Content available at: https://www.ipinnovative.com/open-access-journals

International Journal of Clinical Biochemistry and Research

Journal homepage: https://www.ijcbr.in/

Original Research Article

The Vax effect: Role of global vaccination initiatives in pandemic control and impact in Dehradun during COVID-19

Ankita Singh[1]*, Nivedita Chetan Gurada[1], Nidhi Mahendru[2], Abhijeet Kashyap[1], Sourabh Bhanu[1,3], Narotam Sharma[1], Ritu Kaushik[1,4]

[1]*DNA Labs – A Centre for Applied Science (DLCAS), Dehradun, Uttarakhand, India*
[2]*Guru Nanak Khalsa College, Yamuna Nagar, Haryana, India*
[3]*Maharishi University, Lucknow, Uttar Pradesh, India*
[4]*IIMT, Meerut, Uttar Pradesh, India*

ARTICLE INFO

Article history:
Received 22-08-2023
Accepted 04-12-2023
Available online 10-02-2024

Keywords:
Vaccination
Omicron
Asymptomatic
Symptomatic
COVID- 19

ABSTRACT

COVID-19 was one of the most contagious diseases spread throughout the world and caused by the Corona virus. Its cellular and molecular profiling was performed on individuals suffering from Covid-19-like sickness in Dehradun. During this investigation, 100 random samples were taken from patients. Real Time PCR amplification of suspected cases of Covid-19 was done where 68% of the cases were positive. The proportions and patterns of positive cases and hospital admissions for covid-19 in the third wave in Dehradun were significantly different when compared to the first and second waves. This disparity was caused by a number of factors, including changes in lifestyle, natural immunological ability to cope with recent waves of natural infections, and the most important factor, which was that more than 83% of people over the age of 18 years had received the first or both doses of the vaccine. The Covid-19 vaccines were so effective due to which there was a very low rate of serious infection, hospitalization, and mortality.

1. Introduction

The eradication of the SARS-CoV-2 beta corona virus, which belongs to the subgenus Sarbeco virus, was one of the most difficult challenges during the third wave. The genetic material of a virus, known as RNA, is continually changing, leading to the generation of new varieties, or strains. This virus is not new to the Earth, but it is new to mankind. Because of the rapid spread and rising number of corona virus disease 19 (Covid-19) cases caused by a new corona virus, severe acute respiratory syndrome corona virus 2 (SARS-CoV-2), rapid and accurate virus and/or disease detection is becoming increasingly important in order to control the sources of infection and assist patients in preventing illness progression.[1] According to one study,[2] the symptoms of SARS-CoV-2 were fever (59.1%), coughing (55.9%), and asymptomatic (19.3%). SARS-CoV-2 has been labelled a pandemic because the new corona virus has spread around the world as an extremely hazardous illness.[3]

The use of nucleic acid testing or clinical characteristics of infected persons as the gold standard for determining a definitive diagnosis of Covid-19 patients has proven difficult. For accurate sickness diagnosis and management, newer molecular instruments and processes are being applied. The detection of SARS-CoV-2 virus by RT-PCR is significantly more sensitive than normal culture methods; it has a shorter turnaround time and advantages over real-time RT-PCR.[4,5] A rapid turnaround time also contributed in the correct containment of this highly contagious virus

* *Corresponding author*.
E-mail address: ankitaofficial10@gmail.com (A. Singh).

https://doi.org/10.18231/j.ijcbr.2023.057

in the general population during the Covid-19 epidemic. Real-time PCR is commonly employed for diagnosis, and it is unclear whether the semi-quantitative capability of this method, which determines viral load using cycle threshold (Ct) values, may be used. Every government was hunting for vaccinations to protect their citizens, either by creating them or importing them from other countries. Vaccines look to be a game-changing technology, so it's critical to understand their efficacy and safety.[6,7] A recent case study was carried out to evaluate vaccination status, which covers the relationship of numerous indicators with regard to SARS-CoV-2Virus and its Clinical importance to investigate its epidemiology.[8,9] Inoculation of respiratory infections in humans by air media is crucial to determining the advantages of immunizations, and large-scale surveys are required.

