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COVID 19 breakthrough infections in vaccinated dental student community of North Kerala- A survey based analysis

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ABSTRACT

Background: The ongoing global COVID-19 pandemic has infected hundreds of millions of people over the world, imposing a tremendous burden on the global healthcare system including the dental community. COVID-19 vaccines are currently the best defense against the rapidly evolving severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). However, there are emerging concerns about vaccine breakthrough infections. This study has been done to assess the COVID- 19 breakthrough infection among the vaccinated Dental student community of North Kerala and also evaluate and compare the severity of COVID-19 infection among vaccinated and non-vaccinated individuals.

Materials and Methods: A survey was performed within the Dental student community which included BDS students, House surgeons and Post graduates by means of a questionnaire administered online via Google forms that consisted of demographic information and questions to assess severity of the COVID-19 breakthrough infection. The data were analyzed using the SPSS version 26 software. Result was presented in frequencies, percentages and charts showing the interrelatedness of the variables examined.

Results: Among the 714 respondents there were 11.9% males and 88.1% females. Majority of the study subjects reported to have completed two doses of Covid vaccine, while 11.5% had taken only a single dose and 1% had not been vaccinated at all. Around 13% of subjects gave history of being Covid positive before vaccination and (14.7%) got infected even after vaccination.

Conclusion: New Covid variants are being evolved continuously, thereby increasing the chance for transmissibility and evasion of the host immune response. This could be the reason for the 14.7% breakthrough infections reported in our study. Therefore, the need for future studies to recognize factors leading to inadequate vaccine response in those with breakthrough infections and ways to mitigate them is highlighted.

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1. Introduction

COVID-19 infection which is caused by severe acute respiratory syndrome Corona virus 2 (SARS-CoV-2) had its first case confirmed at Wuhan, China in December 2019. WHO declared COVID-19 pandemic spread across

the world in March 2020. As of 1 July 2022, more than 545 million cases have been confirmed, with about 6.4 million deaths attributed to COVID-19, making it one of the deadliest pandemics in history.¹ The second wave of COVID-19 infection hit India in mid of March 2020. Within a short span of time, the infection spread very rapidly. It was thought to be caused by a different strain which was

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the Indian strain – B.1.617. According to WHO, any variant which increases transmissibility, virulence of disease and decreases the efficacy of vaccine is known as a variant of concern. Hence the Indian-Delta variant (B.1.617.2) is designated as a variant of concern.²

Ever since the declaration of COVID-19 outbreak, the scientific community has been working on a war footing to formulate vaccines that will help contain the effects of the pandemic. As of date numerous vaccines have been developed and used worldwide with variable effectiveness in preventing and reducing the severity of the infection. The WHO data shows that as of June 2022 over 11,000 million vaccine doses have been administered worldwide.¹

India started the administration of vaccines for COVID-19 infection from 16 January 2021 with a focus primarily on India's healthcare workers and frontline workers. Later, in a phased manner, the vaccination drive also extended to senior citizens and those ≥ 45 years with other co-morbidities. From 1 May 2021 onwards, those aged >18 years were also eligible for the vaccine. India is currently administering two important vaccines, one developed by AstraZeneca with Oxford University (Covishield) and one by the Indian firm Bharat Biotech (Covaxin). Both these vaccines were approved on January 2021, ahead of the vaccine rollout. In April 2021, a third vaccine known as Russia's Sputnik V was also approved for use.³

A vaccine breakthrough is said to occur when someone gets infected with an organism that they are fully vaccinated against. For the COVID-19 vaccine, this means that someone tests positive for SARS-CoV-2 two weeks or more after receiving the full series of an authorized COVID-19 vaccine.⁴ In second wave, several healthcare workers suffered from breakthrough infection and some of them had moderate to severe disease requiring hospital /ICU admission & even death.²

Since lakhs of people across India are getting vaccinated daily, a breakthrough disease was expected. Fortunately, there is also evidence from various research studies that the COVID-19 vaccine reduces the risk of people getting really sick and needing to go to the hospital or ultimately dying from COVID-19.⁴

