Unrestricted Social Interaction: Underappreciated Cause of COVID 19 Surge

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Unrestricted Social Interaction: Underappreciated Cause of COVID 19 Surge

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SUMMARY

India had the worst conditions during the second wave, and yet, its cause for the enormous spike of COVID-19 cases in short time span remains unexplained. We retrospectively studied the comparative secondary attack rate, incidence proportion rate and extent of unrestricted social interactions' contribution between the first and second wave of COVID-19 to decipher what caused the second wave's enormous spike in COVID-19 cases. We found that the unrestricted social interaction accounted equally, i.e., >42% of all COVID-19 cases in the both waves. Overall secondary attack rate rose 58% in the second wave's, among which, we find increment of 2.5-fold and 88% for the age group <10 years and >50years, respectively, while it remains stable in the age group 10-50years. We find significantly higher incidence proportion rate, ~39%, in household size of two- and three members in the second wave while it was significant in household size of four or more members in the first wave. We anticipated that changes in the pattern of unrestricted social interaction amongst household members escalated the secondary attack rate and higher incidence proportion rate even in two members family size could lead to the unprecedented surge of COVID-19 cases in the second wave.

Corona Virus Disease 2019's (COVID-19's) global impact has been devastating because it has disrupted the lives of millions of people by causing them to lose their jobs, which is also a major cause of the economy's decline. As of 25 Jun, 2021, there were 173 million confirmed COVID 19 cases and it has claimed 3.73 million confirmed deaths since its inception globally.¹ The present evidence indicates that COVID 19 is transmitted to people who are within 1 meter of contact with the COVID 19 infected patient and contact with virus-containing droplets or aerosols spreads infection. Limiting close contact between an infected patient and healthy people is critical to breaking COVID 19 chains, therefore most countries implemented national level lockdowns as an effective strategy for limiting COVID 19 cases.^{2,3}

There are very few quantitative studies available, with the majority reporting data until April 2020, that determined the secondary attack rate in the first wave, while none have determined the comparative secondary attack rate between the first and second waves, as well as the extent of unrestricted social interaction's contribution to the surge of COVID 19 cases. Quick identification of suspicious cases within family members is the greatest way to prevent COVID 19 transmission within family members.^{4,5,6} The average COVID 19 incubation period [the interval between virus exposure and symptom onset], which is 5 – 6 days, creates difficulty in locating suspected COVID 19 infected members until 5-6 days post the infection, during which, healthy family members are exposed to COVID 19 infected members, causing the emergence of new COVID 19 patients.⁶

India first reported confirmed COVID 19 case on January 27, 2020⁶, which began to rise to the maximum daily reported 0.9 million cases in the first wave on September 19, 2020.⁷ It then declined to the reported minimum 8635 cases in January 2021⁸, prompting many researchers to conclude that the worst of the pandemic had passed the country.⁹ In contrast, cases began to rise again in March 2021, reaching a peak of about 4 million reported daily in May 2021, resulting in the emergence of the second wave.^{10,11}

Scientists are worrying about the cause of the second wave and trying to determine the contribution of different factors to the unprecedented surge, whether it's due to the unfortunate confluence of factors, such as unrestricted social interactions, the introduction of emerging infectious variations and insufficient vaccine coverage, etc. In the present research, we investigated at the comparative epidemiology of COVID-19 to decipher what caused the second wave's enormous spike in COVID-19 cases. Untangling the cause could be helpful to governments attempting to curb or prevent similar surges around the world.

Epidemiology of COVID 19

Figure 1 shows comparative graphical epidemiology of COVID-19 secondary cases emergence in the first wave and the second wave. In the second wave from January 2021 to May 2021, we total traced 1587 unrestricted social interaction (proximate contact) who were linked to 437 primary cases [tracing method: 203 in-person, 94 through hospitals and 140 over the phone (table-1)]. Among the 1587 proximate contact, 213 members, 978 members and 396 members were age below 10 years, between 10 to 50 years and above 50 years, respectively. Of the total 1587 unrestricted social interaction with the 437 primary cases, 36.8% primary cases [161 primary cases] developed 334 secondary cases (table-2), wherein 23 members, 178 members and 133 members were age below 10 years, between 10 to 50 years and above 50 years, respectively [table-1].

In the first wave from January 2020 to December 2020, we total traced 436 unrestricted social interaction (proximate contact) who were linked to 112 primary cases [method of tracing: 77 primary cases in-person and 35 primary cases over the phone (table-1)]. Among the 436 proximate contact, 63 members, 201 members and 172 members were age below 10 years, between 10 to 50 years and above 50 years, respectively. Of the total 436 unrestricted social interaction with the 112 primary cases, 25.0% primary cases [28 primary cases] developed 82 secondary cases (table-2), wherein 3 members, 54 members and 25 members were age below 10 years, between 10 to 50 years and above 50 years, respectively [table-1].