2. Materials and Methods

In this investigation, a total of 100 cases exhibiting symptoms of SARS-CoV-2 (covid-19)-like sickness and meeting the criterion of additional symptoms as described by the National Centre for Disease Control, New Delhi, India, were considered. The samples were gathered from various sites within the Dehradun district between September and December 2021. DNA Labs- A Centre for Applied Science (DLCAS) in Dehradun, Uttarakhand, performed the whole SARS-CoV-2 viral genetic profiling. The Covi Path Covid-19 RT-PCR Amplification kit was used to extract the RNA. The Silica Column extraction method was used, as well as a fully automated Insta N Mag-32, Nucleic Acid Extractor, and HiGenoMB was used. The extracted RNA Template was used for Real Time PCR amplification of SARS-CoV-2 probable cases. Master Mix was infected with the SARS-CoV-2 virus for all samples. The Spike protein (S) is encoded by 3831 base pairs of SARS-CoV-2 RNA and determines which type of cell the virus will infect.[10,11] Qiagen's Rotor gene Q Multiplex Real time PCR machine was used for amplification. All requested patients' vaccination status was documented in accordance with ICMR criteria, and data was compiled based on the presence or absence of Ct values, or viral loads indicated by Ct value, and clinical outcomes. Furthermore, a comprehensive overview was conducted to assess the vaccination rate updates in the Dehradun district and other districts within Uttarakhand, considering factors related to both vaccine hesitancy and vaccine acceptance.

3. Result

The vast majority of new infections were caused by unvaccinated individuals, and 90% of confirmed positive cases were asymptomatic. Due to the 'de-coupling' of SARS CoV-2 infection from moderate to severe disease, the usage of hospital beds, oxygen beds, and intensive care units (ICUs) has remained modest. Subclinical disease emerged in people who had been fully immunized. Other aspects of the health-care system provide some confidence. Although there were Covid-19 cases admitted to hospitals, a significant proportion of Covid-19 dedicated beds remained empty. Then there was the case when the majority of those hospitalized for suspected Covid-19 were discovered to have other health issues. They were hospitalized for causes other than SARS Covid-19 symptoms. In the third wave, almost all persons who were either unvaccinated or had previous health issues were seen to be hospitalized to the ICU after testing positive for Covid-19.

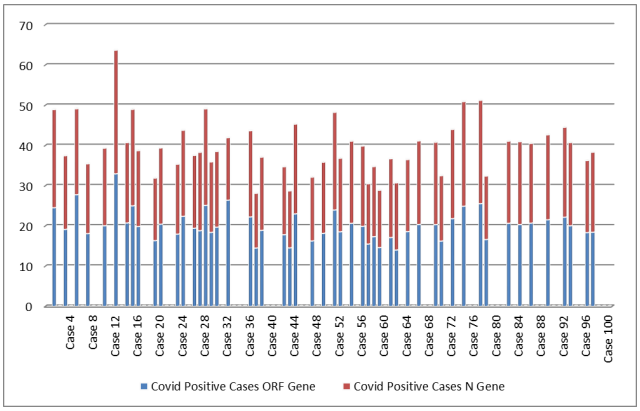

Figure 1: Positive cases with Open Reading Frame(ORF) and Nucleocapsid(N) Gene Positive value and Negative cases

Out of a total of 100 cases (68%), 54 were positive for Covid-19 and 46 were negative, with 6 cases being vacinated yet positive and 22 vaccinated patients being negative for Covid-19 patients were unvaccinated and positive for Covid-19, while 7 patients were unvaccinated and negative. There were 13 vaccinated but positive instances, and 87 vaccinated but negative ones. Males outnumbered females (59) by a large margin. The gender distribution of patients in the current study revealed a male preponderance over females. Many research[12,13] reported a comparable preponderance of males over girls as 58%, 62%, respectively. A few studies conducted in India also shown that males were more likely to be infected with Covid-19 than females.[14–16] Males are also more likely than females to be infected with Covid-19.[17–19] It has been proposed that females are less susceptible to viral infections due to natural protection from the X chromosome and sex hormones.[20]

The percentages and patterns of positive cases and admitted patients for covid-19 were radically different when we compared the third wave in Dehradun to the first and second waves. According to the findings, the majority of those who tested positive were unvaccinated, while there were rare cases when vaccinated people tested positive, which was not as harmful as not having active protection due to vaccination. Because no vaccine is

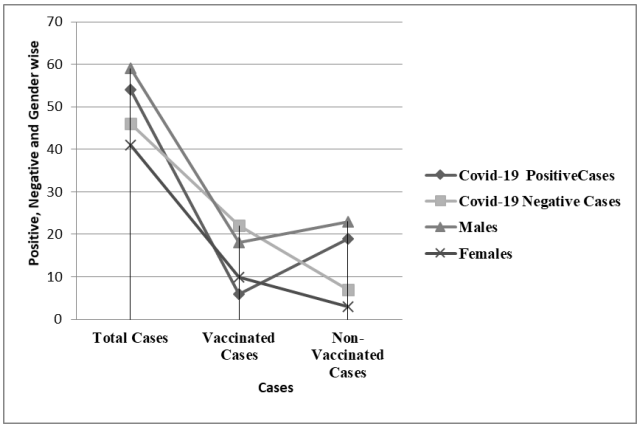

Figure 2: Covid-19 cases in vaccinated and non-vaccinated patients along with male and female proportion