Unfortunately, even the education sector is not spared from the consequences of this pandemic. Almost all educational institutions in the world closed their gates a few weeks after the infection started spreading at an enormous rate, affecting 1.57 billion students in 191 countries, 63 million teachers and philanthropists in the field. In India, the first COVID-19 positive case was reported in Kerala on 30th of January 2020. On March 2020, India imposed its first lockdown. According to UNESCO, over 32 core Indian learners stopped moving to schools and colleges. Most of the higher education institutions reacted positively, managed hindrances and lessened the threat of pandemic by changing the face to face classroom into online teaching-

learning.⁵

Though Kerala was successful in controlling the initial spread of the disease, the state could not control the infection later. The initial increase in the COVID-19 cases was due to infected people coming from outside, but they were soon outnumbered by people getting infected through immediate local contact. Kerala even became the first state in India where community spread of COVID-19 was officially confirmed.⁶

After the first lockdown in March 2020, the dental education was given via online classes. Later the dental colleges in Kerala gradually started re functioning with the dental students around January 2021. Very soon there was again a second lockdown around 2nd week of April 2021 after the second wave started hitting the state. The dental classes then again resorted back to the online mode. Finally, around July 2021 the dental colleges in Kerala started functioning again back in full swing via the physical mode of teaching. By then majority of the dental students had received at least one dose of the Covid vaccine.

During the early stages of the pandemic, scientists had hypothesized that SARS-CoV-2 transmission would be slowed by herd immunity resulting from spontaneous infection, vaccination or both. Although several studies have demonstrated that SARS-CoV-2 infection in vaccinated individuals presents clinically with mild symptoms, it is critical to determine whether severe symptoms can arise in others despite a single dose or both doses of vaccination, as the development of variants is a continuous process.⁷

However, concerns have emerged regarding the effectiveness of vaccines against various SARS-CoV-2 strains.⁸ Post vaccination breakthrough infections can sometimes occur because COVID-19 vaccines do not offer 100% protection. Early studies suggest that COVID-19 vaccines protect against severe illness and might be effective at preventing infection; however, data on the impact of vaccination on transmission in congregate settings are limited. Additional data are needed to differentiate breakthrough infections from sequelae of previous infections and to determine whether persons with breakthrough infections can transmit virus.⁹

This study was conducted to evaluate the rate of breakthrough infection among the dental students and an attempt was made to assess how clinical outcomes differ between vaccinated and non-vaccinated, infected students.

2. Aims and Objectives

1. To assess the COVID-19 breakthrough infection in the vaccinated dental student community of North Kerala.
2. To evaluate and compare the severity of COVID-19. infection among vaccinated and unvaccinated individuals.

3. Materials and Methods

Dept. of Oral Pathology and Microbiology, PSM Dental College, Thrissur, conducted a study to detect COVID-19 vaccine breakthrough infections in Dental student community of North Kerala which included BDS students, House surgeons and Post graduates. The survey was performed via online mode by means of Google forms. The introduction of the questionnaire defined the purpose and objectives of the study and the responses were recorded anonymously. The participation was completely voluntary and consent was implied by answering the questionnaire. A questionnaire was developed which consisted of demographic information on age, gender and year in college. It also included questions to assess severity of the COVID-19 breakthrough infection among the Dental student population and also to compare the above between vaccinated and non-vaccinated Dental student population. The vaccination status was evaluated in detail along with the reason for not getting vaccinated. The severity of infection among vaccinated and non-vaccinated people were also evaluated and compared. The study was reviewed and approved by the Ethical committee of the institute.

3.1. Data and sample collection

The current survey was initiated in September 2021. The survey captured 714 respondents within a nine-week period. The respondents were Dental students including house surgeons and post graduate students from various colleges among the districts of North Kerala. The dataset was downloaded from Google forms, imported to Excel and cleaned. Data analysis was done using the SPSS version 26.

Descriptive statistics were used to evaluate the distribution of responses to individual questions. Chi square tests were used to identify statistically significant differences in clinical outcome among vaccinated and unvaccinated students.

