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Analysis of Factors Responsible for Susceptibility of SARS-Cov-2 Infection among Vaccinated and Non-Vaccinated Individuals: A Survey-Based Study

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ABSTRACT
Covid-19 pandemic had a very high impact on everyone including both physiologically and psychologically. The presence of comorbidities has shown an increased severity rate in people infected with Covid-19. Vaccination also plays an important role by decreasing the severity rate of infection. The study was conducted to identify factors responsible for susceptibility of SARS-Cov2 infection among both vaccinated and non-vaccinated individuals. A survey-based study was carried out through an online portal using Google Forms. A questionnaire was designed which included questions related to demographic factors, vaccination status, travel history, presence of any comorbid conditions or any other chronic disease, major symptoms experienced in SARS-Cov-2, and preventive measures followed after vaccination. Data were analyzed using Microsoft Excel and statistical analysis was done using IBM SPSS, where p-value < 0.05 was considered as significant. A total of 600 responses were received. Responses with incomplete information were excluded from our study. 335 responses were included in this study. Out of the total responses, the population was categorized into two major groups: vaccinated and non-vaccinated. General awareness or concern about safety measures was observed more among individuals belong to medical profession, whereas rate of acquiring infection of SARS Cov-2 was found highest in the population from the non-medical profession in case of both vaccinated (137/184) 74.5% and non-vaccinated (108/151) 71.5%, compared with individuals from medical profession (47/184)25% vaccinated and (43/151)27% non-vaccinated. Among vaccinated individuals (31/184)16.8% were found to have a breakthrough infection. In this study commonest mode of transmission was observed due to close contact with family and friends 36.7%(51/139, followed by unknown sources 20.1%(28/139), and 12.9%(18/139) acquired from hospital contact and traveling least were acquired from workplace i.e 9.4%(13/139). Statistically, the data was significant (p<0.01) . The severity of the disease was observed more among non-vaccinated individuals who acquired the severe disease symptoms, than that in the vaccinated group. Most of the vaccinated individuals recovered by home isolation 81.2%(147/181) and 18.8%(34/181) required hospital assistance, among non-vaccinated, 75%(111/148) were recovered by home isolation and 25%(37/148) required hospital assistance. To conclude results from this study suggests that improper use of masks, lack of knowledge about the possible routes of transmission and not following safety measures were observed to be the major causes of spreading and transmission of infection. Educating general population on the importance of vaccination and the safety measures to be followed before and after vaccination can help in reduction of breakthrough infection as well as from SARS cov-2 cases.
Keywords: *SARS cov-2, vaccination, breakthrough infection, masks.*

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INTRODUCTION

Covid-19 pandemic had a very high impact on everyone including both physiologically and psychologically along with this economic stability -turn down in agriculture, tourism, and aeronautics, and there has been a drastic change in the way of living [1, 2]. The affected individuals with psychological disorders have shown many symptoms like sadness, restlessness, short-tempered, fatigue, irritability, and impulsiveness [3].

The presence of comorbidities like diabetes and heart diseases, advanced age, and other abnormalities like high leukocyte count, and other parameters like high D-dimer has shown an increased severity rate in people infected with Covid-19 [4].

Although various issued reports from other parts of the globe suggest that breakthrough infections after vaccination are not so common. Furthermore, it also appears that people who have got breakthrough infections can transfer or spread the virus to others whether they have mild or no symptoms. According to the Indian Council of Medical Research, a breakthrough infection may bypass vaccine-induced immunity.[5]As reported by the ICMR (Indian Council of Medical Research) COVID infections after vaccination were extremely rare in the vaccinated population of India with a very low incidence rate. There are very high chances of falling ill after being vaccinated as it takes about 14- 15 days to build immunity or as low — as the chances for any person who has not taken the dose of vaccination. Due to different mutations in the virus, there is origin of other variants which could be one of the factor responsible for acquiring breakthrough infections post vaccination as they can escape the immune response. Present study was conducted to analyze major factors responsible for susceptibility of SARS Cov-2 infection among both vaccinated and non-vaccinated individuals.