100% effective, "breakthrough infections" were always a possibility. The symptoms are frequently mild, which admits the phenomena of "breakthrough infections" caused by vaccination ineffectiveness, as demonstrated by the yellow fever vaccine's 98% effectiveness. However, this still means that 2% of people will become sick.[21–24]

The current study examines the gender distribution of Covid-19 cases, demonstrating a significant male preponderance over girls, a tendency supported by earlier research. It consistently shows that males have a higher incidence of Covid-19 than females. The study also looks at the influence of vaccination, finding that the majority of positive cases in the third wave in Dehradun were among unvaccinated people.

Aside from the study, an evaluation was conducted to explore Hesitancy against the newly produced COVID-19 vaccinations is a global occurrence. Although, for much clearer data, vaccination/infection history would necessitate substantial investigation, data collecting, and analysis. According to available literature, vaccine reluctance varies greatly between countries.[35–38] Vaccine hesitation was defined by the WHO as a "delay in acceptance or refusal of vaccination despite the availability of vaccination services." Various survey items deployed to investigate questions pertaining to COVID-19 vaccine hesitancy, such as whether people are willing to be vaccinated, the reasons why they are willing or unwilling to do so, and the most trusted sources of information in their decision-making, across 13 studies conducted in Africa, South Asia, Latin America, Russia, and the United States. Overall, they discovered that the average acceptance rate across all studies in low- and middle-income countries (LMICs) was 80.3%, with the lowest acceptance rates in Burkina Faso.[37–40] When we see the data 10 July to 6 August 2023), approximately 1.5 million new COVID-19 cases and over 2500 deaths were reported globally, and an increase of 80% and a drop of 57%, respectively, While five WHO areas reported decreases in both the number of cases and deaths, the Western Pacific Region reported an increase in both cases and deaths.[41–45]

When we talk about Uttarakhand Total 91, 18, 676 - 80.00% of citizens received at-least one dose of vaccine in Uttarakhand, about 87,33,083 - 76.61% fully vaccinated.[42,46] The table provides the data of vaccination till 2 Nov 2023 of covid-19 showing the non-hesitancy (Figure 3) of people of districts of Uttrakhand and Dehradun and other districts.

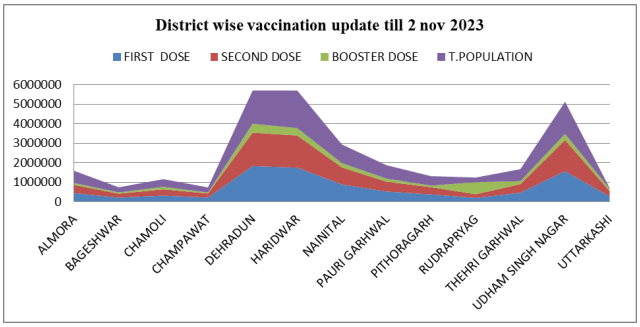

Figure 3: Vaccination data of Districts of Uttarakhand including Dehradun

Like the nationwide approach to COVID-19 vaccination in India, the immunization process in Uttarakhand has unfolded in several stages. Initially, healthcare workers, frontline personnel, and senior citizens received primary focus for vaccination. Over time, the eligibility criteria for vaccination may have evolved to encompass various age groups and other specific categories. Vaccination centers were established in multiple government and private healthcare facilities throughout Uttarakhand. Awareness campaigns aimed at promoting vaccination and educating the public on its significance have been conducted by the state government and health authorities.[41–43]

4. Discussion

The study emphasizes that even with immunizations a small number of people may still become infected with the virus. The bulk of the top Covid-19 vaccines achieved efficacy against symptomatic infection of more than 90% in phase 3 trials. Real-world efficacy studies in the United Kingdom, Israel, and Canada show that vaccine efficacy is slightly lower outside of the trial setting, most likely due to the spread of the more vaccine-resistant Delta variant. Estimates suggest protection against symptomatic illness at 60-90 percent, depending on the vaccination. Only a small percentage of fully vaccinated patients who test positive for Covid-19 die.[47–50] PHE's real-world studies show that the BioNTech/Pfizer vaccination is still 96% effective against hospitalization, whereas the Oxford/AstraZeneca vaccine is 92% effective. However, Natalie Dean, a biostatistics professor at Emory University in Atlanta, stressed that