4. Results

According to the present study which was conducted to get insights about breakthrough infection in vaccinated Dental student community of Kerala, the following results were obtained. Among the 714 respondents there were 85(11.9%) males and 629(88.1%) females. Maximum number of respondents belonged to 21-23 years age group (47.9%), followed in decreasing order by 24 years and above (26.5%) and 18-20 years (25.6%) age groups respectively. The study subjects mainly comprised of dental undergraduates (82.8%) followed by House Surgeons (13.9%) and Post graduates (3.4%). Majority of the study subjects reported to have completed two doses of Covid vaccine, while 11.5% had taken only a single dose and 1% had not been vaccinated at all. Unavailability of vaccines (10.1%) seemed to be the major reason for not being fully

vaccinated; fear of vaccines (1.3%) and history of allergy (1.1%) were also reported as reasons for not accepting covid vaccine. The study participants were mostly vaccinated with Covishield (97.3%) rather than Covaxin (1.7%). Around thirteen percent of subjects gave history of being Covid positive before vaccination and (14.7%) got infected even after vaccination. A major proportion of the respondents (74.4%) had no history of COVID-19 while (17.1%) had mild symptoms and (8.5%) had moderate symptoms when they were down with Covid. Home isolation (21.7%) was the most opted treatment modality whereas few had utilized hospital (2.1%) and outpatient (1.8%) services as well. Comorbidities like Asthma and Pregnancy were reported by only 2.2% and 0.3% of study subjects respectively (Table 1)

Comparison of post vaccination symptoms (Figure 1) showed that fever and headache were the most prevalent symptoms for both Covishield (59.6%, 40.6%) and Covaxin (41.7%, 33.3%) groups. Less commonly, 'fatigue' was reported among (34.0%) of subjects in Covishield group and 'soreness of injection site' among 33.3% in the Covaxin group. The proportion of subjects with vomiting and diarrhoea was relatively less in both the groups. The differences between the two vaccine groups based on prevalence of post vaccination symptoms were statistically insignificant ($p > 0.05$).

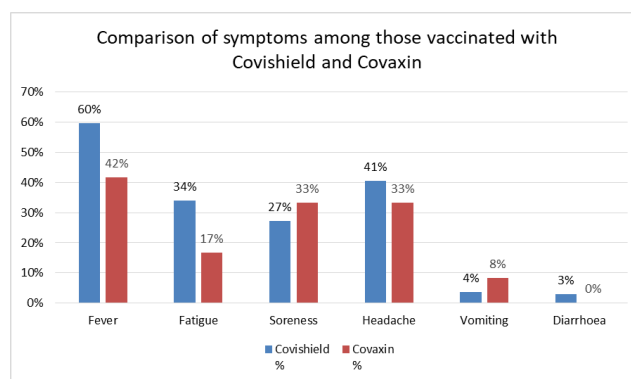


Fig. 1: Comparison of symptoms among those vaccinated with Covishield and Covaxin

According to frequency distribution of study population based on the period during which they have become covid positive (Figure 2), 4.6% and 7.7% of respondents reported on being positive on 14th day or more after 1st and 2nd doses respectively. The proportion of subjects who became positive within first 14 days after 1st or 2nd dose was insignificant ($p > 0.05$).

Analysis of data regarding breakthrough infection after getting vaccinated with Covishield or Covaxin (Table 2), showed that 85% of respondents in Covishield group and 100% of study subjects in Covaxin group showed protection against symptomatic COVID-19. However, these differences between the two groups were not statistically

Table 1: Frequency distribution of study population based on variables considered for study

Variable(N)	Subgroups N(%)			
	Male			Female
Gender (714)	85 (11.9)			629 (88.1)
Age Groups (714)	18-20y	21-23y		24y and above
	183 (25.6)	342 (47.9)		189 (26.5)
Designation (714)	House Surgeon	Post graduate		Undergraduate
	99 (13.9)	24 (3.4)		591 (82.8)
Vaccination Status (714)	No vaccination	Single dose		Two doses
	7 (1.0)	82 (11.5)		625 (87.5)
Reasons for not taking vaccines (714)	Fear of vaccines	History of allergy	Taken both doses	Vaccine unavailable
	9 (1.3)	8 (1.1)	625 (87.5)	72 (10.1)
Vaccine type (714)	Covaxin	Covishield		Nil
	12 (1.7)	695 (97.3)		7 (1.0)
Positive before vaccination (714)	Yes			No
	89 (12.5)			625 (87.5)
Positive after vaccination (707)	Yes			No
	104 (14.7)			603 (85.3)
Symptoms (714)	Covid Negative	Mild		Moderate
	531 (74.4)	122 (17.1)		61 (8.5)
Comorbidity (714)	Asthma	Pregnancy		Nil
	16 (2.2)	2 (3)		696 (97.5)
Treatment modality (714)	Home isolation	Hospital	Outpatient	Covid negative
	155 (21.7)	15 (2.1)	13 (1.8)	531 (74.4)

