# **Original Research Article**

DOI: https://dx.doi.org/10.18203/2394-6040.ijcmph20214284

# COVID-19 vaccination and breakthrough infections among healthcare workers: an online survey

# Ramesh Masthi, Gowri Hebbar\*

Department of Community Medicine, Kempegowda Institute of Medical Sciences Bangalore, Karnataka, India

**Received:** 31 August 2021 **Accepted:** 05 October 2021

# \*Correspondence: Dr. Gowri Hebbar,

E-mail: hebbar05@gmail.com

**Copyright:** © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

#### **ABSTRACT**

**Background:** COVID-19 vaccinations were started in India among health care workers in January, 2021. These vaccinations provide protective immunity against the infection but may not completely exclude the possibility of contracting the infection. The objective was to assess the risk of contracting COVID-19 disease following vaccination; to describe the adherence to COVID appropriate behavior by vaccinated individuals.

**Methods:** A cross-sectional study was conducted using an online questionnaire. The subjects selected were health care workers, medical students and other frontline workers. The sample size was 393. The risk of COVID-19 following vaccination was assessed against various factors like age, type of vaccination, status of vaccination, pre-existing comorbidities etc.

**Results:** Out of the 393 vaccinated subjects, 57 (14.5%) acquired COVID-19 breakthrough infection. Majority of these individuals (75.4%) experienced mild symptoms. All vaccinated individuals were protected from severe COVID-19 disease. Most vaccinated individuals continued to strictly adhere to COVID appropriate behavior i.e., masks (97.0% and 98.0%), sanitized hands (93.0% and 98.0%) and maintain social distanced (91.6% and 86%) in both fully and partially vaccinated groups following vaccination.

**Conclusions:** One tenth of the subjects were infected with COVID-19 following vaccination. Most experienced mild symptoms and risk of severe disease was significantly reduced. There was no significant association between the type of vaccine administered and risk of infection.

Keywords: Breakthrough infection, COVID appropriate behaviour, COVID-19 vaccine

#### INTRODUCTION

Coronavirus disease is an infectious disease caused by a new coronavirus SARS-CoV-2. This disease was first reported in Wuhan, the largest metropolitan area in China's Hubei province, in December 2019. It was declared as a public health emergency of international concern on January 30<sup>th</sup> 2020 and as a pandemic on March 11<sup>th</sup> 2020. Currently there have been over 180,000,000 cases of the COVID-19 disease reported and over 4,000,000 deaths.<sup>3</sup>

The widespread infection and the morbidity and mortality associated with COVID-19 has triggered a tidal wave of

vaccine developments. Within the first 9 months of the advent of the virus, there were 200 vaccine candidates out of which 36 had entered clinical trials. <sup>4,5</sup> Some of the prominent ones include mRNA vaccine- 1273 (Moderna TX, Inc) and BNT162b1 (BioNTech FosunPharma, Pfizer), vector virus Sputnik vaccine and ChAdOx1 (University of Oxford) and Killed whole virus vaccine-Covaxin (Bharat Biotech). <sup>6-10</sup> The efficacy of the vaccines varied between 66.7% (Oxford university), 81% (Covaxin), 91.6% (Sputnik) 94.10% (Moderna) and 95% (Pfizer). <sup>6-10</sup>

Housing a population of 1.38 billion, the COVID-19 phase-1 vaccination drive in India covering health care workers and frontline workers started on 16<sup>th</sup> January,

2021.<sup>11</sup> The vaccine programme was initiated with the vaccines Covishield (by Serum Institute of India Ltd) and Covaxin (by Bharat Biotech International Ltd).<sup>12</sup> Subsequently the elderly, people above 45 years of age and lastly people above 18 years were included in the vaccination program.<sup>13</sup>

The COVID-19 vaccines greatly provide protective immunity against severe disease and death. The vaccines do not prevent infection and COVID-19 disease is seen in vaccinated individuals. Another factor to be considered is the 'Peltzman effect' where people are more likely to engage in risky behaviours when safety measures are mandated. Following vaccination, people might get a false sense of security causing them to get lax about other public health and social measures like social distancing and wearing of masks. This study explores the possibility of COVID-19 infection following vaccination. The objective of the study is to assess the risk of COVID-19 breakthrough infections among vaccinated individuals and to describe the COVID appropriate behaviour followed by vaccinated individuals.