COVID-19's Overall Comparative Epidemiology

Unrestricted social interaction of the primary case within household members contributed 42.3% and 43.3%, respectively, to the surge in COVID 19 cases in the first and second waves, indicating that unrestricted social interaction, an underappreciated cause of COVID 19 transmission, is a significant contributor and one of the major causes in the surge in COVID 19 cases. We were surprised to found that the overall secondary attack rate in the second wave was 1.6 folds higher (58% higher), which is 10.1% compared to 6.4% in the first wave [figure-2(A)], and that this could be potential cause behind the unprecedented surge in COVID 19 cases in the second wave. Incidence proportion rate was determined to be 12.2% higher in the second wave, at 21.1%, compared to 18.8% in the first wave [figure-2(C)].

COVID-19's Comparative Epidemiology by Age Group

The age group below 10 years contributed 7% (23 secondary cases) of the total secondary cases (334 secondary cases) in the second wave, compared to 4% (3 secondary cases of total 82 secondary cases) in the first wave (figure-1). The reason for the 2-fold increase in overall COVID 19 cases is due to 86 % increment in secondary attack rate in the second wave, which is 8.9%, compared to the first wave, which is 4.8 percent [figure-2(B)], which caused the Incidence proportion rate to double to 10.8% in the second wave from 4.8 percent in the first wave [figure-2(D)]. Similarly in the age group above 50 years, the secondary attack rate surge 2.5 folds in the second wave to 26.0% from 10.5% in the first wave [figure-2(B)] that cause 2.3 folds increment in the Incidence proportion rate to 33.6% from 14.5% in the first wave, this cause unexpected surge (33.3% increment) in contribution of age group above 50years to 40% proportion (133 secondary cases) of the total secondary cases (334 secondary cases) compared to 30% proportion (25 secondary cases of total 82 secondary cases) in the first wave (figure 1). Compared to the age group below 10 years and above 50years, contrary characteristics observed in the age group between 10 – 50years, wherein proportion of the age group between 10-50 years decreased to 53% in the second wave compared to 66% proportion of the total secondary cases in the first wave (figure-1), the cause behind this unexpected situation is lower secondary attack rate in this age group, which is 11.3%, in the secondary wave compared to 13.4% in the first wave [figure-2(B)], that ultimately lower the incidence proportion rate in second wave to 18.2% from 26.9% in the first wave [figure-2(D)].

COVID-19's Comparative Epidemiology by family Size

In the second wave, we were surprised to find that the incidence proportion rate in two- and three-member families was 39.0 percent and 38.9 percent, respectively, whereas it was zero in the first wave. In the second wave, the incidence proportion rate increased by 6.8% and 9.5

percent in the five- and eight-member family sizes, respectively, to 24.8 percent and 44.4 percent, up from 18.0 percent and 34.9 percent in the first wave (figure-3, table-3).

In contrast to other family sizes, the incidence proportion rate in the four- and six-member family sizes slightly declined by 3% and 0.6% in the second wave, falling to 19.6% and 11.3%, respectively, from 22.6% and 11.9% in the first wave. In the second wave, the incidence proportion rate in seven-, nine-, and ten-members family size was determined to be 6.3%, 3.8%, and 0%, respectively (figure-3, table-3).

DISCUSSION

Between the first and the second wave of COVID 19 cases in India, we retrospectively studied the comparative secondary attack rate, incidence proportion rate and extent of unrestricted social interaction. The epidemiological data of the first and second wave explicitly indicating that unrestricted social interaction accounts for more than 42% of all COVID 19 cases. The 58% increment of the secondary attack rate in the second wave clearly indicates changes in the pattern of unrestricted social interaction between household members; the cause could be that household members were more conscious in the first wave; however, as cases decline sharply and reach their lowest in the month of January 2021, COVID 19's fear is dissipated; further, the government has relaxed participation of a greater number of peoples in social function.

India had the worst-ever conditions in the second wave compared to the first wave, similar to what the United States experienced, when the secondary attack rate in India was 10.1%, which was consistent with the United States' secondary attack rate of 10.5 percent.¹²

In the second wave, when unrestricted social interaction was defined by age group, we found a 2.5-fold (250%) increase in the secondary attack rate in the age group above 50 years and an 88 percent increase in the age group below 10 years compared to the first wave, while it remained stable in the age group 10-50 years in both waves. These findings indicate that the new COVID 19 variant, particularly delta variant¹³, in the second wave has a high affinity for infecting peoples with age below 10 years and above 50 years while it's not significantly change for age group 10-50 years in the both waves.