MATERIAL AND METHODS

A survey-based study was carried out through an online portal using Google Forms. A six months study was conducted from the period of May-October-2021. Prior approval was taken from the Institutional Scientific and Ethics Committee. A questionnaire was designed which included questions related to demographic factors, vaccination status, travel history, presence of any comorbid conditions or any other chronic disease, major symptoms experienced in SARS-Cov-2, and preventive measures followed after vaccination.

This study presents an analysis to track the cases of breakthrough contamination post vaccination and the risk factors associated with susceptibility to SARS Cov-2 among vaccinated and non-vaccinated individuals. Data collected were analyzed and proportions were calculated using Microsoft Excel. Statistical analysis were done using IBM SPSS, where p-value < 0.05 was considered as significant.

RESULTS

A total of 600 responses were received. Responses with incomplete information were excluded from our study. 335 responses were included in this study. Out of the total responses, the population was categorized into two major groups: vaccinated and non-vaccinated. Total vaccinated 54.9% (184/335) and non-vaccinated 45% (151/335)

Among vaccinated, male and female ratio was found to be 55.4% (102/184): 44.6 % (82/184) (1:1) and among non-vaccinated male and female ratio was 57.6% (87/151) : 42.3% (64/151) (1:1)

Table 1: Gender wise distribution of vaccinated & Non-vaccinated individuals.

Gender	Vaccinated		Non-Vaccinated		Chi-square value	Df	p-value
	Frequency	**Percent**	**Frequency**	**Percent**			
Male	102	55.4	64	42.4	0.16	1	0.68
Female	82	44.6	87	57.6			
Total	184	100	151	100			

Among total number of vaccinated respondents 56.35% (102/184) of respondents mentioned of not experiencing adverse effects post vaccination. On statistical analysis, the output variable (Adverse effects) along with vaccination was found to be significant.($p<0.01$)

While comparing the sociodemographic features, it has been observed that in the case of the vaccinated group the percentage of acquiring SARS Covid 2 was found highest in the age group of 26-35 years 36.4 % (67/184) followed by the age group of 15-25years 24.5% (45/184) and 36-45years 20.1% (37/184)and least were observed in the age group of above 45years 19% (35/184).

A similar pattern of acquiring SARS Covid 2 infection was observed in the case of the non-vaccinated population as well, highest in the age group of 26-35 years 43% (65/151) followed by the age group of 15-25years 28.5% (43/151) 36-45years 16.6% (25/151)and above 45years)11.9% (18/151. Which was statistically proven to be non-significant.

General awareness or concern about safety measures was observed more among the people belonging to the medical profession, but the rate of acquiring infection of SARS Cov-2 was found highest in the population from the non-medical profession in case of both vaccinated 74.5% (137/184) and non-vaccinated 71.5% (108/151, as compared to the people belong to the medical profession 25%(47/184)

vaccinated and 27% (43/151)non-vaccinated. Statistically, this has proven to be non-significant. (p=0.23)

Table 2 : Frequency of Covid infection among vaccinated and non-vaccinated individuals

Frequency of Covid infection	Vaccinated		Non-Vaccinated		Chi-square value	Df	p-value
	Frequency	**Percent**	**Frequency**	**Percent**			
One time	173	94.02	142	94.04	97.6	1	0.00** (significant)
Two time	11	5.98	9	5.96			
Total	184	100%	151	100%			

Among vaccinated individuals 16.8% (31/184) were found to have a breakthrough infection. Data was statistically significant. (p<0.01). The highest was observed among the age group of both 26-35 years and 45 and above years. Most of them belong to other professions 58% and the least was observed among academicians 3%. Amongst the total breakthrough infected,74% of the population got the infection after the 1st dose of vaccination.

Table 3 : Frequency of breakthrough infection post covid vaccination

Breakthrough Infection	Frequency	Percent	Chi-square value	Df	p-value
Yes	31	16.8	80.9	1	0.00** (significant)
No	153	83.2			
Total	184	100.00			

Table 4:Sociodemographic and factors related among breakthrough infected individuals

	Age group	**Frequency**	**Percentage**
Age group	15-25	12	38.71%
	26-35	8	25.81%
	36-45	3	9.68%
	45+	8	25.81%
Profession	Student	7	22.58%
	Technician	5	16.13%
	Others	18	58.06%
	Academician	1	3.23%
Type of Mask Used			
	Single surgical	1	3.23%
	Double surgical	8	25.81%
	Cloth mask	11	35.48%
	N95	1	3.23%
No. of vaccine doses obtained	After First dose	23	74.19%
	After Second dose	8	25.81%
Total		31	

The severity of the disease was observed more among non-vaccinated individuals who acquired the severe disease symptoms, than that in the vaccinated group. 30.8%(32/104) of the population was found to have a mean Cycle threshold value in Real-time PCR between cycles of 16-25. On the other hand in non-vaccinated individuals around 45.5%(50/110) of the population had a mean Ct value between 16-25. Statistically, data was significant (p<0.01).

