

Serosurvey of Haryana and Odisha: COVID-19 Hybrid Immunity

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ABSTRACT

The seroprevalence in Indian states Haryana and Odisha has been investigated. The seropositivity in the Haryana population increased with time from 8% to 14.8% to 76.3% as recorded in August, October 2020, and September 2021, respectively. The virus spread was continuous as the increase in seroprevalence was monotonous. The three COVID-19 pandemic waves that hit Haryana in September, November 2020, and May 2021 infected the population and generated antibodies. The last serosurvey conducted in September 2021 which registered 76.3% seroprevalence might have a contribution from vaccination as 25% of all the population was fully vaccinated and 60% had one dose. The seroprevalence in Odisha was found to be 20.8%, 68.1%, and 73% in the surveys conducted in August 2020, June, and August 2021, respectively. The survey conducted in Odisha in August 2021 found that 93% of the healthcare workers had antibodies suggested that in the general population also, 93% seroprevalence might be possible by strong vaccination drive or repeated virus exposure. A maximum seroprevalence of 75% was found in the age group of 19-44 years and the lowest of 66% was recorded among 60-plus individuals.

Keywords: Antibodies enhancement, Haryana serosurvey, hybrid immunity, Odisha serosurvey.

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I. INTRODUCTION

The world has set foot in the third year of the COVID-19 pandemic with 260 million cases and 5.2 million deaths worldwide [1]. The fight against the deadly virus is not yet over. The appearance of the highly contagious Omicron variant (B.1.1.529) once again has put the virus on the center stage. The Omicron variant has a large number of mutations in the spike protein. It spreads faster than Delta and Wuhan variants. Though the infectivity of Omicron variant and escaping ability from vaccine protection has not been measured and established yet thoroughly. The vaccines in use till now target the original Wuhan strain and reduce the risk of hospitalisation and death. The existing vaccines also work against the more infectious Delta variant. The Delta variant currently accounts for more than 99% of infections worldwide. In the fierce fourth wave of the pandemic in Europe, the cases are surging in spite of two-thirds of the European population has already been fully vaccinated. The recent surge in the US is also a big reason for worry. One of the big concerns in the pandemic is the unequal distribution of COVID-19 vaccines. Out of the 8 billion doses given so far, the rich countries made up for most of them while the poor countries like the African nations could only get less than 10% of the doses.

On the vaccine development front, the first protein-based vaccine developed by Novavax has been approved for emergency use in Indonesia. Protein-based vaccines are slow to develop. Protein-based vaccines have advantages: they are stable at higher temperatures, cost effective, and easy to scale up. In the phase 3 trial, Novavax proved to have an efficacy of more than 90% and the vaccine was safe. More protein-based vaccines from the makers: Clover Biosciences (China), Biological E (India), Sanofi/GSK (France/UK), and S K Biosciences (South Korea) have reached the final approval stage. These vaccines were developed to cover the Delta variant mutation of the virus protein. They are superior to earlier vaccines as they are tailored for the mix-and-match approach and the booster shots strategies. Several pre-existing drugs were tested in the initial stage of the COVID-19 pandemic including the FDA (Food and Drug Administration, US) approved Remdesivir. The drug was expensive and had limited use and impact. Very recently the data of two antiviral oral drugs; molnupiravir (Merck) and Paxlovid (Pfizer) were announced. These drugs are easy to manufacture, store and distribute. The efficacy of molnupiravir and Paxlovid were 50% and 89%, respectively in preventing severe disease and hospitalisation.

From the viewpoint of the dynamics of the virus spread, before the emergence of the Omicron variant, the daily new infections in Japan decreased to 44 as recorded on November 22, 2021 [2]-[4]. This figure was the lowest for the year 2021. The cases decreased after the fifth Delta pandemic wave. The decrease in the cases in Japan was due to the robust vaccination drive Japan undertook. More than 76% population has been fully vaccinated. To accelerate inoculation of the third booster shot, Japan government has permitted the use of a mix-and-match approach [5], [6]. Moderna and Pfizer vaccines will be used for booster shots. The third shot will be available from February 2021 for the

public. For healthcare workers, it had started already from December 1, 2021. The data have shown that a two-shots vaccination gives an efficacy of more than 90%, though the rate of breakthrough infections increased after six months. Therefore, a third booster shot is recommended. There was a hope to see an end of the pandemic in India, before the Omicron variant appeared, as the number of novel coronavirus cases decreased continuously, and the third wave did not hit for a very long time of up to 5 months. The active cases declined to 98,416, the lowest in 552 days. For ten straight days, the daily new infections remained [7] below 10,000.

