The Omicron Variant: Prevalence, Transmissibility, and Pathogenicity

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**ABSTRACT**

The Omicron variant that caused a huge surge in COVID-19 infections worldwide has been studied in terms of prevalence, infectivity, and virulence. The first study conducted in South Africa showed the low pathogenic nature of the Omicron variant compared to the Delta and original Wuhan variants. The deaths, ICU admissions, length of the hospital stay, and also the need of oxygen support all reduced greatly in Omicron infected patients as compared to the earlier variants. The share of the Omicron variant in Delhi (India) rose rapidly. In two weeks (December 21, 2021-January 3, 2022), the omicron prevalence increased from 38% to 81%. Because of the Omicron variant, in the last week of January 2022, Delhi’s caseload surged nine folds. The cases analysed in Delhi, Mumbai, and throughout India revealed that the number of deaths during the Omicron wave was much lower compared to the Delta and Wuhan variants.

**Keywords:** Delta variant, Omicron variant, Omicron prevalence and transmissibility, Omicron pathogenicity, SARS-CoV-2 mutation.

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I. INTRODUCTION

COVID-19, an infectious disease caused by the novel coronavirus SARS-CoV-2, has devastated the world. It originated from Wuhan (China) and very rapidly spread all over the globe to become the COVID-19 pandemic. The pandemic has resulted in the worst economic crises ever since the 1930s. A WHO and World Bank report revealed that more than half a billion people have been pushed into poverty due to the payment of huge medical expenses [1].

On the dynamics of the virus spread, after the second COVID-19 wave receded on December 14, 2021, India registered the lowest number (5,784) of COVID-19 cases in 571 days [2]. This was 21.3% lower than the cases recorded a day before on December 13. The overall novel coronavirus tally in India stands at 34,703,644 cumulative infections with 475,888 deaths. The active caseload was also at the lowest of 88,993 cases in 563 days. The above decrease in the cases is being seen cautiously as the latest Omicron variant like in many countries has also emerged in India. Till December 13, 2021, India registered 41 Omicron cases from Maharashtra (20), Rajasthan (9), Gujarat (4), Karnataka (3), Delhi (2), Kerala (1), Andhra Pradesh (1), and Chandigarh (1).

On December 14, 2021, the US surpassed 800,000 COVID-19 related deaths [3], [4]. In the year 2021 alone, around 450,000 Americans died despite the robust vaccination drive that was undertaken in the US starting from December 2020. More people might have lost lives if the vaccination drive was slow or had not started at all since the majority of the people who died were unvaccinated. As the data were analysed, the risk of dying from the disease was fourteen times higher in unvaccinated individuals compared to that of fully vaccinated ones. The US has fully vaccinated 60% of its 332 million population. The country is now facing the fifth wave of the pandemic in winter as people prefer to stay indoors making the virus spreading rapidly. Also, Omicron the recent variant of the coronavirus has caused a large surge of new infections worldwide since it was first identified in South Africa on November 25, 2021. Around December 14, 2021, Omicron consisted of about 3% of the US cases and is expected to increase as already happening in many countries.

Winning the fight against the pandemic has become difficult because of the emergence of new variants time and again. As per the WHO update, till August 3, 2021, the following variants appeared on the date and the countries they were identified [5]. Alpha (UK, September 2020), Beta (South Africa, May 2020), Gamma (Brazil, November 2020), and Delta (India, October 2020). The presence of Alpha, Beta, Gamma, and Delta strains was registered in 182, 132, 81, and 135 countries, respectively. These are not the last variants, more will appear in the future. The new strains may be more or less transmissible and neutral or more harmful. It is yet to be seen as time passes. The emergence of a more transmissible and infectious Delta variant before the Omicron, caused a surge in COVID-19 cases all around the globe from US and UK to Asia and Africa. In four weeks period around August 5, 2021, the Delta variant spread in about 65 countries as detected by genetic sequencing. It remained the most transmissible and infectious variant of the original Wuhan strain until the Omicron strain emerged in South Africa. The Delta variant was 50% more transmissible than the Alpha strain (detected in the UK). The Delta variant is more contagious and to some extent resistant to current vaccines and treatments. It causes more severe illness. In many countries, it has become a dominant strain. The Delta variant has also spread in countries that have vaccinated a large portion of their populations. The cases of Delta variant increased in Israel, although it has fully vaccinated 62% of its population. The effectiveness of Pfizer’s vaccine was marginally decreased to 88% against the Delta variant from 93.7% registered against the Alpha strain. The effectiveness of the AstraZeneca vaccine against the Delta was also reduced to 67% from 74.5%.