#### **METHODS**

A descriptive cross-sectional online study was conducted among healthcare workers (HCW) from across India during May 2021. Snowball sampling technique was followed for the selection of the health care workers, i.e., one vaccinated individual will in turn identify another health care worker and pass on the questionnaire. HCWs aged between 18 years and above, had received at least one dose of COVID-19 vaccine were eligible to participate in the study. A total of 413 responses were generated, after data cleaning 393 were included for the final analysis. The sample size was calculated based on the feasibility and constraints in conducting the study. The health care workers included medical doctor, dental doctor, medical students, staff nurse, lab technicians and pharmacy. They worked in various settings like dedicated COVID hospitals, dedicated COVID health centres, COVID care centres (DCH/DCHC/CCC), medical colleges, nursing homes and individual clinics.

The data was collected online using Google forms. The questionnaire was semi-structured with both open and closed-ended questions, and captured details of age, workplace exposure, existing comorbidities, days after vaccination, type of vaccine, status of vaccination etc.

#### Inclusion criteria

Health care workers with access to the internet and tech savvy were included.

#### Exclusion criteria

Immuno-compromised, chronically ill and deceased vaccinated individuals were excluded from the study.

#### Operational definitions

Covid19 vaccine breakthrough infection, is defined as the detection of SARS-CoV-2 RNA or antigen in a respiratory specimen collected from a person ≥14 days after receipt of all recommended doses of an FDA-authorized COVID-19 vaccine.<sup>22</sup>

COVID-19 disease was described as mild, moderate and severe based on the definition given by ICMR (mild: upper respiratory tract infection symptoms with no shortness of breath or hypoxia; moderate: respiratory rate  $\geq\!\!24/\!\!$ minute, breathlessness or SpO2 90% to  $\leq\!\!93\%$  on room air; severe: respiratory rate  $>\!\!30/\!\!$ minute, breathlessness or SpO2<br/>90% on room air).

#### **RESULTS**

A total of 393 health care workers in the age range of 18 to 74 years with median age 26 (IQR-17, 21, 38) years were included. 214 (54.5%) were males, 177 (45.1%) females and 2 (0.5%) others as described in Table 1. Majority 334 (85%) health care workers were in the age range of 18-45 years.

Table 1: Age and gender distribution of the subjects (n=393).

Age	Vaccinat	ted	Total	
(years)	Male	Female	Others	Total
18-30	140 (65.4)	110 (62.1)	2 (100.0)	252 (64.1)
31-44	48 (22.4)	36 (20.3)	-	84 (21.4)
45-59	24 (11.3)	29 (16.4)	-	53 (13.5)
60 and above	02 (0.9)	02 (1.1)	-	04 (1.0)
Total	214 (100.0)	177 (100.00)	2 (100.0)	393 (100.0)

227(65.6%) of the health care workers were doctors, 121 (30.7%) were medical students and 45 were dental doctors, nurse and paramedical staff. 219 (55.8%) were working in CCC/DCH/DCHC either in the OPD, wards, ICU, fever clinics, triage centre and vaccination centre. 61(15.5%) were working in non-covid hospitals either in OPD, wards, ICU, fever clinics, and vaccination centres. 78 (19.8%) were medical students and 35 (8.9%) worked in dental colleges and clinics.

344 (87.5%) health care workers (HCW) were fully vaccinated and 49 (12.5%) were partially vaccinated. Majority 357 (90.8%) HCW had taken Covishield and 36 (9.2%) had taken Covaxin.

The median number of days after vaccination was 60 (IQR 41, 84). The minimum and maximum number of days after vaccination was 1 and 120 days. Majority 261

(66.4%) HCW had completed more than 45 days after vaccination followed by 83 (21.2%) 16-45 days after vaccination.