Coming again to the new Omicron variant of the virus, a consortium of 28 Indian laboratories, INSACOG (Indian SARS-CoV-2 Genomics Sequencing Consortium) has recommended inoculation of a third booster shot of vaccines for high risk and above 40 years old individuals [8] in India. The booster dose will increase the antibodies levels necessary to neutralize the Omicron variant. There exists a possibility of new spike genes of Omicron variant decreasing the neutralizing efficacy of the vaccines currently in use.

To address the issue of waning SARS-CoV-2 antibodies over time, Canada is another country which has recommended [9] third booster shots for all adults. A booster dose is known to enhance the protection against the old and new variants and thus reducing the virus spread. The emergence of a new variant compelled the vaccine-makers to revise their vaccine shots to address the issues caused by the new mutant. The researchers have recommended [10] getting additional booster shot to be on the safer side since the data on new variant are not available and developing new variant-specific vaccines will take time. On the front of developing booster shots, it was found [11] that after the inoculation of mRNA shot (Moderna or Pfizer), six tested vaccines (AstraZeneca, Pfizer, Moderna, Johnson & Johnson, CureVac NV, Novavax Inc.) raised the level of the antibodies. The antibodies' level was measured four weeks after the booster was inoculated. The emergence of the Omicron variant of the COVID-19 virus has established the fact that humans have to live with the novel coronavirus. There is a need to find long term strategies to live unharmed with the emerging variants of the virus. Individuals can stay safe by observing the following practices and habits. Since the virus is airborne in the form of aerosol or droplets, the accumulation of virus in enclosed spaces can be avoided by ventilation. Offices, restaurants, schools, buses, and trains need to be made safer by taking appropriate measures of proper ventilation, hand hygiene, sanitization, and mask usage. The buildings fitted with air conditioners may have air filtration devices that remove virus-loaded droplets and aerosols. Researchers around the globe are working to contain the pandemic and open the world for normal pre-pandemic activities. Shervani et al. have reported in recently published articles [12]-[21] the up-to-date data and results of different aspects of the COVID-19 virus and disease. In this research, we have described the results of the serosurveys conducted in the Indian states of Haryana and Odisha. The enhancement of the SARS-CoV-2 antibodies by vaccination has also been demonstrated. The data and the results described in this article are very useful to contain the

pandemic especially by vaccination drive.

II. METHODS

Haryana’s Health Department and Department of Community Medicine (Post Graduate Institute of Medical Sciences, Rohtak) conducted the survey in Haryana. The sample size of the first survey was 18,700 and in the second it was 15,840. The sample size of the third survey was much larger consisting of 36,520 residents. The samples were collected from all the 22 districts of the state. To ensure uniform treatment of the samples, the processing of samples was done in one laboratory located in Panchkula township. Samples of both vaccinated and unvaccinated individuals were collected to obtain the data. The serosurvey in Odisha was undertaken by the Regional Medical Research Centre (RMRC) located in Bhubaneswar, Odisha. The RMRC is an affiliate of the Indian Council of Medical Research (ICMR). The serosurvey was conducted in 12 out of 30 districts of Odisha in the period August 29-September 15, 2021. The districts Sambalpur, Sundergarh, Jharsuguda, Keonjhar, Khurda, Puri, Balasore, Mayurbhanj, Jajpur, Kandhamal, Kalahandi, and Nabarangpur were included in the survey. A total of 5,796 samples were collected out of which 4,247 were found positive for the COVID-19 virus antibodies. The samples of healthcare workers (HCWs) were taken separately and out of 1,312 samples, 1,232 had antibodies. August 2020, Odisha serosurvey data comprised of the survey conducted in three major cities of Odisha Bhubaneswar, Berhampur, and Rourkela. The overall seropositivity across the three cities was 20.8%. The seroprevalence varied largely among the three cities. The highest was recorded in Berhampur (31.1%) followed by Rourkela (25.6%) and Bhubaneswar recorded the lowest (5.2%).