Among both the groups a small number of the population required hospital assistance for recover. Most of the vaccinated individuals recovered by home isolation 81.2%(147/181) and 18.8%(34/181) required

hospital assistance, among non-vaccinated, 75%(111/148) were recovered by home isolation and 25%(37/148) required hospital assistance. Data is statistically non-significant (p=0.17)
While correlating the comorbid status on SARS Cov-2 infection, no significant correlation between comorbid/ chronic illness of patients with SARS Cov –2 infections were found.

Table 3: Severity of diseases among vaccinated and non-vaccinated individuals

CT value	Vaccinated		Non-Vaccinated		Chi-square value	Df	p-value
	Frequency	Percent	Frequency	Percent			
Not mentioned	39	37.5	20	18.2	11.9	3	0.00** (significant)
1-15	1	1.0	4	3.6			
16-25	32	30.8	50	45.5			
26-35	32	30.8	36	32.7			
Total	104	100	1110	100			
No	175	95.1	147	97.4	1.12	1	0.29
Yes	9	4.9	4	2.6			
Total	184	100.0	151	100.0			
Home isolation	147	81.2	111	75.0	1.85	1	0.17
Hospital Treatment	34	18.8	37	25.0			
Total	181	100	148	100			

Among the vaccinated Covid infected group, 4.9%(9/184) have reported the presence of chronic infections, whereas in the case of the non-vaccinated covid infected group only 2.6%(4/151) population/individuals had a history of chronic infections. Data was statistically non-significant (p=0.29). However, Among vaccinated-covid-infected groups, only 9%(16/177) individuals have reported the use of steroids, whereas among non-vaccinated 12.2%(18/148) were using steroids. Statistically, the data was non-significant. (p=0.36)
In our study commonest mode of transmission was observed due to close contact with family and friends 36.7%(51/139, followed by unknown sources 20.1%(28/139), and 12.9%(18/139) acquired from hospital contact and traveling least were acquired from workplace i.e 9.4%(13/139). Statistically, the data was significant (p<0.01)

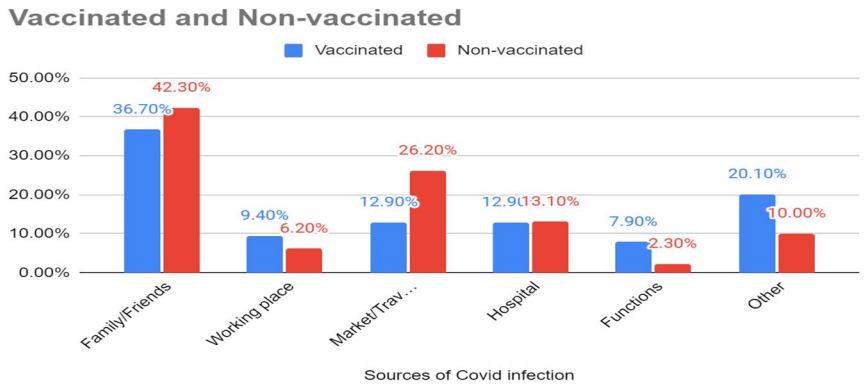

Fig 1: Possible route of COVID transmission

Diverse types of masks were used by various populations. Out of the total vaccinated individuals, 47.3%(83/184) used simple cloth masks, 26,1%(48/184) used N95 masks,18.5%(34/184) were using double surgical masks and 8.2%(15/184) have used single surgical masks. Whereas in the case of total non-vaccinated 32.5%(49/151) used an N95 mask, 27.8%(42/151) used a simple cloth mask, 28.5%(43/151) used a double surgical mask and 11.3%(17/151) have used single surgical mask. Statistically, the data were found to be significant (p=0.00)