26 (45.6%) HCW were overweight/obese, 11 (19.3%) had diabetes mellitus, 17 (29.8%) had hypertension, 3 (5.3%) hypercholesteremia, 2 (3.5%) hypo/hyperthyroid, 7 (12.3%) asthma/seasonal allergy, 2 (3.5) neurological problems and 1 (1.8) neurological problem. After COVID-19 vaccination, majority 382 (97.2%) always wore the mask, 386 (93.6%) did hand sanitization and 357 (90.8%) practiced social distancing.

Table 2: Comparison of vaccinated subjects and COVID-19 disease (n=57).

Age (years)	Fully vaccinated	Partially vaccinated	Total			
rige (jears)	(n=43)	(n=14)	(n=57)			
18-30	27 (62.7)	10 (71.4)	37 (65)			
31-44	10 (23.3)	-	10 (17.5)			
45-59	5 (11.7)	3 (21.4)	8 (14.0)			
60 and above	1 (2.3)	1 (7.2)	2 (4.5)			
Type of professional						
Doctors	23 (53.5)	5 (35.7)	28 (49.1)			
Medical students	14 (32.5)	9 (64.3)	23 (40.4)			
Others	6 (14.0)	-	6 (10.5)			
Days after vaccination						
0-15	3 (7.1)	7 (50.0)	10 (17.5)			
16-45	20 (46.5)	7 (50.0)	29 (50.9)			
46-90	18 (41.9)	-	18 (31.6)			
>90	-	-	-			
Source of contact						
DCHC, DCH, CCC	8 (17.4)	4 (28.6)	12 (20.0)			
OPD, wards, ICU	9 (19.6)	2 (14.3)	11 (18.3)			
Triage centre, fever clinic	3 (06.5)	1 (7.1)	4 (06.7)			
Vaccination centre	5 (10.9)	1 (7.1)	6 (10.0)			
Primary contact, home	21 (45.7)	6 (42.9)	27 (45.0)			
Severity of symptoms						
Asymptomatic	6 (14.0)	4 (28.6)	10 (17.5)			
Mild	35 (81.4)	8 (57.1)	43 (75.4)			
Moderate	2 (4.6)	2 (14.3)	4 (7.1)			
Severe	-	-	-			
Comorbidities						
Diabetes mellitus	1 (2.3)	1 (7.1)	2 (3.5)			
HTN	1 (2.3)	1 (7.1)	2 (3.5)			
Overweight/ obese	2 (4.7)	3 (21.5)	5 (8.8)			
None	39 (90.7)	9 (64.3)	48 (84.2)			
	. /		, ,			

Figures in parenthesis indicate percentage

Out of the 393 vaccinated health care workers, 57 (14.5%, CI 0.11-0.18) subjects had COVID-19 disease (breakthrough infection) after vaccination. Majority 37 (64.9%) were in the age group of 18-30 years. There was no statistically significant association after vaccination between the COVID-19 disease and no disease. The median age was 25 (IQR 20, 36) years and the age range was between 1-70 yrs. 43 (75.4%) were fully vaccinated and 14 (24.6%) were partially vaccinated as described in Table 2. Majority 31 (54.3%) were females and 26 (45.7%) were males. 43 (75.4%) worked in DCH hospital, 11 (19.3%) were medical students and 3 (5.3%) were dentists. Majority 35 (81.4%) and 8 (57.1%) had mild symptoms in the fully and partially vaccinated groups and was statistically significant (z=5.82, <0.05). 48 (84.2%) had no comorbidities and 5 (8.8%) were obese/overweight.

There was no statistically significant association between the type of vaccine [Covishield (14.5%) and Covaxin (13.8%)] taken and covid19 disease ( $\chi^2$ =0.09, p=0.9).

A vast majority had continued to wear masks (97.0% and 98.0%), sanitize hands (93.0% and 98.0%) and followed social distancing (91.6% and 86%) in both fully and partially vaccinated groups.

26 (45.6%) primary contacts of the vaccinated and positive cases developed COVID-19 disease, 17 (29.8%) did not know and 14 (24.6%) did not develop the disease.