III. RESULTS AND DISCUSSION

A. Seroprevalence in Haryana

The third serosurvey conducted in the state of Haryana in September 2021 found that 76.3% of the population had antibodies against COVID-19 infection [22]. Fig. 1 is the horizontal bars showing the district-wise seroprevalence in Haryana. The seropositivity [23] of each district has been mentioned in the bracket as follows: Kurukshetra (85%), Rohtak (84.6%), Mahendergarh (81.6%), Panipat (81.5%), Nuh (79.7%), Charkhi Dadri (78.6%), Gurgaon (78.3%), Sonipat (77.9%), Ambala (77.5%), Palwal (77.5%), Jind (76.8%), Fatehabad (75.4%), Karnal (75%), Rewari (74.8%), Panchkula (72.8%), Hisar (72.4%), Sirsa (72.4%), Yamunanagar (72.1%), kaithal (71.5%), Jhajjar (70.8%) and Bhiwani (69.7%), Faridabad (64.2%).

Fig. 2 compares the seroprevalence registered in all the three serosurveys of Haryana conducted in August, October 2020, and September 2021. In the first survey, the seropositivity was 8% and in the second round, it was 14.8%. In the third survey, the seroprevalence rose to 76.3%. The bars in the figure have been plotted as per the scale in months.

Fig. 3 shows the increase in seroprevalence with time in

months. The plot was constructed from the data shown in Fig. 2. The plot shows a near-monotonous increase in seroprevalence in Haryana’s population with time, indicating that the virus spread with time was uniform. The three pandemic waves (September, November 2020, May 2021) that hit Haryana and the presence of the large number of active cases were the reasons for infecting the large population that resulted in generation of antibodies.

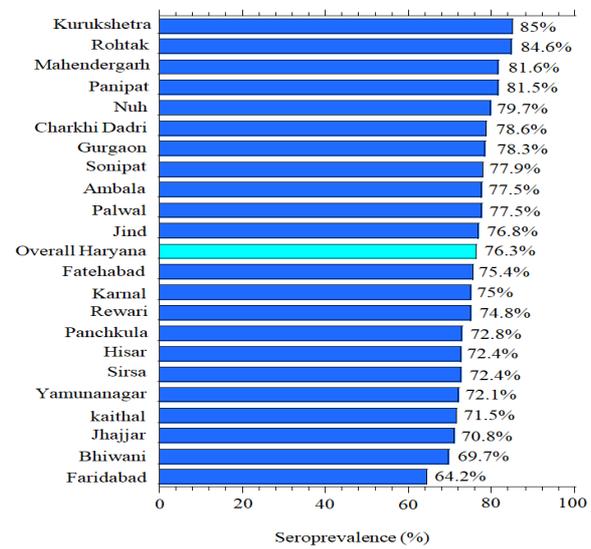


Fig. 1. District-wise seroprevalence registered in Haryana in the third survey.

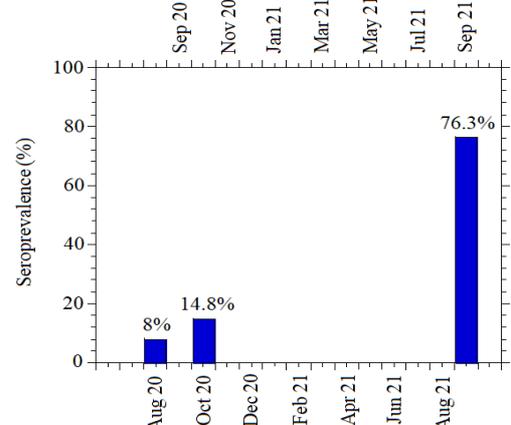


Fig. 2. Bars showing the seroprevalence in Haryana population in all three surveys.

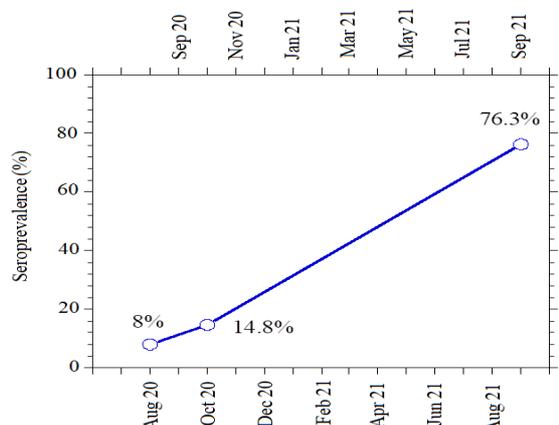


Fig. 3. Increase in seroprevalence with time (month) in Haryana’s population.