Even before the Delta wave was over, the countries around the world started battling with the new highly transmissible Omicron variant which spreads 70 times faster than other strains. The Omicron variant was first reported in South Africa in November 2021 and is now present almost all over the world. The variant Omicron not only spreads faster but also evades immunity generated from past infections and vaccines. A substantial reduction in the neutralizing antibodies generated by two shots of AstraZeneca-Oxford or Pfizer-BioNTech vaccines was noticed against the Omicron variant compared to the existing variants. Researchers suggested that the depletion of antibodies can be overcome by inoculating a third booster shot [6]. A laboratory study showed [7] that a booster dose of Pfizer-BioNTech vaccine after the initial two-dose raised antibodies protection 25-fold. The virus fighting ability of a booster shot against Omicron was the same as that of a two-shot regimen against the original Wuhan strain. Investigations are underway to confirm if a booster shot is enough or if a new vaccine formulation is needed to fight against the Omicron variant. The results will be out shortly. Moreover, the winters are approaching in the US, Europe, and many other countries, so a booster shot will give better protection against the Omicron strain. Because of the fear of the Omicron variant, the countries are planning new strategies. Japan’s government is considering shortening the interval between the second and third booster shots from 8 months to 6 months [8]. A third booster shot makes up for the loss of antibodies over time and thus is known to stop breakthrough infections, severe illnesses, and deaths. European nations have already started administering the booster shots. The people in other countries are also demanding an early rollout. The booster shots rollout will start in Japan with healthcare workers followed by the general population. Priority will be given to the aged and the individuals with comorbid conditions. Japan will also procure 120 million Pfizer Inc.’s vaccines in the year 2022 for booster shots. Omicron is more contagious but it does not cause more severe illness, hospitalisation, or death as was the case with the Delta variant.

Towards the vaccine development, Japanese researchers are working on a “dream” COVID-19 vaccine that will give lifetime protection against the virus [9]. This is a big milestone in the development of vaccines as the fight against the novel coronavirus entered its third year. The new vaccine with lifetime efficacy will be a game-changer in
eradicating the COVID-19 pandemic. Unlike the current vaccines which require periodic boosters to make up the immunity loss over time, the new vaccine will give strong lifelong protection against the virus. The vaccine is based on the concept of the smallpox vaccine which gave lifetime protection and helped in eradicating the deadly disease. Reference [10]-[21] have covered several topics of COVID-19 research: herd immunity [10], health index theory and the dynamics of the spread [11], [12], seropositivity investigations [13], [14], stability of the virus and sanitization method [15], SARS-CoV-2 in pets [16], application of supercomputer in treatment and prevention of the disease [17], vaccine development [18], detection and treatment [19], serosurvey and antibodies enhancement by vaccination [20], [21].

II. MATERIALS AND METHODS

For genome sequencing of Delhi’s samples, three labs were used: Lok Nayak, the Institute of Liver and Biliary Sciences, and the National Center for Disease control. In Mumbai, the BMC (Brihanmumbai Municipal Corporation) conducted the genome sequencing at Kasturba Hospital Laboratory and the National Institute of Virology, Pune.

III. RESULTS AND DISCUSSION

A. Omicron Study in South Africa

A study was conducted [22], [23] at the Steve Biko Academy Hospital (South Africa) by analysing the disease pattern of 466 patients from the current Omicron wave and 3,976 patients from the previous COVID-19 infections. Omicron infection originated in South Africa and spread with an unprecedented speed around the globe, though it caused a much milder illness and fewer deaths than Delta and original Wuhan strains. But if a low pathogenicity Omicron variant is repeated around the globe in large numbers then the net result will be a large number of cases and fatalities. Many believe that the less virulent nature of the Omicron variant is an indication of the COVID-19 pandemic entering into the less harmful endemic phase. Fig. 1 shows the various hospital outcomes and data recorded in the COVID-19 ward during the first global Omicron outbreak that occurred in South Africa. The data of the Omicron wave and previous waves (Delta and Wuhan variants) have also been compared. The Omicron data are from November 14, 2021 and data of other waves are since May 4, 2020. The deaths and ICU admissions were significantly low in the Omicron outbreak at 4.5% and 1%, as compared to 21.3% and 4.3%, respectively in previous variants. The length of hospital stay decreased to 4 days in the Omicron wave from longer 8.8 days in earlier waves. Only 45% of patients required oxygen support in Omicron compared to 99.5% in other waves. However, patients’ mean age reduced to 39 years in Omicron compared to 49 years in other infections. Apart from reduced pathogenicity of Omicron strain, vaccination also has a role in decreasing the severity of the disease.