Table 2: Breakthrough infection based on vaccine type and extent of symptoms according to vaccination status

Whether positive after vaccination	Vaccine			Total	P Value* (significant at $p \leq 0.05$)
	Covaxin	Covishield			
No	12(100.0%)	591(85.0%)		603(85.3%)	P=.147
Yes	0(0.0%)	104(15.0%)		104(14.7%)	
Total	12(100.0%)	695(100.0%)		707(100.0%)	
*p values based on Chi-square test; Pearson Chi-Square value =2.105					
Vaccination status	Symptoms			Total	P Value* (significant at $p \leq 0.05$)
	Negative	Mild	Moderate		
No vaccination	4(57.1%)	1(14.3%)	2(28.6%)	7(100.0%)	P=.042
Single dose	42(51.2%)	25(30.5%)	15(18.3%)	82(100.0%)	
Two doses	485(77.6%)	96(15.4%)	44(7.0%)	625(100.0%)	
Total	531(74.4%)	122(17.1%)	61(8.5%)	714(100.0%)	Significant

Breakthrough infection based on vaccine type and extent of symptoms according to vaccination status

significant ($p > 0.05$).

Considering the extent of symptoms according to vaccination status (Table 2), it was observed that among those who had completed two full doses of vaccine, the proportion of subjects who were Covid negative, mildly symptomatic and moderately symptomatic were 77.6%, 15.4% and 7.0%; whereas the corresponding values were 57.1%, 14.3% and 28.6% for those who had not taken any vaccines and 51.2%, 30.5% and 18.3% for those who completed only single dose. The distribution was found to be statistically significant ($p \leq 0.05$).

With regard to extent of symptoms based on Gender (Table 3), 7.5% of Females and 16.5% of males

had moderate symptoms including fever, chills, rigor, diarrhoea, cough and chest pain with statistically significant difference ($p \leq 0.05$) while 17.3% of females and 15.3% of males exhibited mild symptoms like headache, sore throat and loss of taste or smell. A statistically significant difference ($p \leq 0.05$) was also observed between males and females while comparing reasons for not getting vaccinated (Table 3). Fear for vaccines was reported only by female respondents and unavailability of vaccines was mentioned by 8.6% of females and 21.2% of males as the reason for not getting vaccinated.

Table 3: Gender based distribution of subjects for Covid symptoms and reasons for not getting vaccinated

Gender	Symptoms				Total	P Value (significant at $p \leq 0.05$) P=0.021 Significant
	Negative	Mild	Moderate			
Female	473(75.2%)	109(17.3%)	47(7.5%)		629(100.0%)	
Male	58(68.2%)	13(15.3%)	14(16.5%)		85(100.0%)	
Total	531(74.4%)	122(17.1%)	61(8.5%)		714(100.0%)	

*p values based on Chi-square test; Pearson Chi-Square value =7.767

Gender	Reasons				Total	P Value (Significant at $p \leq 0.05$) P=0.003
	Fear of vaccines	Medical history of allergy	Taken both doses	Vaccine unavailable		
Female	9(1.4%)	7(1.1%)	559(88.9%)	54(8.6%)	629(100.0%)	
Male	0(0.0%)	1(1.2%)	66(77.6%)	18(21.2%)	85(100.0%)	
Total	9(1.3%)	8(1.1%)	625(87.5%)	72(10.1%)	714(100.0%)	