The comparative incidence proportion rate by household size indicating that, in the first wave, the significant secondary cases were found only in households with four or more members, whereas in the second wave, we found a significantly higher incidence proportion rate in households with two to three members when compared to households with four or more members.

Social interaction among household members is unfettered, and there is currently no policy in place in any country that restricts it. Furthermore, household members also underappreciate the value of social interaction unless they came to know about confirmed COVID 19 infected family members within household, and this ignorance leads to an increase in secondary attack rates throughout the incubation phase, resulting in emergent of more numbers of secondary cases. As a result, the greater secondary attack rate in the second wave compared to the first wave could be a cause of an unprecedented surge of infectious cases in the second wave because it is the only parameters that could surge infectious case in short time span, i.e., within incubation period, for example, of the total 437 primary cases in the second wave, the 161 primary cases developed 334 secondary cases within incubation period. Further explanation is that, compared to the all other interactions, such as at public places, transportation, healthcare, etc were the following preventing measure like wearing a mask is mandatory in the most

countries, the risk of unrestricted social interaction is highest in the household because the most population spend more time without following any preventive measures at home, resulting in longer and more frequent unprotected interactions between household members than the all other interactions.

In conclusion, we found that changes in the pattern of unrestricted social interaction, which escalated the secondary attack rate by 58%, and higher incidence proportion rate even in household size of two- and three members in the second wave could lead to the unprecedented surge of COVID-19 cases in the second wave. Although no government can limit social interaction among family members, they can raise awareness among household members through different programming about the importance of taking effective preventative measures to break unprotected interaction among household members as much as possible in order to avoid COVID 19 transmission among healthy household members and quarantine of any suspected household member.

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Second Wave of COVID 19

First Wave of COVID 19

Figure-1: Comparative graphical overview and characteristics of emergence of Secondary Cases in the second wave and the first wave.

Figure-2: (A) Comparative SAR in the first wave Vs the second wave, (B) Comparative overall SAR Vs particular age group, (C) Comparative IPR in the first wave Vs the second wave, (D) Comparative overall IPR Vs particular age group

Figure-3: Comparative Characteristics of Secondary Cases within different family Size

METHOD

Case Definition: Primary Case refers to a first COVID 19 case [confirmed by RT-PCR test] in the family. Secondary Case refers to a subsequent COVID 19 case [confirmed by RT-PCR test] generated due to unrestricted social interaction of the primary case with other the family members while residing in the same house with the primary case.

Method: A retrospective cohort study was undertaken to trace primary cases, number of unrestricted social interaction of the primary cases within family members (proximate contact to the primary cases) and secondary cases. The study was carried out with only the necessary data collected utilising a Covid 19 transmission questionnaires sheet. Our research team contacted each primary case through visiting hospitals, individual at their homes and by contacting friends and relatives over the phone and were interviewed with the COVID 19 questionnaires that asked about 8 mandatory questions.

Out of the eight mandatory questions, a first question seeks information about the primary case; the second question seeks information about total number of household population, potential information to determine the total number of unrestricted social interaction of the primary case within the family members while residing in the same house; a third, fourth, and fifth questions seek information about the age wise distribution, i.e., <10 years, 10-50 years and >50 years, of the answer of second question; a sixth, seventh and eighth questions seek age wise distribution, i.e., <10 years, 10-50 years and >50 years, on number of secondary cases generated post the incubation period, which is 5-6 days, due to the unrestricted social interaction of the primary case within the family members while residing in the same house, respectively.

For first wave of COVID 19, responses were collected from COVID 19 infected member in the time window between January 2020 to December 2021 and for second wave of COVID 19, responses were collected from COVID 19 infected member in the time window between January 2021 to May 2021.

Statistical Analysis: In the present research, we used simple statistical approach to calculate Secondary attack rate (SAR) and Incidence Proportion Rate (IPR) by referring the information presented on Centers for Disease Control and prevention (CDC), USA.¹

The proportion of primary cases (i.e. actual number of primary cases of the total number of primary cases) that developed secondary cases within the disease-free population is referred to as the secondary attack rate (SAR).