Table 1: A summary of prominent Covid-19 vaccines, showcasing their varying efficacy results from Phase III clinical trials conducted across different regions, presented in a tabular format with references

Vaccine	Type	Developer	Phase III Efficacy (%)	Geographical Areas	References
Oxford-AstraZeneca (AZD1222)	Viral Vector (ChAdOx1-5)	University of Oxford, AstraZeneca	70.4 (Overall, 95% CI 54.8–80.6) 62.1 (2-standard dose, 95% CI 41.0–75.7) 90.0 (Low dose + standard dose, 95% CI 67.4–97.0)	UK	(Voysey et al., 2021)[25]
Johnson & Johnson (Ad26.COV2.S)	Viral Vector (Ad26)	Johnson and Johnson	66.9 (95% CI 59.0–73.4) 76.3 (≥60 years old, 95% CI, 61.6–86.0)	USA	(Tehrani and Sajadi, 2021)[26]
Moderna (mRNA-1273)	mRNA	Moderna and NIAID	94.1 (95% CI 89.3–96.8)	USA	(Baden et al., 2021)[27]
Pfizer-BioNTech (BNT162b2)	mRNA	Pfizer and BioNTech	94.6 (95% CI 89.9–97.3)	USA, Germany	(Iannone et al., 2020)[28]
Gamaleya (Sputnik V)	Viral Vector (rAd26+rAd5)	Gamaleya Research Institute, Russia	91.6 (95% CI 85.6–95.2)	Russia	(Logunov et al., 2021)[29]
CanSino (Convidecia)	Recombinant Adenovirus (Ad5)	Beijing Institute of Biotech, CanSino Biological	65.7 (As per company claim)	China	(Zhu, F et al., 2022)[30]
Novavax (NVX-CoV2373)	Protein Subunit	Novavax (Gaithersburg, USA)	89.7 (95% CI 80.2–94.6)	USA	(Ian J et al., 2021, polack et al., 2020)[31,32] (39,40)
Covaxin	Inactivated Virus	Bharat Biotech	77.8 (95% CI 65.2–86.4)	India	(Ella et al., 2021)[32]
Sinovac-CoronaVac	Inactivated Virus	Sinovac Biotech	Varied	Multiple countries including Brazil, Turkey, Indonesia	(Al Kaabi et al., 2021)[33]
Sinopharm-BBIBP-CorV	Inactivated Virus	China National Pharmaceutical Group (Sinopharm)	Varied	Multiple countries including UAE, Bahrain, Egypt	(Wu, Y et al., 2021)[34]

these findings were based on averages and that efficacy was reliant on individuals' existing risk profiles. Individuals with impaired immune systems may only create enough antibodies to resist a 100-fold dilution. In contrast, healthy young adults may have enough for a 10,000-fold dilution and are "likely impervious" to infection.[51,52] If scientists could establish a happy medium between the two extremes, vaccine manufacturers would be able to update vaccines more quickly for new strains, and policymakers would be able to better determine who needed booster doses the most. Due to the urgent global need to combat the pandemic, COVID-19 vaccinations were created and launched in record time. The Pfizer-BioNTech vaccine was the first COVID-19 vaccine to be approved for emergency use. On December 2, 2020, the United Kingdom authorized its use for emergency purposes.[53,54] Other vaccines, including the Moderna vaccine, the AstraZeneca-Oxford vaccine, and the Johnson & Johnson vaccine, were also approved for emergency use in a number of nations in late 2020 and early 2021. The precise dates of permission vary depending on the country and regulatory body.[55] On January 16, 2021, India initiated its Covid-19 vaccine campaign. Initially, the nation approved two vaccines for emergency use. Oxford-AstraZeneca's Covishield AstraZeneca licensed the Serum Institute of India (SII) to manufacture the vaccine. Covishield was one of the first vaccinations used in India's vaccination campaign. Covaxin (Bharat Biotech Vaccine) is an inactivated viral vaccine developed in partnership with the Indian Council of Medical Research (ICMR) by Bharat Biotech. It was approved for emergency use