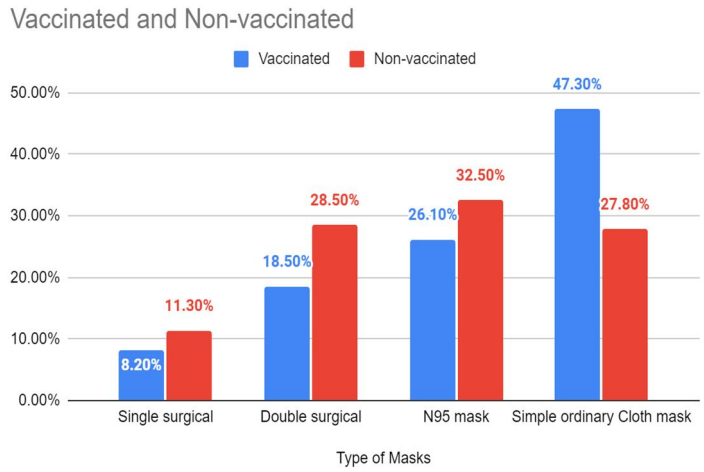

Fig 2: Various types of masks used by both vaccinated and non-vaccinated individuals

There was statically no significance found in the manifestation of post covid opportunistic infection in the study population as only 4%(7/177) of vaccinated-infected individuals/patients have reported to acquire post Covid fungal infection, whereas 4.7%(7/149) non-vaccinated infected have reported the same. Statistically non-significant (p=0.74).

In this present study, the population reported for negative impact on their daily routine activity as in vaccinated covid infected group around 23.4 %(43/171) individuals have experienced anxiety, 16.8%(31/171) have experienced depression and isolation and 10.9%(20/171) have reported stress-related fatigue, among non- vaccinated 49.7%(75/) have experienced anxiety, 29.1%(44//)stress-related fatigue and 28.5%(43/) have experienced depression and isolation. Statistically, the data was non-significant. (p=0.51)

While assessing the effect of covid on sleep quality or in experiencing vivid dreams, it was observed among the vaccinated covid infected group, 60.6%(103/170) individuals reported no change in sleep quality, 23.5%(40/170) had sleep pattern longer than usual, 10%(17/170) have experienced lack of sleep, 2.4%(4/170) have reported disturbed sleeping pattern along with vivid dreams. Among non-vaccinated 34.2%(40/117) have reported no change in sleep quality, 36.8%(43/117) had sleep time longer than usual, 15.4%(18/117) have experienced a lack of sleep, 5.1%(6/117) have experienced disturbed sleeping pattern along with vivid dreams. Statistically, the data was significant. (p<0.01)

Body metabolism/ digestion was significantly disturbed in the case of non- vaccinated covid infected individuals as approximately 25.2% (45/178) vaccinated covid infected individuals reported the loss of appetite, whereas 73.6%(131/178) had a normal appetite, in case of non-vaccinated-infected individuals 56.1%(78/139) have reported for loss of appetite and 40.2%(56/139) have reported for normal appetite. Statistically, the data was significant. (p<0.01)

DISCUSSION

As per our study, a total number of 600 responses were recorded. After making use of the choice standards, 265 responses have been excluded, and 335 responses met inclusion criteria and have been included in this study.

In our analysis males (56.4%) were comparatively more infected with SARS cov-2 than females (43.5%).George Bwire et al. mentioned in their study that females were observed to be more resistant to infections than men, and this may be mediated by several variables, including sex hormones and high expression of coronavirus receptors (ACE 2) in men, as well as lifestyle factors, such as smoking and drinking at higher rates in men than in women. Another possibility could be implementing of preventive measures like as frequent hand washing, face mask use, and stay-at-home directives more by females than males [6].