# **DISCUSSION**

The study focused on HCW as they are the frontline in management of COVID-19 and more exposed than the general population. Majority of the subjects in the study are below 45 years, doctors and working in DCH/DCHC/CCC. Females were more compared to males. This could be due to the snowball sampling and younger professionals being more tech savvy in answering the online questionnaire.

The majority of the HCW were fully vaccinated as they were most vulnerable and were rightly the first to receive the vaccine. However, it was disheartening to observe that about 10% were yet to be fully vaccinated even after 5 months of commencement of vaccination drive in India indicating vaccine hesitancy. A study in rural areas of Bangalore had observed that about 20% had vaccine hesitancy. A study from Arab region showed a significant rate of vaccine hesitancy among Arabs in and outside the Arab region (83% and 81%, respectively). 25

Female participants, 30-59 years-old, those without any chronic diseases, lower-level of academic education, and those who do not know the type of vaccine are more hesitant to receive COVID-19 vaccination in study done in and outside the Arab region.<sup>25</sup> The most cited reasons for hesitancy are concerns about side effects and distrust

in healthcare policies, vaccine expedited production, published studies and vaccine producing companies.<sup>25</sup>

Maximum proportion of subjects had taken covishield as expected with Serum institute of India being the largest suppliers of COVID-19 vaccine in India. The Department of biotechnology had recently informed the parliamentary standing committee on science and technology, environment, forests and climate change that the estimated manufacturing capacity of Covishield is 70-100 million doses every month, while Covaxin has a planned production capacity of 12.5 million a month.<sup>26</sup>

45 days after two doses of vaccination is said to protect against the disease. The fully vaccinated people who developed the disease were infected mostly between 0-45 days after the vaccination dose (53.5% of fully vaccinated subjects). This is similar to another study in Israel where the median interval between second vaccination dose and detection of infection was 39 days.<sup>14</sup>

The type of vaccine administered and breakthrough infection was not significant in the current study. It was observed that people were infected irrespective of the type of vaccine given. <sup>14</sup> Similar studies conducted in UK, New Delhi, Chicago and Bangalore observed that the breakthrough infections varied between 0.2-13.27% irrespective of the vaccine administered. <sup>15-18</sup>

Two separate studies conducted by AIIMS and NCDC showed that it was possible for the delta strain of SARS-Cov-2 to be able to escape antibodies produced by 2 doses of both Covishield and Covaxin<sup>27</sup>.

Majority experienced mild symptoms similar to the observation of the current study. The vaccine protects against severe forms of the disease similar to the findings from a study in the UK. 15,19-21

Another study that was conducted in Odisha found that out of 274 fully vaccinated individuals with breakthrough infections 9.9% required hospitalization. <sup>19</sup> Older individuals showed lesser odds of symptoms continuing for more than 28 days. <sup>15</sup> In a study conducted by CMC, Vellore, 2 doses of vaccination provided a protective effect of preventing infection by 65%, hospitalization by 77%, need for oxygen therapy by 94% and need for ICU admission by 94%. <sup>20</sup>

Similarly in the US, out of 10,262 reported breakthrough infections from 46 states, only 27% were asymptomatic and only 10% were hospitalized (29% of whom where asymptomatic or hospitalized due to non-COVID-19 reasons).<sup>21</sup>

A negligible few had discontinued COVID appropriate behaviour after getting vaccinated like wearing of mask, hand sanitization and social distancing, while majority followed COVID appropriate behaviour which was a good sign to observe in the current study. About 50% of the vaccinated COVID-19 positive HCWs' primary contacts had developed COVID-19 implying that it is important to continue the practice of COVID appropriate behaviour even after vaccination. Moreover HCW, by virtue of their profession, are at an increased risk of developing COVID-19.<sup>28</sup>

The present study observed that breakthrough infections occurred irrespective of the place work i.e., DCH/DCHC/CCC. The HCWs informed that they had followed COVID appropriate behaviour and still breakthrough infection was observed telling us about the importance to continue with the strictest COVID appropriate behaviour while working in the hospital.

This study has some limitations. As this was an online questionnaire, we assume that the subjects were speaking the truth. The snowball sampling technique may be biased and may not be giving the true information. The sample is not a true representative of health care workers across India. This study does not take into account the number of deaths that have occurred due to breakthrough infections following vaccination as it is beyond the scope of the study.