in India and has been used in the country's vaccination efforts. As the immunization campaign progressed, India approved more vaccines for emergency use, although Covishield and Covaxin were the initial vaccinations introduced in the country's Covid-19 programmed.[53,55,56] Although the Omicron variant appears to induce lesser symptoms than prior variants in persons who have been completely vaccinated and boosted, we do not know if another variant with more severe symptoms and the same level of immune escape will emerge. SARS-CoV-2 may also become endemic and continue to circulate in the community for the foreseeable future.[56,57] COVID-19 vaccination hesitancy can stem from a range of factors. Safety concerns and apprehensions about potential side effects may have deterred some individuals. Additionally, distrust in the vaccine development process or pharmaceutical companies can be a driver of hesitancy, and the proliferation of misinformation and vaccine-related myths may have sowed doubts about vaccination. Needle phobia is a significant impediment for certain people, while others may harbor the belief that natural infection offers superior immunity compared to vaccination. Negative encounters with vaccines in the past can further contribute to vaccine hesitancy, as can concerns regarding the rapid pace of vaccine development and approval processes. In regions where COVID-19 cases have remained relatively low, a sense of complacency may have developed among certain individuals, leading to reduced urgency in pursuing vaccination. Meanwhile, a wait-and-see approach may be favored by some, as they prefer to observe how the vaccine performs in others before opting for vaccination themselves. Additionally, cultural or religious convictions can significantly impact vaccination decisions. Limited access to vaccination centers and logistical difficulties can pose substantial barriers to getting vaccinated. Concerns about vaccination may also arise among individuals with specific health conditions or allergies. Lastly, political or ideological beliefs may play a role in influencing vaccine hesitancy. Crucial for public health initiatives is the need to confront these apprehensions through educational outreach, transparent communication, and the widespread dissemination of precise information. This approach fosters vaccine acceptance and contributes to the containment of COVID-19 transmission.[50,58]

5. Conclusion

Transmission rate of omicron was limited in third wave because Covid-19 Vaccines was Master key to prevent infection and reduce transmission. In order to maintain the control over omicron and other virulence effect of Covid-19 vaccinated people also need to continue social distancing and keep wearing a mask in public places. It's good thing to see the population of Dehradun were much more conscious of wearing masks more carefully and acquired in the life style as basic requirements.[59] In a nutshell the adoption rate of the Covid-19 vaccine and vaccination intention were unsatisfactory for achieving herd immunity. It is critical for governments, public health professionals, and economic and social groups to adopt a strategy to increase vaccination acceptance, particularly among the working population.[36,60] This Covid-19 pandemic has changed the way we live, and it will continue to shape our future life. People are conceptually more willing to be vaccinated and wear masks in daily life and remote working and learning will probably become a feasible option in the future. Whether or not we will encounter another pandemic this century is unknown but, just in case, we will need to be prepared mentally, scientifically, and infrastructuraly.[35,36,46,49,50,60]

6. Source of Funding

None.

7. Conflict of Interest

None.

References

1. Ciotti M, Ciccozzi M, Terrinoni A, Jiang WC, Wang C, Bernardini S. The COVID-19 pandemic. *Crit Rev Clin Lab Sci*. 2020;57(6):365–88.
2. Hageman JR. Current Status of the COVID-19 Pandemic, Influenza and COVID-19 Together, and COVID-19 Viral Variants. *Pediatr Ann*. 2020;49(11):448–9.
3. Platto S, Xue T, Carafoli E. COVID19: an announced pandemic. *Cell Death Dis*. 2020;11(9):799. doi:10.1038/s41419-020-02995-9.
4. Rifai N, Gillette MA, Carr SA. Protein biomarker discovery and validation: the long and uncertain path to clinical utility. *Nat Biotechnol*. 2006;24(8):971–83.
5. Mayer-Blackwell K, Koshlan S, Cohen-Lavi L, Crawford JC, Souquette A, Gaevert JA, et al. TCR meta-clonotypes for biomarker discovery with tcrdist3: identification of public, HLA-restricted SARS-CoV-2 associated TCR features. *bioRxiv*. 2021;10:424260. doi:10.1101/2020.12.24.424260.
6. Huggett J, Dheda K, Bustin S, Zumla A. Real-time RT-PCR normalisation; strategies and considerations. *Genes Immun*. 2005;6(4):279–84.
7. Gibson UE, Heid CA, Williams PM. A novel method for real time quantitative RT-PCR. *Genome Res*. 1996;6(10):995–1001.
8. Lash TL, VanderWeele TJ, Haneuse S, Rothman KJ. Modern epidemiology. vol. Vol. 3. Philadelphia: Wolters Kluwer; 2008.
9. Rothman KJ. Epidemiology: an introduction. United Kingdom: Oxford University Press; 2012.
10. Pujadas E, Beaumont M, Shah H, Schrode N, Francoeur N, Shroff S, et al. Molecular profiling of coronavirus disease 2019 (COVID-19) autopsies uncovers novel disease mechanisms. *Am J Pathol*. 2021;191(12):2064–71.
11. Belouzard S, Millet JK, Licitra BN, Whittaker GR. Mechanisms of coronavirus cell entry mediated by the viral spike protein. *Viruses*. 2012;4(6):1011–33.
12. Guan WJ, Ni ZY, Hu Y, Liang WH, Ou CQ, He JX, et al. Clinical Characteristics of Coronavirus Disease 2019 in China. *N Engl J Med*. 2020;382:1708–20.
13. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J. Clinical Characteristics of 138 Hospitalized Patients With 2019 Novel Coronavirus-Infected Pneumonia in Wuhan, China. *JAMA*. 2020;323(11):1061–9.
14. Richardson S, Hirsch JS, Narasimhan M, Crawford JM, Mcginn T, Davidson KW, et al. Presenting Characteristics, Comorbidities, and Outcomes Among 5700 Patients Hospitalized With COVID-19 in the New York City Area. *JAMA*. 2020;323(20):2052–9.