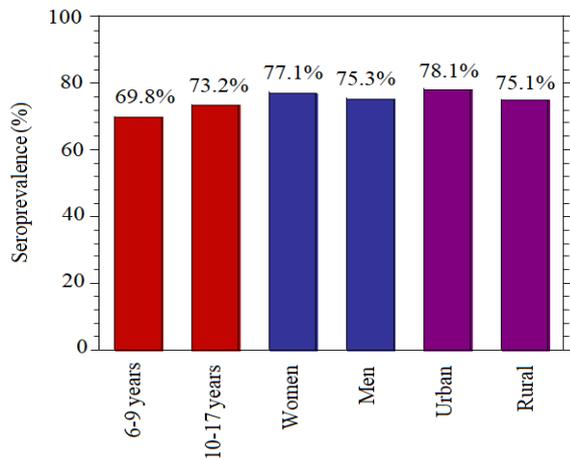


Fig. 4. Bars showing the seroprevalence in different groups in Haryana population registered in third survey.

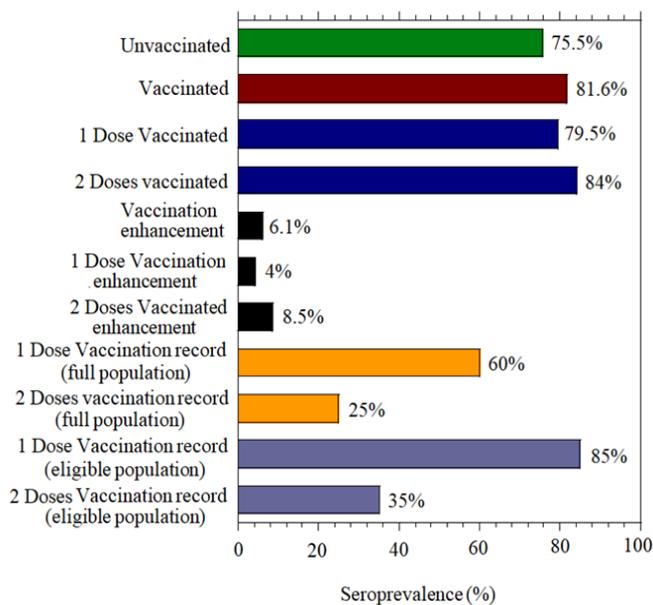


Fig. 5. Seroprevalence enhancement by vaccination in Haryana population found in the third survey.

The seroprevalence in children, men and women, rural and urban population recorded in the third survey of Haryana has been shown in Fig. 4. Urban areas had a slightly higher seroprevalence of 78.1% as compared to the 75.1% registered in rural areas. The seropositivity rate was 75.3% among men whereas it was marginally higher at 77.1% among women. The adolescents of 6-9 years had seropositivity rate of 69.8% and 73.2% seroprevalence was found among the age group 10-17 years.

The seroprevalence in the vaccinated and unvaccinated population of Haryana and the effect of vaccination has been compared in Fig. 5. The vaccinated individuals had a seroprevalence of 81.6% while the unvaccinated population had lesser 75.5% individuals who developed antibodies. The vaccination had enhanced the antibodies in the 6.1% population. One-dose vaccinated population had 79.5% individuals who developed antibodies whereas in fully vaccinated (two-dose) 84% of the population had antibodies. One-dose and two-dose vaccination enhancement was 4% and 8.5%, respectively as shown in Fig. 5. The enhancement of antibodies in the population upon vaccination showed that antibodies formation was due to both virus infection and

vaccination. Spike protein antibodies test confirmed that the antibodies developed were due to the vaccination. On the vaccination front, 24.7 million recipients in the state of Haryana were vaccinated around the time when the third survey was undertaken in September 2021. The first dose was given to 17.4 million and more than 7.3 million had received both doses. This comes out to be 25% of all (adults and adolescents) the population of the state was fully vaccinated and 60% partially with one dose. Considering the eligible adult population, 35% received the two doses and 85% population partially vaccinated (Fig. 5). The absence of COVID-19 waves in Haryana for a very long time of 5 months (July-November 2021) [4] suggested that the overall seroprevalence of 76%, developed by infection and vaccination combined, was enough to protect the people from the new infection.