To calculate secondary attack rate (SAR), we use

$$SAR(t1, t2) = \frac{\sum_{i=1}^N A^{Nprime}(t1, t2)}{\sum_{i=1}^N T^{Hpop}(t1, t2) - \sum_{i=1}^N T^{Nprime}(t1, t2)} \times 10^n \dots\dots\dots (1)$$

wherein,

$\sum_{i=1}^N A^{Nprime}$ is summation of actual number of primary cases that developed the secondary cases;

$\sum_{i=1}^N T^{Nprime}$ is summation of all number of primary cases;

$\sum_{i=1}^N T^{Hpop}$ is summation of all numbers of house hold population;

t1 and **t2** represent time window, i.e., t1 refers to January 2020 and t2 refers to December 2020 for first wave, similarly t1 refers to January 2021 and t2 refers to May 2021 for second wave; and **10ⁿ** is generally 100%, i.e. n = 2.

The proportion of a disease-free population that infected with COVID 19 is referred to as the incidence proportion rate (IPR). To calculate Incidence Proportion Rate (IPR), we use

$$IPR(t1, t2) = \frac{\sum_{i=1}^N T^{NSec}(t1, t2)}{\sum_{i=1}^N T^{Hpop}(t1, t2) - \sum_{i=1}^N T^{Nprime}(t1, t2)} \times 10^n \dots\dots\dots (2)$$

wherein,

$\sum_{i=1}^N T^{Nsec}$ is summation of all number of secondary cases developed through $\sum_{i=1}^N A^{Nprime}$.

We use simple statistical approach to estimate the contribution of unrestricted social interaction in the surge of COVID 19 cases as follow:

$$E^{Usi}(t1, t2) = \frac{\sum_{i=1}^N T^{NSec}(t1, t2)}{\sum_{i=1}^N T^{Nprime}(t1, t2) + \sum_{i=1}^N T^{NSec}(t1, t2)} \times 10^n \dots\dots\dots (3)$$

wherein, E^{Usi} refers to extent of unrestricted social interaction's contribution in the surge of COVID 19 cases.

We also assess the effect of age and household size on SAR and IPR. To determine Secondary Attack Rate and Incidence Proportion Rate for the particular age group age, i.e., <10 years, 10–50 years and >50 years), we slightly modified equation 1 and equation 2 as follow.

To calculate secondary attack rate (SAR), we use

$$SAR^{pag}(t1, t2) = \frac{\sum_{i=1}^N A^{Nprime-pag}(t1, t2)}{\sum_{i=1}^N A^{Hpop-pag}(t1, t2)} \times 10^n \dots\dots (4)$$

wherein,

SAR^{pag} refers to secondary attack rate pertain to particular age group, i.e., <10 years or 10 – 50 years or >50 years;

$\sum_{i=1}^N A^{Nprime-pag}$ is actual number of primary cases that developed the secondary cases within particular age group;

$\sum_{i=1}^N A^{Hpop-pag}$ is summation of particular age group population that developed proximate contact with primary cases.

To calculate Incidence Proportion Rate (IPR), we use

$$IPR^{pag}(t1, t2) = \frac{\sum_{i=1}^N T^{Nsec-pag}(t1, t2)}{\sum_{i=1}^N A^{Hpop-pag}(t1, t2)} \times 10^n \dots\dots (5)$$

wherein,

IPR^{pag} refers to incidence proportion rate pertain to particular age group;

$\sum_{i=1}^N T^{Nsec-pag}(t1, t2)$ is summation of secondary cases of the particular age group, i.e., <10 years or 10 – 50 years or >50 years.

To determine Incidence Proportion Rate per family size (IPR^{fs}), we slightly modified equation 5 as follow.

$$IPR^{fs}(t1, t2) = \frac{\sum_{i=1}^N T^{Nsec-fs}(t1, t2)}{\sum_{i=1}^N A^{Hpop-fs}(t1, t2)} \times 10^n \dots\dots (6)$$

wherein,

IPR^{fs} refers to incidence proportion rate pertain to particular family size;

$\sum_{i=1}^N T^{Nsec-fs}(t1, t2)$ is summation of secondary cases of the particular family size;

$\sum_{i=1}^N A^{Hpop-fs}(t1, t2)$ is summation of particular family size population that developed proximate contact with primary cases.

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AUTHORSHIP

Jayendrakumar Patel: Conceptualisation of research design and research method. Data curation, formal analysis and validation of data, investigation, writing first original draft manuscript and editing.

Shalin Parikh, Rakesh Patel, Shwetaben Patel, Ronak Patel, Payalben Patel and Ankita Patel: These authors contributed equally in Data curation and formal analysis. Review first original draft manuscript.

DECLARATION OF INTERESTS

We declare no competing interests.

ADDITIONAL INFORMATION

Supplementary Information is available for this paper.