![Fig. 1. The hospital outcomes of the Omicron variant studied in Steve Biko Academy Hospital complex (South Africa).](image)

The bars in Fig. 2 show the age distribution of vaccination carried out in South Africa [24], [25]. Since the rate of vaccination was slower among younger adults than the older ones, the mean age of patients in the COVID-19 ward in the Omicron wave reduced to 39 years from 49 years recorded in earlier waves. This proved that the vaccination is effective in preventing serious illness from the current highly transmissible Omicron variant. Although the overall rate of vaccination in South Africa is not large, only 26% (Fig. 2) of the full population has received both shots. The above data showed that the hospitalization rate will further decrease in South Africa and other countries if vaccination is ramped up aggressively.

B. Omicron in India

1) Omicron Prevalence in Delhi

The Omicron variant started spreading in the community in India as well. The virus was introduced by the foreign travelers who landed in the country. A Delhi government’s genome sequencing report [29] showed that out of 1,553 COVID-19 positive samples collected between December 1 and 31, 2021, 28% of the samples had Omicron variant, 34% Delta, and 38% others. In another genome sequencing report of the samples collected in Delhi city, it was noticed that the Omicron constituted 46% of the total COVID-19 infections as reported on December 30, 2021 [26]. Due to
the surge in Omicron cases, the overall caseload in Delhi increased rapidly. The daily cases were <100 after receding the fourth Delta wave. On December 29, 2021, the cases surged to 923 with a positivity rate of 1.29% because of the Omicron variant. The hospitalisation rate in Omicron cases is very less as compared to the Delta variant and the number of patients who needed oxygen support were only a few. In Lok Nayak Jai Prakash (LNJP) hospital (Delhi), a total of 70 Omicron patients were admitted till December 30, 2021, out of which 50 were discharged. Most of the cases were asymptomatic and only 4 patients (5.7%) had mild infections (fever, throat infection, weakness, and loose motion). It was reported on January 3, 2022, that 81% of coronavirus cases in Delhi were of Omicron variant while 8.5% had Delta strain. Out of 187 samples tested, 152 had (81%) Omicron and 8.5% had Delta strain [27]. The Omicron infection came to India around December 1, 2021, through infected foreign passengers. It spread faster and became the major variant while the share of other variants shrank. The transmissibility of Omicron is very high, and pathogenicity is low since no Omicron patient in Delhi hospitals required oxygen support in the beginning of the omicron wave. On January 3 in Delhi, 4,099 COVID-19 cases were recorded with positivity increased to 6.5%. The surge in the cases was due to the Omicron variant as the number of cases before Omicron was very low at below 100. The genome sequencing conducted of 468 samples in Delhi between December 21-28 showed that 38% of patients infected with the Omicron variant and 31% of samples had Delta mutation [28]. In genome sequencing reports [29] of COVID-19 samples in Delhi between January 1-3, it was found that the Omicron variant was 65% of the total samples. Out of 72 samples, 47 were infected with Omicron, while 20 had Delta and its sublineages.

Fig. 3 and 4 were constructed from the above SARS-CoV-2 genome sequencing conducted in Delhi. The first date of the sample collection period was considered to make the % prevalence of the Omicron variant versus the time plot. The prevalence of Omicron was less on the earlier date of the spread, 38% on December 21 which increased to 46% on December 30 (Fig. 3). On January 3, 81% of the samples had Omicron lineage of the coronavirus. Fig. 4 are the bars showing the change of Omicron and Delta variant share on the dates mentioned. The Omicron variant increased from 38% to 81% from December 21-28 to January 3, whereas the Delta strain decreased from 31% to 8.5% in the above period. On December 21, Delhi registered 102 new cases when the Omicron variant was 38%, the cases surged to 4,099 on January 3 with an increasing Omicron variant to 81%. However, the COVID-19 related fatalities did not show a surge in this period. The daily fatality on December 21 was one that remained the same [30], [31] even though the cases surged. This showed that the pathogenicity of the Omicron variant is not lethal compared to the Delta variant.