B. The Serosurvey in Odisha

The seroprevalence was found to be 20.8%, 68.1%, and 73% as recorded in August 2020, June, and August 2021, respectively in the three surveys conducted in Odisha. The bars in Fig. 6 show the percent seroprevalence in three surveys. The bars are located at the position on the time axis in months. Fig. 7 is the plot constructed from Fig. 6. The increase in seroprevalence with time was monotonous. An increase of seroprevalence in Haryana (Fig. 3) and Odisha (Fig. 7) showed a similar pattern of monotonous increase with time. The seroprevalence in both the states was nearly the same, Haryana had seroprevalence of 76.3%, recorded in September 2021, and in Odisha, it was 73%, recorded in August 2021. Fig. 8 compares the seroprevalence in general population and healthcare workers (HCWs) recorded in Odisha. The survey conducted in June 2021 recorded the seroprevalence of 68.1% in the general population and 85% in HCWs. In August, the seroprevalence rose to 73% in general population and 93% in HCWs. A maximum seroprevalence of 93% may develop in the general population too as was seen in HCWs by repeated exposure to the virus and conducting a strong vaccination drive.

The age-wise seroprevalence has been shown in Fig. 9. The children in the age group 6-10 had 70% seroprevalence whereas the 11-18 years age group registered 74% seroprevalence. The children similar to the adults were infected by fellow children, adults, and family members with whom they came in contact. The seroprevalence of 75% was reported in 19-44 years age group whereas it was 72% and 66% in 45-60 and 60-plus, respectively. There was no big difference in seroprevalence between rural and urban population of Odisha. It was 72.7% in rural and 73.7% in urban areas. No difference in the seroprevalence was found taking Covaxin or Covishield vaccines. The overall seropositivity of 73% in Odisha population showed that at some point in time 73% of the population had symptomatic or asymptomatic infections. Higher seroprevalence indicates the spread of the virus was rapid among the population whereas lower seroprevalence suggests that the spread of the infection was limited by taking pandemic control measures. If the vaccination was not done, then the virus could penetrate in the population more deeply and could cause more damage. On the vaccination front, in Odisha, 66.5% seropositive adults have received at least first dose, 25.5%

fully inoculated whereas 41% have received partial vaccination and 33% remained unimmunized. Other important findings were that among seropositive individuals, 13% had COVID-19 symptoms and 23% were positive for the COVID-19 test.

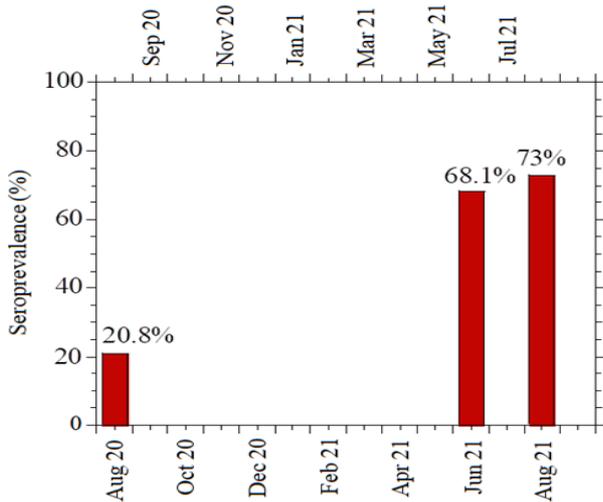


Fig. 6. Bars showing the increase in the seroprevalence with time (month) in Odisha population in different surveys.

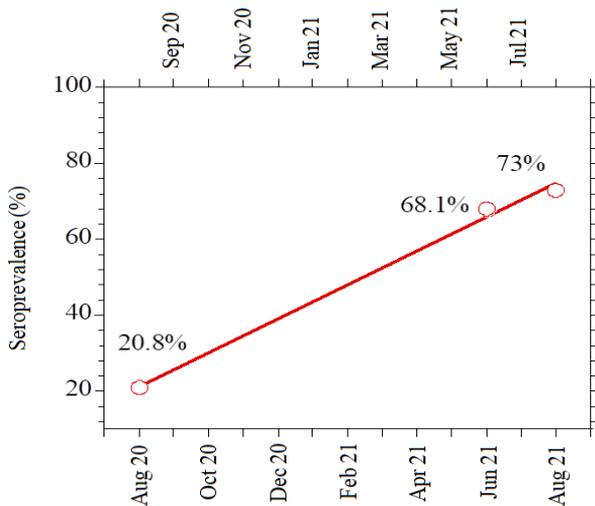


Fig. 7. Increase in the seroprevalence with time (month) in different surveys in Odisha.

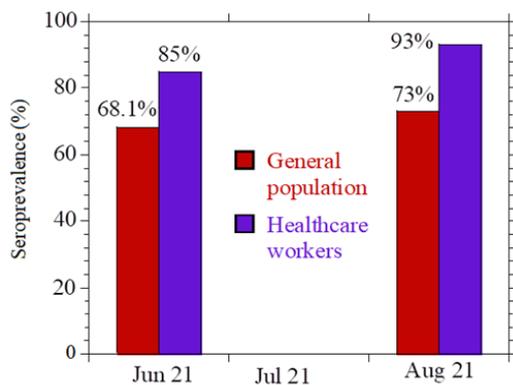


Fig. 8. Increase in seroprevalence from June to August 2021 in the general population of Odisha and their HCWs.

