=0.48). The spread of disease was higher when there was more gap between the day of isolation from start of symptoms; though it was not statistically significant (p<0.66). There was a significant association between number of family members, type of family, presence of comorbidity among the contacts and spread of disease. Among 58 contacts of primary cases, 19 were with one or more Comorbidity. In these 19 contacts, 14/19 (73.4 %) were RTPCR positive and there was significant association of comorbidity with number of secondary cases among contacts (p<0.04). There was no association found between education, occupation, and 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 2 and 3 rooms than 4 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= 0.003). Household contact had more positivity rate than neighborhood contact though it's not significant (p=0.62). Other factors like families living in pakka house, ventilation and cross ventilation of house and residing in Containment zone were not associated with spread of disease (Table 3).

Table 1: Characteristics of primary pediatric cases.

Parameters		Frequency, (n=11)	Percentage (%)
Age (years)	Mean±SD	12.7±5.1	
Gender	Male	5	45.5
	Female	6	54.5
Symptoms	Present	11	100.0
	Absent	0	0
Duration of contact with index case	Isolated on same day	1	9.1
	Isolated on day1	2	18.2
	Isolated on day 2	3	27.3
	Isolated on day 3 and above	5	45.4
Outcome	Death	0	0
	Survived	11	100.0

Table 2: Sociodemographic and other factors affecting SAR from pediatric primary cases.

Parameters		Contacts		Chi-square	P value
		Positive, (n=32)	Negative, (n=26)		
Characteristics of primary cases					
Age (years)	<5	4 (12.5)	7 (26.9)	2.84	0.24
	5-10	8 (25.0)	8 (30.8)		
	>10	20 (62.5)	11 (42.3)		
Gender	Male	15 (46.9)	16 (61.5)	1.24	0.26
	Female	17 (53.1)	10 (38.5)		
Duration of contact with index case	Isolated on same day	3 (9.4)	4 (15.4)	1.65	0.66
	Isolated on day1	5 (15.6)	6 (23.1)		
	Isolated on day 2	8 (25.0)	7 (26.9)		
	Isolated on day 3 and above	16 (50.0)	9 (34.6)		
Characteristics of contacts					
Age (years)	<15	7 (21.9)	5 (19.2)	0.74	0.69
	16-60	12 (37.5)	8 (30.8)		
	>60	12 (37.5)	13 (50.0)		
		34.52±16.8	30.85±16.7	0.83	0.41
Gender	Male	13 (40.63)	13 (50)	0.51	0.48
	Female	19 (59.38)	13 (50)		
Education	Professional	0 (0)	3 (11.54)	8.94	0.18
	Graduate/PG	4 (12.5)	3 (11.54)		
	Intermediate/ diploma	7 (21.88)	5 (19.23)		
	High school	13 (40.63)	5 (19.23)		
	Middle school	2 (6.25)	5 (19.23)		
	Primary	3 (9.38)	4 (15.38)		
	Illiterate	3 (9.38)	1 (3.85)		
Occupation	Profession	0 (0)	2 (7.69)	7.43	0.28
	Semi profession	0 (0)	1 (3.85)		
	Clerical/ shop owner	3 (9.38)	5 (19.23)		
	Skilled worker	1 (3.13)	0 (0)		
	Semi-skilled worker	3 (9.38)	1 (3.85)		
	Unskilled	4 (12.5)	1 (3.85)		
	Unemployed	2 (65.63)	16 (61.54)		
Socio economic status	Class II	20 (62.5)	17 (65.38)	1.69	0.43
	Class III	10 (31.25)	9 (34.62)		
	Class IV	2 (6.25)	0		
No. of family members	Upto 6	29 (90.6)	15 (56.3)	8.94	0.003
	Above 6	3 (9.4)	11 (43.7)		
Type of family	Joint	3 (9.4)	11 (43.7)	8.50	<0.0001
	Nuclear	29 (90.6)	15 (56.3)		
Comorbidity	Yes	14 (43.8)	5 (19.2)	3.91	0.04
	No	18 (56.2)	21 (80.8)		

Table 3: Household environmental factors affecting SAR from pediatric primary cases.