Fig. 5. Bars showing daily caseload recorded in Delhi between December 20, 2021–January 13, 2022 in third Omicron wave.
2) The Dynamics of Omicron Spread in Delhi

Fig. 5 is the bars showing the daily new novel coronavirus cases reported in Delhi. On December 21, 2021, 38% of the total cases in Delhi were of the Omicron variant. Due to the emergence of the Omicron strain, the cases in Delhi started surging from the baseline cases of <100 to higher numbers. On December 22, new cases increased to 125. The surge in Fig. 5 was apparent when the number of the new cases went up to 180 as reported on December 24. The caseload increased with time, on January 13; 28,867 new cases were reported. The surge was due to a highly transmissible Omicron variant. By January 3, the Omicron variant had spread already to a greater extent to make 81% of the total COVID-19 cases in Delhi (Fig. 3 and 4).

3) Omicron Prevalence in Mumbai and the Dynamics of the Spread

The daily caseload of Mumbai in the Omicron wave has been shown in Fig. 6. The daily new caseload on December 20 was 191. This number was the baseline caseload registered after the second pandemic wave (hit in April 2021) receded. In Mumbai, the cases started increasing earlier compared to Delhi. The surge in the cases was apparent from December 20 onward. Omicron variant was just 2% of the total Mumbai samples on December 16 [32] whereas on December 9, the Omicron cases were below 1% of the total of Mumbai caseload [33]. Till December 16, community transmission of Omicron variant did not occur in Mumbai as was noticed from the genome sequencing report. Delta variant and its derivatives were still the dominant strains. The COVID-19 samples collected between December 21 and 22 in Mumbai showed that 37.6% of the samples were of the Omicron variant [34]. By December 31, 55% of Mumbai’s total cases had Omicron variant whereas the remaining 32% and 13% of the samples were of Delta derivatives and Delta lineage, respectively [35]. The cases increased slowly from December 20 but the surge was prominent from December 28 due to the community spread of the Omicron variant. The increase in the cases continued until January 7, 2022. From January 8 to January 11, cases decreased but increased again on January 12, then decreased on January 13. The maximum caseload of 20,971 cases registered on January 7 had a match of the date on which the Omicron spread was at the threshold as the samples collected in the period January 7-10 for the genome sequencing in the city Nagpur which is located in the same state of Maharashtra as is Mumbai had 100% Omicron dominance out of the total samples analyzed [36]. In another genome sequencing result of the samples collected between January 1 and January 6, the Omicron was 96% [37] of the total caseload in Nagpur. Therefore the cases in Mumbai peaked only on January 7 and not before.

The bars in Fig. 7 show the increase of daily novel coronavirus caseload with time recorded in India. Before December 27, the daily caseload of <8,000 cases were reported. These were the baseline cases after receding the second wave that hit in May 2021. The Omicron variant surge was apparent after December 28. Overall India, the surge came late compared to Mumbai and Delhi. The increase in daily caseload was monotonous except on January 10, when there was a slight dip in the new cases.

Fig. 8 is the test positivity rate (TPR) plots of the COVID-
19 virus spread in Delhi, Mumbai, and India for the period December 20, 2021, to January 14, 2022. In Delhi, the baseline TPR was 0.2. The TPR started increasing on December 24 which was also reflected in the caseload plot when cases increased (Fig. 5). The TPR in Delhi showed a continuous increase up to a value of 30.6 registered on January 14. The TPR plot of Mumbai showed a continuous increase from December 25 till January 6 and after that TPR decreased. The TPRs on December 25 and January 6 were 1.32 and 27.7, respectively. The overall plot of TPR in India showed almost a continuous increase from December 20 till January 14. The TPR values on December 20 and January 14 were 0.5 and 16.6, respectively. The TPR showed a dip on January 3 and January 10. The decrease in TPR on January 3 and 10 was also reflected in the daily caseload plot of India (Fig. 7).