*p values based on Chi-square test; Pearson Chi-Square value =14.070

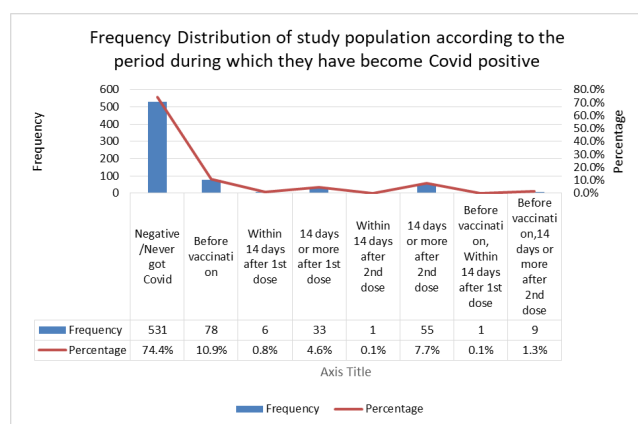


Fig. 2: Frequency distribution of study population according to the period during which they have become Covid positive

5. Discussion

Unique opportunities for research in the COVID-19 era can be done through online surveys with the help of digital tools and networks. The conventional methods for obtaining data from people with the help of pencil and paper are not feasible during the pandemic. Creating and administering an online survey can be done in a fraction of the time compared to the cost needed to organize a similar in-person research study.^{10,11}

According to the vaccination status of our study, 87.5% of the study population was fully vaccinated, 11.5% of the population had received their first dose and around 1% remained non-vaccinated. In Kerala, as of 4th January 2022, 62.23% of the population was fully vaccinated, 77.4% of the population had received their first dose and around 22.57% was not vaccinated.¹²

Around 10413620 people in Kerala have received the Covishield vaccine and around 1565750 people have received the Covaxin.¹² In our case 98% of participants took Covishield and only 2% Covaxin.

A study was conducted by R.Vaishya et al. according to which 31621 health care workers were vaccinated from January 16, 2021, to June 15, 2021. The age range of this study was 33 years and consisted of 14980 males and 13362 females.¹³ In our study the age range was 23 years and 88% were females and 11.9% were males.

In a study conducted by M. Bergwerk et al. on COVID 19 breakthrough infections in vaccinated health care workers, among 1497 fully vaccinated health care workers, 39 SARS-COV-2 break through infections were documented.¹⁴ In our study 14.7% break through infections were noted.

In a study conducted by Sabnis R et al., break through infection rate in health care workers was 18.65%. Break through cases showed moderate, severe or critical symptoms in 19.7% participants. In our study breakthrough cases presented with mild symptoms which included headache, sore throat, loss of taste and smell.

The main treatment modality accepted by participants in our study was home isolation (86.9%) and none of them were in critical condition.

The various reasons for the breakthrough infection to spread among the dental community could be most commonly due to the consistent interaction of the dental students with the patients and also the inadequate precautionary measures taken by the students and house surgeons while attending a patient. It is also possible that an infected person from the college staying in the hostel premises transmit the infection among the other hostel students. The day scholars attending the dental colleges and availing different means of public transport daily could be another reason for the spread of this infection.

5.1. Research highlights

1. This study result emphasizes on the continued role of public health mitigation measures to prevent breakthrough infections.

2. In spite of breakthrough infections being mild, Dental students pose high risk of transmitting the disease to patients.
3. The continued risk due to rise of new variants with high potential for vaccine evasion is made evident by this study.

6. Conclusion

The result of our study showed 14.7% breakthrough infections among the vaccinated Dental students. This study shows that there is a continuous battle happening between immunization and natural selection of potential viral escape mutants. Mostly new variants will be evolved continuously, driven by selection for increased transmissibility and evasion of the host immune response. These results highlight the importance of identifying the breakthrough infections at the earliest and detecting the vaccine escape variants causing it. This study also shows that there is a need for a larger study, which would help to determine the necessity to produce modified vaccines or doses along with monoclonal antibodies.

Hence, it is imperative to maintain high vaccination coverage among Dental professionals to reduce the incidence of breakthrough infections happening within various Dental institutions.

7. Source of Funding

No funding was received for this study.

8. Conflicts of Interest

The authors disclose no conflicts of interest.

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