Household environmental factors		Contact (%)		Chi-square	P value
		Positive, (n=32)	Negative, (n=26)		
Type of house	Kachha	19 (59.38)	9 (34.62)	3.52	0.06
	Pakka	13 (40.63)	17 (65.4)		
No. of rooms	2	22 (68.75)	9 (34.6)	12.13	<0.0001
	3	7 (21.88)	17 (65.4)		
	4	3 (9.38)	0		
Overcrowding	Yes	19 (59.4)	17 (65.4)	0.47	0.027
	No	13 (40.6)	9 (34.6)		
Bedroom with attached toilet	Yes	7 (21.9)	0	2.99	0.003
	No	25 (78.1)	26 (100.0)		

Continued.

Household environmental factors		Contact (%)		Chi-square	P value
		Positive, (n=32)	Negative, (n=26)		
Ventilation of house	Adequate	13 (40.6)	9 (34.6)	0.22	0.64
	Inadequate	19 (59.4)	17 (65.4)		
Cross ventilation	Yes	27 (11.2)	59 (11.9)	0.06	0.81
	No	214 (88.8)	441 (88.1)		
Type of contact	Household	24 (75.0)	18 (69.2)	0.24	0.62
	Neighbor	8 (25.0)	8 (30.8)		
Containment zone	Yes	26 (81.2)	22 (84.6)	0.34	0.73
	No	4 (18.8)	4 (15.4)		

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 and 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. This study summarises the transmission dynamics within the households from the early 11 paediatric COVID-19 index cases and their 58 high risk contacts residing in PMC, Pune area and estimates a high transmission potential from children to household members. Previously, very few studies have reported family clusters which presented data on the household transmission when the index case was a child. This is one of the few studies that exclusively assessed the household transmission risk from paediatric COVID-19 index cases. Among 58 contacts, 32 (55.2%) were RTPCR positive giving SAR of 55.2% which is very high as compared to other studies conducted in Gujarat and Karnataka State.[10-13] 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 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.[14] The high SAR might be due the fact that all pediatric index cases included in this study were symptomatic in nature; this may increase chances of the transmission of COVID-19 due to high viral load and longer duration of shedding of the virus. All contacts in this study were high risk contacts. As nationwide lock down was there during the study period which increases the contact between the index case and contacts. These pediatric index cases even if isolated in the hospital were always accompanied by an adult member of the family increasing the contact period. Detected infection rates among young children may be low, but this study suggests that infected young children transmit the virus within the family to the same extent as parents.[15] Other study has shown that the infection course in children is milder compared to adults.[12] In this study also all pediatric index cases as well as pediatric positive contacts were mild in nature and no mortality reported among any of the case.

There was a significant association between number of family members, type of family, presence of comorbidity among the contacts and spread of disease. Among 58 contacts of primary cases, 19 were with one or more comorbidity. In these 19 contacts, 14/19 (73.4 %) were RTPCR positive and there was significant association of comorbidity with number of secondary cases among contacts ($p<0.04$). There was no association found between factors of primary case as age, gender, gap of onset of symptoms and admission, education and occupation of contacts and spread of disease in contacts. 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.[12]

There is evidence that individuals living in more crowded housing units are more likely to contract the virus; so more the no 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 no. of rooms in the house, presence of overcrowding and bedroom with attached toilet. 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 is a small study from Pune city presenting data of 11 paediatric index cases. The authors presented that 32 (55.2%) out of 58 close family cases developed secondary infection. However, the generalizability of the findings is limited as the study included index cases during the early months of infection. Apart from the retrospective nature of the study, multiple testing could not be done in the primary contacts (familial) to establish temporality due to resource constraints. Limitation associated with telephonic interaction restricted us to some critical information only. A larger study with in depth personal interaction with the cases is needed for better understanding of the transmission trends of the disease in paediatric index cases.

CONCLUSION

The SAR from paediatric index cases is 55.2% and is closely associated with co-morbidity, family size, overcrowding and bedroom attached with toilet. Though COVID-19 infection among children is mild in nature; infected young children transmit the virus within the family to the same extent as adults. Hence, home quarantine should be advocated in smaller families with appropriate isolation facilities; more emphasis is given to co-morbid individuals.

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