Fig. 9 is the bar graph showing the daily deaths that occurred in India in the surge of the Omicron wave. The number of deaths varied in the range 122-534, the lowest 122 on January 3 and the highest 535 registered on January 4. Daily new infections surged from 5,326 (December 20) to 264,207 (January 13) (Fig. 7) but the number of deaths did not show any remarkable change. This suggested the less pathogenic or lethal nature of the Omicron variant compared to the Delta and Wuhan variant where the number of deaths was proportional to the caseload [31]. The daily COVID-19 related deaths that occurred in Delhi have been shown in Fig. 10. The number of fatalities in the period of December 20 to January 3 remained below one whereas the caseload increased several folds from 91 to 4,099 (Fig. 5). After January 4, the number of deaths increased to a maximum of 40 causalties (on January 12). Though the increase in fatalities is not as huge as that occurred in the fourth Delta variant wave which hit Delhi in April 2021 [31].

The daily deaths registered in Mumbai in Omicron wave have been shown by bars in Fig. 11. The number of fatalities remained below 3 from December 20 until January 5 whereas the caseload surged several folds from 191 (December 20) to 15,014 (January 5) cases. The number of deaths is much lower in the Omicron wave than in the Delta variant in April, 2021 [38]. Fig. 12 compares the hospitalisation rate in Delhi and Mumbai for COVID-19 patients in the Omicron wave. In Delhi, the hospitalisation rate increased slowly from December 25, 2021, onward except on December 30 and 31 when there was a slight decrease in the number of hospitalisation. The increase in the number of hospitalisation was steeper from January 3 onward. The rate of hospitalisation followed the caseload continuous increase with time (Fig. 5). The hospitalisation rate in Mumbai is low compared to that of Delhi because the caseload of the latter was more. The hospitalizations in Mumbai peaked on January 7, the date when the caseload was the highest (Fig 6). It started decreasing from January 8 onward as the caseload decreased when the Omicron wave started receding in Mumbai.

IV. CONCLUSIONS

In the present study, the various hospital outcomes and data recorded in the COVID-19 ward during the first global Omicron outbreak that took place in South Africa and later in India were studied. The data of the Omicron wave and previous waves (Delta and Wuhan variants) were also compared. The deaths and ICU admissions were reduced in the Omicron outbreak to 4.5% from 21.3% and 1% from
4.3%, respectively as compared to the previous COVID-19 infections. The length of hospital stay also curtailed to 4 days in the Omicron wave from 8.8 days as reported in previous waves. Only 45% of patients required oxygen support in the Omicron wave as compared to 99.5% in other waves. However, the mean patient age came down to 39 years in the Omicron wave as compared to 49 years as per recorded data of earlier waves. This may be attributed to the fact that the rate of vaccination was slower among younger adults than older ones resulting in a reduction in the mean age of the patients. Proving that the vaccination is one of the factors which has contributed in decreasing the severity of the disease and is also effective in preventing serious illness from the highly transmissible Omicron variant. The Omicron wave data acquired for India revealed that the number of deaths varied in the range 122-534, the lowest 122 on January 3 and the highest 535 as registered on January 4. Daily new infections surged from 5,326 (December 20) to 264,207 (January 13) but the number of deaths did not show any remarkable change, demonstrating the less pathogenic or lethal nature of the Omicron variant as compared to the Delta and Wuhan variants where the number of deaths was proportional to the caseload. The number of the fatalities in the period December 20 to January 3 in Delhi remained below one whereas the caseload increased several fold from 91 to 4,099. After January 4, the number of deaths increased to a maximum of 40 causalities (on January 12). However, the increase in fatalities was not as huge as happened in the fourth Delta variant wave which hit Delhi in April 2021. In Mumbai, the number of fatalities remained below 3 from December 20 until January 5 whereas the caseload surged several folds from 191 (December 20) to 15,014 (January 5) cases pointing out that the number of deaths is much lower in Omicron wave than the Delta variant wave which knocked Mumbai in April 2021. This again advocated that the pathogenicity of the Omicron variant is not lethal compared to the Delta variant. Nonetheless, the hospitalization rate in Mumbai was low compared to Delhi owing to the more manageable endemic form.

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