Study done by Singh et al. stated that maximum rate of infection were observed with the age group of 30–49 years (25.58%) and 0–29 years (58.5%) and least rate of infection were observed among 50 years and above (15.2%)[10] .Similar findings were observed in our study, which depicts younger people were more affected with SARS cov-2 (36.4% vaccinated &43% non-vaccinated). One of the possible reason could the casual behaviour of young people towards COVID 19 infection and following least precautionary measures. Infectivity rate was observed less in from medical professions as compared to non-medical professions individuals. Karlsson *et al*. also mentioned that the hazard of COVID-19 contamination in

health care employees after the first wave decreased because of extra understanding of transmission dynamics and increased accessibility to strong PPE, optimized triage systems, implementation of latest contamination manage measures with non-stop masks use in hospitals [7].
Another study done by Nguyen et al. have mentioned that, relative to the general population, front-line health-care professionals had at least a threefold greater chance of reporting a positive COVID-19 test and predicted COVID-19 infection, even after controlling for other risk variables [8].
Among both vaccinated and non-vaccinated 94.02% individuals have acquired COVID infection once whereas 6% have got infected twice Alinaghi *et al*. in their study from Iran showed that although reinfection can be feasible due to the fact a few research have proven humoral immunity weakens over time. Cavanaugh *et al*. findings from this study suggested that Full vaccination is linked to a lower risk of reinfection in previously infected people while remaining unvaccinated is linked to a higher risk of reinfection in previously infected people [9].
Differences in CT value (16-25) was also observed among vaccinated (31%) and non-vaccinated (45.5%) individuals in our study. Schreiber et al. in a tier study stated that the viral load of vaccinated individuals is less than in those who are not vaccinated [10]. Hibberd *et al*. mentioned that individuals who have been on immunosuppressants, the utilization of huge doses of steroids following SARS cov-2 hampers antibody formation and adversely influences the vaccine response & can cause step forward infections [11]. In our study, 16.8% of individuals got breakthrough infections an observation from our study also states that breakthrough infected individuals were either on steroids or some underlying preexisting chronic conditions. Study by Harel *et al*. mentioned that breakthrough cases found in their investigation were due to immune evasion, mediated by specific changes present in these strains, they said [12].
While comparing the severity level of SARS cov-2 infection among vaccinated and non-vaccinated individuals, we found only 19% of completely vaccinated individuals required hospital assistance for treatment, this could be probably the effectiveness of getting both the doses.
Various types of masks confer different levels of protection. In our study, 26.07% of vaccinated people & 39.8% non-vaccinated have used surgical masks (single and double) and 26.1% vaccinated & 32.5% non-vaccinated used N95 masks. Ordinary cloth masks were used by 26.09% vaccinated & 32.49%. We compare our data with a study in which it was mentioned that N95 masks provide markedly more protection from SARS virus infections as compared to other types of masks. The WHO states that the risk of COVID-19 is increased by inappropriate use of masks, such as improper donning or doffing, insufficient maintenance, long or repeated use of disposable masks, no dry cleaning of fabric masks, or using masks made of non-protective material [13]. In our study, we observe that even after using N95 masks both vaccinated and non-vaccinated people got infected with SARS cov-2. Probable reasons could be inappropriate use of a mask, pulling down the mask to talk, touching the mask too much, and using the same mask for a longer duration [14]. Sozak et al. stated that most mask types were able to prevent the spread of contaminated areas by about 80%, but this prevention was about 60% for N95 masks with bulbs. Similar results were obtained for exhaled diffusion in single and double surgical masks in this study. Cloth masks are effective depending on the quality of the material [15].

CONCLUSION

To conclude administration of all the doses of SARS cov-2 vaccination has played a very major role not only in significant reduction rate of SARS cov-2 infection, but also in the severity rate of infection. Furthermore our results also suggests that improper use of masks, lack of knowledge about the possible routes of transmission and not following safety measures were observed to be the major causes of spreading and transmission of infection. Educating general population on the importance of vaccination and the safety measures to be followed before and after vaccination can help in reduction of breakthrough infection as well as from SARS cov-2 cases.

Declaration

Ethics approval and consent to participate: Prior approval was taken from the Institutional Scientific and Ethics Committee

Consent for publication: Written consent was taken from the study participants. Anonymous and unlinked information was collected.

Availability of data and materials: Data supporting the results can be found in records.

Competing interest: The authors declare that they have no competing interests

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Authors' contributions: AW Collected the data. AW, SG, SU and US analysed and interpreted the results and prepared the manuscript. All authors read and approved the final manuscript.

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