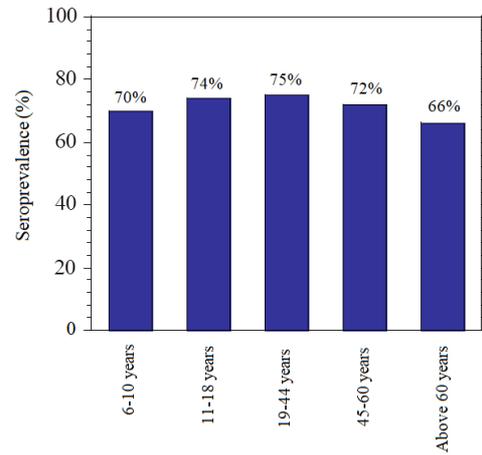


Fig. 9. Age-wise seroprevalence in Odisha population recorded in August 2021.

IV. CONCLUSIONS

The statewide COVID-19 serological survey conducted in Indian states of Haryana and Odisha indicated an almost monotonous increase in seroprevalence with time manifesting that the spread of the virus with time was continuous and uniform. The seroprevalence in both states was almost comparable. Haryana had a seroprevalence of 76.3% in September 2021 and in Odisha, it was 73%, as recorded in August 2021. The third survey carried out in Haryana and Odisha yielded many important observations. In Haryana, urban areas had slightly higher seroprevalence of 78.1% than the rural areas which showed seroprevalency of 75.1%. The seropositivity rate was 75.3% among men and it was marginally higher to 77.1% among women. The vaccinated individuals had seroprevalence of 81.6% while in unvaccinated population, 75.5% individuals developed antibodies pointing that the vaccination drive enhanced the antibodies production in 6.1% population. Single dose of vaccination resulted in the development of antibodies in 79.5% of individuals whereas in double dose vaccinated population 84% had antibodies. The antibodies enhancement upon one-dose and two-dose vaccination was 4% and 8.5%, respectively. The formation of antibodies by both infection and vaccination has validated the concept of hybrid immunity. The seroprevalence in rural and urban population was nearly the same, 72.7% for rural and 73.7% for urban areas. Covaxin and Covishield, the two main vaccines used in India, gave a similar result. In Odisha, the seropositivity was higher in HCWs (85%) than the general population (68.1%), recorded in June 2021 and again in August 2021 survey HCWs had higher seroprevalence (93%) as compared to the general public (73%). The observation of 93% seroprevalence in HCWs reiterated that in the general population a maximum seroprevalence of 93% and above was possible by infection or vaccination or both. As the HCWs developed more antibodies by robust vaccination and repeated exposure to the virus. The two COVID-19 pandemic waves (September 2020 and May 2021) that hit Odisha have generated antibodies in the population to a larger extent and partly the vaccination drive also had a share in seroprevalence. The higher seroprevalence, 73% in Odisha and 76.3% in Haryana might be the reason for the

absence of the third wave for a long time of 5 months (July-November 2021). Moreover, the future waves will not be so damaging again because of the higher seroprevalence in the population. The research presented in this article has shown that higher seroprevalence in the population generated by vaccination or infection can control the pandemic spread. The research is beneficial in encouraging the individuals to get vaccinated and framing the vaccination drive in India and all around the globe.

STATEMENTS

The data and results in this article are very reproducible. The Odisha serosurvey plots and bars were constructed from the data given in [24]-[27]. Author (Zameer Shervani, Ph.D.) is Director of Food & Energy Security Research & Product Center, Sendai, Japan. Co-authors contributed online. Authors have qualifications: Deepali Bhardwaj MBBS, MD, DVDL, M.Phil.; Intizam Khan MBBS; Umair Yaqub Qazi Ph.D.; Sadia Hasan, Ph.D.; Roma Nikhat MCA; Ankira Agarwal MBBS; Aiman Ibrahim MBBS; Adil Ahmed Khan MBBS; Kehkeshan Fatma Ph.D.; Yamin Siddiqui Ph.D.; Abdullah Sherwani B.Tech.; Samar Siddiqui MBBS, DGO; Shazma Khan MBBS, DTCD.

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