15. Grasselli G, Zangrillo A, Zanella A, Antonelli M, Cabrini L, Castelli A, et al. Baseline Characteristics and Outcomes of 1591 Patients Infected With SARS-CoV-2 Admitted to ICUs of the Lombardy Region, Italy. *JAMA*. 2020;323(16):1574–81.
16. Colaneri M, Sacchi P, Zuccaro V, Biscarini S, Sachs M, Roda S. Clinical characteristics of coronavirus disease (COVID-19) early findings from a teaching hospital in Pavia, North Italy, 21 to 28 February 2020. *Euro Surveill*. 2020;25(16):2000460. doi:10.2807/1560-7917.ES.2020.25.16.2000460.
17. Budhiraja S, Soni A, Jha V, Indrayan A, Dewan A, Singh O, et al. Clinical profile of first 1000 COVID-19 cases admitted at tertiary care hospitals and the correlates of their mortality: An Indian experience. *medRxiv*. 2020;doi:10.1101/2020.11.16.20232223.
18. Mohan A, Tiwari P, Bhatnagar S, Patel A, Maurya A, Dar L. Clinico-demographic profile & hospital outcomes of COVID-19 patients admitted at a tertiary care centre in north India. *Indian J Med Res*. 2020;152(1 & 2):61–9.
19. Kaur H, Singh M, Kaur K, Kaur A, Singh R, Patel N, et al. Clinical Profile and Outcomes of Patients Admitted with COVID-19 Infection –Report from a Tertiary Hospital. *J Med Sci Clin Res*. 2021;9(1):94. doi:10.18535/jmscr/v9i1.37.
20. Badawi A, Ryoo SG. Prevalence of comorbidities in the Middle East respiratory syndrome coronavirus (MERS-CoV):A systematic review and meta-analysis. *Int J Infect Dis*. 2016;49:33.
21. Channappanavar R, Fett C, Mack M, Eyck PPT, Meyerholz DK, Perlman S. Sex-Based Differences in Susceptibility to Severe Acute Respiratory Syndrome Coronavirus Infection. *J Immunol*. 2018;198(10):4046–53.
22. Jentes ES, Poumerol G, Gershman MD, Hill DR, Lemarchand J, Lewis RF, et al. The revised global yellow fever risk map and recommendations for vaccination, 2010: consensus of the Informal WHO Working Group on Geographic Risk for Yellow Fever. *Lancet Infect Dis*. 2011;11(8):622–32.
23. Wilson ME, Chen LH, Barnett ED. Yellow fever immunizations: indications and risks. *Curr Infect Dis Rep*. 2004;6(1):34–42.
24. Barrett AD, Monath TP, Barban V, Niedrig M, Teuwen DE. 17D yellow fever vaccines: new insights. A report of a workshop held during the World Congress on medicine and health in the tropics, Marseille, France, Monday 12 September 2005. *Vaccine*. 2005;25(15):2758–65.
25. Voysey M, Clemens SAC, Madhi SA, Weckx LY, Folegatti PM, Aley PK, et al. Safety and efficacy of the ChAdOx1 nCoV-19 vaccine (Azd1222) against SARS-CoV-2: an interim analysis of four randomised controlled trials in Brazil, South Africa, and the UK. *Lancet*. 2021;397(10269):99–111.
26. Tehrani ZR, Sajadi MM. Single-dose Ad26.COV2.S vaccine-room for improvement. *JAMA Netw Open*. 2021;4(11):e2133012. doi:10.1001/jamanetworkopen.2021.33012.
27. Baden LR, Sahly ME, Essink B, Kotloff K, Frey S, Novak R. Efficacy and Safety of the mRNA-1273 SARS-CoV-2 Vaccine. *N Engl J Med*. 2021;384(5):403–16.
28. Iannone M, Janowska A, Tonini G, Davini G, Dini V. Safety and efficacy of the BNT162b2 mRNA COVID-19 vaccine during Ixekizumab treatment for hidradenitis suppurativa. *Clin Dermatol*. 2021;39(4):701–2.
29. Logunov DY, Dolzhikova IV, Shcheblyakov DV, Tukhvatulin AI, Zubkova OV, Dzharullaeva AS, et al. Safety and efficacy of an rAd26 and rAd5 vector-based heterologous prime-boost COVID-19 vaccine: an interim analysis of a randomised controlled phase 3 trial in Russia. *Lancet*. 2021;397(10275):671–81.
30. Zhu F, Jin P, Zhu T, Wang W, Ye H, Pan H, et al. Safety and immunogenicity of a recombinant adenovirus type-5-vectored corona virus disease 2019 (COVID-19) vaccine with a homologous prime-boost regimen in healthy participants aged≥ 6 years: a randomized, double-blind, placebo-controlled, phase 2b trial. *Clin Infect Dis*. 2022;75(1):783–91.
31. Polack FP, Thomas SJ, Kitchin N, Absalon J, Gurtman A, Lockhart S, et al. Safety and efficacy of the BNT162b2 mRNA Covid-19 vaccine. *N Engl J Med*. 2020;383(27):2603–15.