Table 1: Primary Cases, Proximate Contact and Secondary Cases

Characteristics		First Wave			Second Wave		
		Primary Cases	Proximate Contact	Secondary Cases	Primary Cases	Proximate Contact	Secondary Cases
Overall Summary							
Traced Contacts		112	436	82	437	1587	334
Age Wise Distribution							
Age	< 10 Years	112	63	3	437	213	23
	10-50 Years		201	54		978	178
	> 50 Years		172	25		396	133
Demographic distribution by Method of Tracing							
In-Person	< 10 Years	77	43	2	203	90	12
	10-50 Years		142	35		491	88
	> 50 Years		112	18		168	60
Hospital	< 10 Years	-	-	-	94	59	4
	10-50 Years		-	-		187	42
	> 50 Years		-	-		98	29
Over-the-phone	< 10 Years	35	20	1	140	64	7
	10-50 Years		59	19		300	48
	> 50 Years		60	7		130	44

Table-2: Comparative quantitative characterization of epidemiology of COVID 19

Parameters	First Wave	Second Wave
Overall		
Total Primary Cases	112	437
Proximate Contact	436	1587
Actual Number of Primary Cases That Developed Secondary Cases	28	161
Total Secondary Cases	82	334
Total House Hold Members (populations)	548	2024
Secondary Attack Rate (SAR)	6.4	10.1
Incidence Proportion Rate (IPR)	18.8	21.1
Extent of unrestricted social interaction's contribution in the surge of COVID 19 cases was	42.3	43.3
Age below 10 Years		
Total Primary Cases	49	157
Proximate Contact	63	213
Actual Number of Primary Cases That Developed Secondary Cases	3	19
Total Secondary Cases	3	23
Secondary Attack Rate (SAR)	4.8	8.9
Incidence Proportion Rate (IPR)	4.8	10.8
Age between 10 Years – 50 Years		
Total Primary Cases	107	403
Proximate Contact	201	978
Actual Number of Primary Cases That Developed Secondary Cases	27	111
Total Secondary Cases	54	178
Secondary Attack Rate (SAR)	13.4	11.3
Incidence Proportion Rate (IPR)	26.9	18.2
Age above 50 Years		
Total Primary Cases	91	273
Proximate Contact	172	396
Actual Number of Primary Cases That Developed Secondary Cases	18	103
Total Secondary Cases	25	133
Secondary Attack Rate (SAR)	10.5	26.0
Incidence Proportion Rate (IPR)	14.5	33.6

Table-3: Comparative Demographic distribution of COVID 19's epidemiology by Family Size

Family Size		First Wave				Second Wave			
		Primary Cases	Proximate Contact	Secondary Cases	IPR	Primary Cases	Proximate Contact	Secondary Cases	IPR
2 Members	< 10 Years	9	0	0	0	64	0	0	39.0
	10-50 Years		9	0			37	6	
	> 50 Years		0	0			27	19	
	Total		9	0			64	25	
3 Members	< 10 Years	4	3	0	0	45	11	3	38.9
	10-50 Years		5	0			60	22	
	> 50 Years		0	0			19	10	
	Total		8	0			90	35	
4 Members	< 10 Years	31	4	0	22.6	102	31	3	19.6
	10-50 Years		53	21			210	41	
	> 50 Years		36	0			65	16	
	Total		93	21			306	60	
5 Members	< 10 Years	32	17	1	18.0	108	46	3	24.8
	10-50 Years		52	13			267	63	
	> 50 Years		59	9			119	41	
	Total		128	23			432	107	
6 Members	< 10 Years	27	27	0	11.9	67	53	0	11.3
	10-50 Years		54	10			184	16	
	> 50 Years		54	6			98	22	
	Total		135	16			335	38	
7 Members	< 10 Years	-	-	-	-	16	21	0	6.3
	10-50 Years		-	-			50	3	
	> 50 Years		-	-			25	3	
	Total		-	-			96	6	
8 Members	< 10 Years	9	12	2	34.9	19	28	13	44.4

Family Size		First Wave				Second Wave			
		Primary Cases	Proximate Contact	Secondary Cases	IPR	Primary Cases	Proximate Contact	Secondary Cases	IPR
	10-50 Years		28	10			77	24	
	> 50 Years		23	10			28	22	
	Total		63	22			133	59	
9 Members	< 10 Years		-	-			20	1	
	10-50 Years	-	-	-	-	13	71	3	3.8
	> 50 Years		-	-			13	0	
	Total		-	-			104	4	
10 Members	< 10 Years		-	-			3	0	
	10-50 Years	-	-	-	-	3	22	0	0
	> 50 Years		-	-			2	0	
	Total		-	-			27	0	

Supplementary Files

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