#### CONCLUSION

One tenth of the health care workers had breakthrough COVID-19 infection post vaccination. Majority had mild symptoms and occurred irrespective of type of vaccine administered.

#### Recommendations

COVID-19 vaccines are safe and prevent severe forms of COVID-19 disease. Mass vaccination of the public will bring down the burden of COVID-19 disease in the community.

#### **ACKNOWLEDGEMENTS**

The authors thank all the doctors, interns, frontline workers and medical students who have taken part in this study.

Funding: No funding sources Conflict of interest: None declared Ethical approval: Not required

#### **REFERENCES**

- 1. Corona virus disease (COVID-19). World Health Organization. Available at: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/question-and-answers-hub/q-a-detail/coronavirus-disease-covid-19. Accessed on 1 July 2021.
- Timeline: WHO's COVID-19 response. Available at: https://www.who.int/emergencies/diseases/ novel-coronavirus-2019/interactive-

- timeline?gclid=Cj0KCQjwu7OIBhCsARIsALxCUa OcIkbgQ0mrvE4jdxj5bRyjLw9ZFNkqIO5KP7Nggi chUxMHu3Iin1UaAhM8EALw\_wcB#!. Accessed on 1 July 2021.
- 3. Weekly epidemiological update on COVID-19- 29 June 2021. World Health Organization. Available at: https://www.who.int/publications/m/item/weekly-epidemiological-update-on-covid-19---29-june-2021. Accessed on 1 July 2021.
- Tregoning JS, Brown ES, Cheeseman HM, Flight KE, Higham SL, Lemm NM, et al. Vaccines for COVID-19. Clin Exp Immunol. 2020;202(2):162-92.
- COVID-19 vaccine tracker and landscape. World Health Organization. Available at: https://www. who.int/publications/m/item/draft-landscape-ofcovid-19-candidate-vaccines. Accessed on 6 May 2021
- Oliver S, Gargano J, Marin M, Wallace M, Curran KG, Chamberland M, et al. The Advisory Committee on Immunization Practices' Interim Recommendation for Use of Moderna COVID-19 Vaccine United States, December 2020. MMWR Morb Mortal Wkly Rep. 2021;69:1653-6.
- Pfizer and Biontech conclude phase 3 study of covid-19 vaccine candidate, meeting all primary efficacy endpoints. Available at: https://www.pfizer.com/news/press-release/pressrelease-detail/pfizer-and-biontech-conclude-phase-3-study-covid-19-vaccine. Accessed on 1 July 2021.
- Sputnik V COVID-19 vaccine candidate appears safe and effective. Available at: https://www.thelancet.com/journals/lancet/article/PI IS0140-6736(21)00191-4/fulltext. Accessed on 30 June 2021
- 9. Oysey, Merryn Aban, Marites, et al. Single-dose administration and the influence of the timing of the booster dose on immunogenicity and efficacy of ChAdOx1 nCoV-19 (AZD1222) vaccine: a pooled analysis of four randomised trials -United Kingdom, The Lancet. 2021;397(10277):881-91.
- 10. Phase 3 Clinical Trial of Covaxin, developed by ICMR and Bharat Biotech, shows 81% efficacy. Available at: https://pib.gov.in/Pressreleaseshare. aspx?PRID=1702293. Accessed on 18 May 2021.
- Covid vaccination drive in India to begin from January 16, healthcare workers to get priority. India Today. Available at: https://www.indiatoday.in/ coronavirus-outbreak/story/coronavirus-vaccinationdrive-india-begin-from-january-16-healthcareworkers-priority-1757458-2021-01-09. Accessed on 18 May 2021.
- 12. Bagcchi S. The world's largest COVID-19 vaccination campaign. Lancet Infect Dis. 2021;21(3):323.
- 13. Revised guidelines for implementation of national COVID vaccination program. Available at: https://www.mohfw.gov.in/pdf/RevisedVaccination Guidelines.pdf. Accessed on 8 August 2021.