32. Ella R, Vadrevu KM, Jogdand H, Prasad S, Reddy S, Sarangi V, et al. Safety and immunogenicity of an inactivated SARS-CoV-2 vaccine, BBV152: a double-blind, randomised, phase 1 trial. *Lancet Infect Dis*. 2021;21(5):637–46.
33. Kaabi NA, Zhang Y, Xia S, Yang Y, Qahtani MMA, Abdulrazzaq N, et al. Effect of 2 inactivated SARS-CoV-2 vaccines on symptomatic COVID-19 infection in adults: a randomized clinical trial. *JAMA*. 2021;326(1):35–45.
34. Wu Y, Huang X, Yuan L, Wang S, Zhang Y, Xiong H, et al. A recombinant spike protein subunit vaccine confers protective immunity against SARS-CoV-2 infection and transmission in hamsters. *Sci Transl Med*. 2021;13(606):1143.
35. Thomas SJ, Moreira ED, Kitchin N, Absalon J, Gurtman A, Lockhart S. Safety and efficacy of the BNT162b2 mRNA Covid-19 vaccine through 6 months. *N Engl J Med*. 2019;385(19):1761–73.
36. Goldberg Y, Mandel M, Bar-On YM, Bodenheimer O, Freedman L, Haas EJ, et al. Waning immunity after the BNT162b2 vaccine in Israel. *N Engl J Med*. 2021;385(24):e85.
37. Soriano JB, Murthy S, Marshall JC, Relan P, Diaz JV. A clinical case definition of post-COVID-19 condition by a Delphi consensus. *Lancet Infect Dis*. 2022;22(4):102–7.
38. Houben S, Bonnechère B. The impact of COVID-19 infection on cognitive function and the implication for rehabilitation: a systematic review and meta-analysis. *Int J Environ Res Public Health*. 2022;19(13):7748.
39. Dirican E, Bal T. COVID-19 disease severity to predict persistent symptoms: a systematic review and meta-analysis. *Prim Health Care Res Dev*. 2022;23:e69.
40. Lopez-Leon S, Wegman-Ostrosky T, Perelman C, Sepulveda R, Rebolledo PA, Cuapio A, et al. More than 50 long-term effects of COVID-19: a systematic review and meta-analysis. *medRxiv*. 2021;11:21250617. doi:10.1101/2021.01.27.21250617.
41. Davis HE, Mccorkell L, Vogel JM, Topol EJ. Long COVID: major findings, mechanisms and recommendations. *Nat Rev Microbiol*. 2023;21:133–46.
42. Vaccinate India. Available from: https://vaccinate-india.in/state/35.
43. Weekly epidemiological update on COVID-19 - 10 August 2023. Available from: https://www.who.int/publications/m/item/weekly-epidemiological-update-on-covid-19---10-august-2023.
44. Lau JJ, Cheng SMS, Leung K, Lee C, Hachim A, Tsang LCH. Real-world COVID-19 vaccine effectiveness against the Omicron BA.2 variant in a SARS-CoV-2 infection-naive population. *Nat Med*. 2023;29(2):348–57.
45. 00:00) (The Government of the Hong Kong Special Administrative Region. *Statistics on 5th Wave of COVID-19*. 2021;.
46. Morvan M, Jacomo AL, Souque C, Wade M, Hoffmann T, Pouwels K, et al. An analysis of 45 large-scale wastewater sites in England to estimate SARS-CoV-2 community prevalence. *Nat Commun*. 2022;13(1):4313.
47. World Health Organization. Novel Coronavirus (2019-nCoV), Situation Report - 1. Available from: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200121-sitrep-1-2019-ncov.pdf.
48. CEPI to fund three programmes to develop vaccines against the novel coronavirus, nCoV-2019. Available from: https://cepi.net/news_cepi/cepi-to-fund-three-programmes-to-develop-vaccines-against-the-novel-coronavirus-ncov-2019/.
49. Amman F, Markt R, Endler L, Hupfauf S, Agerer B, Schedl A, et al. Viral variant-resolved wastewater surveillance of SARS-CoV-2 at national scale. *Nat Biotechnol*. 2022;40(12):1814–22.
50. Mok CKP, Cohen C, Cheng SMS, Chen C, Kwok KO, Yiu K, et al. Comparison of the immunogenicity of BNT162b2 and CoronaVac COVID-19 vaccines in Hong Kong. *Respirology*. 2022;27(4):301–10.
51. Chaplin DD. Overview of the immune response. *J Allergy Clin Immunol*. 2010;125(2):3–23.
52. Goodarzi H, Trowbridge J, Gallo RL. Innate immunity: a cutaneous perspective. *Clin Rev Allergy Immunol*. 2007;33:24–32.
53. Patel R, Kaki M, Potluri VS, Kahar P, Khanna D. A comprehensive review of SARS-CoV-2 vaccines: Pfizer, Moderna & Johnson &