- 14. Bergwerk M, Gonen T, Lustig Y, Amit S, Lipsitch M, Cohen C, et al. Covid-19 breakthrough infections in vaccinated health care workers. N Engl J Med. 2021;385:1474-84.
- Antonelli M, Penfold RS, Merino J, Sudre CH, Molteni E, Berry S, et al. Post-vaccination SARS-CoV-2 infection: risk factors and illness profile in a prospective, observational community-based casecontrol study. MedRxiv. 2021.
- Tyagi K, Ghosh A, Nair D, Dutta K, Bhandari PS, Ansari IA, et al. Breakthrough COVID-19 infections after vaccinations in healthcare and other workers in a chronic care medical facility in New Delhi, India. Diabetes Metab Syndr Clin Res Rev. 2021;15(3):1007-8.
- Teran RA, Walblay KA, Shane EL, Xydis S, Gretsch S, Gagner A, et al. Postvaccination SARS-CoV-2 infections among skilled nursing facility residents and staff members-Chicago, Illinois, December 2020–March 2021. Am J Transpl. 2021;21(6):2290-7.
- 18. Second wave: Over 1,000 fully vaccinated Bengaluru cops tested Covid positive. Available at: https://timesofindia.indiatimes.com/city/bengaluru/second-wave-over-1000-fully-vaccinated-bengaluru-cops-tested-covid-positive/articleshow/83681781.cms. Accessed on 30 June 2021.
- 19. Only 10% of Covid vaccine breakthroughs in Odisha needed hospitalisation: Study. Hindustan Times. Available at: https://www.hindustantimes.com/india-news/study-in-odisha-reports-75-breakthrough-infections-101624593473203.html. Accessed on 30 June 2021.
- 20. Two doses of COVID-19 vaccine offer 77% protection against hospitalisation, CMC Vellore study finds. Available at: https://www.thehindu.com/sci-tech/health/two-doses-of-covid-19-vaccine-offer-77-protection-against-hospitalisation-cmc-vellore-study-finds/article34788059.ece. Accessed on 1 July 2021.
- 21. Definition of vaccine breakthrough infection. Available at: https://www.cdc.gov/vaccines/covid-19/health-departments/breakthrough-cases.html.Accessed on 26 October 2021.
- 22. Birhane M, Bressler S, Chang G, Clark T, Dorough L, Fischer M, et al. COVID-19 Vaccine Breakthrough Infections Reported to CDC- United States, January 1-April 30, 2021. Morb Mortal Week Rep. 2021;70(21):792-3.
- 23. Clinical guidance for management of adult Covid19 patients. Available at: https://covid.aiims.edu/clinical-guidance-formanagement-of-adult-covid-19-patients/. Accessed on 30 June 2021.
- 24. Ramesh M, Sowmyashree U. Awareness of COVID 19 vaccine in a Rural Area near Bangalore, Karnataka. Nat J Community Med. 2021;12(3):72-5.

- 25. Qunaibi EA, Helmy M, Basheti I, Sultan I. A high rate of COVID-19 vaccine hesitancy in a large-scale survey on Arabs. Elife. 2021;10:e68038.
- 26. How much vaccines can India make? And the catch Businesstoday.in. Available at: https://www.businesstoday.in/coronavirus/story/after-launching-how-much-vaccine-can-india-make-and-the-catch-293353-2021-04-13. Accessed on 04 June 2021.
- 27. Coronavirus: AIIMS Study Claims Delta Variant Is Highly Infectious Even For Those Who Are Vaccinated. Etimes. Available at: https://timesofindia.indiatimes.com/life-style/health-
- fitness/health-news/coronavirus-aiims-study-claims-delta-variant-is-highly-infectious-even-for-those-who-are-vaccinated/photostory/83395457.cms? picid=83395462. Accessed on 30 June 2021.
- 28. Koh D. Occupational risks for COVID-19 infection. Occup Med. 2020;70(1):3-5.

Cite this article as: Masthi R, Hebbar G. Covid-19 vaccination and breakthrough infections among healthcare workers: an online survey. Int J Community Med Public Health 2021;8:5435-40.