Johnson. *Hum Vaccin Immunother*. 2022;18(1):2002083.
54. Aldali J, Meo SA, Al-Khlaiwi T. Adverse Effects of Pfizer (BioNTech), Oxford-AstraZeneca (ChAdOx1 CoV-19), and Moderna COVID-19 Vaccines among the Adult Population in Saudi Arabia: A Cross-Sectional Study. *Vaccines (Basel)*. 2023;11(2):231.
55. Lotfi H, Mazar MG, Ei NM, Fahim M, Yazdi NS. Vaccination is the most effective and best way to avoid the disease of COVID-19. *Immun Inflamm Dis*. 2023;11(8):e946.
56. Chi WY, Li YD, Huang HC, Chan TEH. COVID-19 vaccine update: vaccine effectiveness, SARS-CoV-2 variants, boosters, adverse effects, and immune correlates of protection. *J Biomed Sci* . 2022;29(1):82.
57. Allen H, Tessier E, Turner C, Anderson C, Blomquist P, Simons D, et al. Comparative transmission of SARS-CoV-2 Omicron (B.1.1.529) and Delta (B.1.617.2) variants and the impact of vaccination: national cohort study, England. *Epidemiol Infect*. 2023;151:e58.
58. Bullock J, Lane JE, Shults FL. What causes COVID-19 vaccine hesitancy? Ignorance and the lack of bliss in the United Kingdom. *Humanit Soc Sci Commun*. 2022;9:87. doi:10.1057/s41599-022-01092-w.
59. Hong L, Jin Z, Xu K. COVID-19 vaccine uptake and vaccine hesitancy in rural-to-urban migrant workers at the first round of COVID-19 vaccination in China. *BMC Public Health*. 2023;23:139–139.
60. Coronavirus disease (COVID-19) Weekly Epidemiological Updates and Monthly Operational Updates; 2023. Available from: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports.

Author biography

Ankita Singh, Jr. Scientist and Quality Manager

Nivedita Chetan Gurada, Intern at DNA Labs https://orcid.org/0000-0002-2079-4114

Nidhi Mahendru, Assistant Professor and HOD https://orcid.org/0009-0004-4522-067X

Abhijeet Kashyap, Intern at DNA Labs https://orcid.org/0009-0005-8903-557X

Sourabh Bhanu, Student

Narotam Sharma, Scientist and Laboratory Director https://orcid.org/0000-0003-0103-2322

Ritu Kaushik, Intern at DNA Labs

Cite this article: Singh A, Gurada NC, Mahendru N, Kashyap A, Bhanu S, Sharma N, Kaushik R. The Vax effect: Role of global vaccination initiatives in pandemic control and impact in Dehradun during COVID-19. *Int J Clin Biochem Res* 2023;10(4):320-326.