Barishal Univ. J. Bio-Sci. **3**(1): 37-45, 2024 (June) ISSN 2411-247X

THE IMPACT OF VACCINATION ON THE PANDEMIC TRAJECTORY OF COVID-19 IN BANGLADESH

REHANA PARVIN[1*], SHOAIB SAIKAT[1], MD. ALAUDDIN[2] AND FAHMIDA SULTANA RIMA[1]

[1]*Department of Biochemistry and Biotechnology, University of Barishal, Barishal-8254, Bangladesh.*
[2]*Department of Biochemistry and Molecular Biology, Jashore University of Science and Technology, Jashore-7408, Bangladesh.*

Abstract

The COVID-19 pandemic has affected millions of people globally, and countries around the world have been working tirelessly to curb the spread of the virus. One of the key strategies in this effort has been the development and deployment of COVID-19 vaccines. However, the effectiveness of these vaccines in reducing COVID-19 infections in the country has not been well documented. To address this issue, a study was conducted to assess the effectiveness of COVID-19 vaccines in reducing COVID-19 infections in Bangladesh. The analysis focused on the number of confirmed COVID-19 cases before and after the introduction of the vaccines. The results of the study indicate that the COVID-19 vaccines have been effective in reducing the number of infections in Bangladesh. The analysis shows a significant decline in the number of confirmed COVID-19 cases after the introduction of the vaccines. However, the study also highlights the need for continued monitoring and surveillance to ensure that the vaccines remain effective against emerging variants of the virus. In conclusion, the results of this study offer significant new information about the efficacy of COVID-19 vaccines in Bangladesh. The results suggest that the vaccines have been effective in reducing the number of COVID-19 infections in the country. The findings of this study have important implications for public health policy in Bangladesh.

Key words: Vaccination, COVID-19, Infection-rate, Public-health, Bangladesh

Introduction

The advent of Coronavirus disease 2019 (COVID-19) took place in December 2019, in the Hubei Province of China (Zhou *et al.* 2020). A group of patients having cough, breath shortness, fever, and other manifestations were hospitalized (WHO 2020). Utilizing computed tomography (CT), those patients have been scanned which uncovered varied opacities (confluent, more profuse, and denser) relative to images of properly functioning lungs (Ai *et al.* 2020). This finding evoked the initial pneumonia diagnosis. Further analysis of nucleic acid utilizing multiplex real-time polymerase chain reaction (RT-PCR) of familiar pathogen panels resulted in negative outcomes, suggesting that the cause for pneumonia was of unclear origin (Van Doremalen *et al.* 2020). Patients' bronchoalveolar lavage (BAL) fluid specimens were investigated to uncover a pathogen with a close genetic sequence to the beta coronavirus B lineage by January 10, 2020. This novel pathogen was observed to have ~80%, ~50%, and ~96% similarity to the severe acute respiratory syndrome virus (SARS-CoV), Middle East respiratory syndrome virus (MERS-CoV), and bat coronavirus RaTG13 genome, respectively (Ai *et al.* 2020, Lu *et al.* 2020, WHO 2020, Zhou *et al.* 2020). The 2019 novel coronavirus (nCoV-19) was named SARS-CoV-2 (severe acute respiratory syndrome virus 2), which is the pathogen that causes COVID-19 (coronavirus disease 2019). This disease has spread to at least two hundred and nineteen countries (Hasell *et al.* 2020).

[*]Corresponding author E-mail: <rehanadu@yahoo.com>.

The SARS CoV-2 pandemic that causes COVID-19 has had a catastrophic effect on public health, having more than 526.87 million confirmed cases and 6.31 million deaths across more than two hundred countries as of May 2022 (Hasell *et al.* 2020) and found to have higher fatality rate predominantly in aged men revealing a gender specific pattern (Hossain *et al.* 2024, Rima *et al.* 2022). In spite of different regional and national non-pharmaceutical interventions for instance as measures of social distancing, restrictions of travel, orders of staying at home, as well as lockdowns, many countries resume struggling with the COVID-19 case growth (Hsiang *et al.* 2020, Pinto Neto *et al.* 2021, The 2020). In Bangladesh, several COVID-19 vaccines have been approved for use, including the Oxford/AstraZeneca vaccine, the Pfizer-BioNTech vaccine, and the Sinopharm vaccine. It is apparent that an effective vaccination program for COVID-19 is required to terminate the pandemic and help a restoration to normal life (Kissler *et al.* 2020, Van Riel and de Wit 2020). By the end of February 2021, two vaccines of COVID-19 had been authorized in the U.S. are mRNA-1273 (Moderna) and BNT162b2 (Pfizer/ BioNTech) (Creech, Walker and Samuels 2021). In two large randomized controlled trials (RCTs), the Moderna vaccine showed an efficacy of 94.1% (95% confidence interval [CI], 89.3% to 96.8%) and the Pfizer vaccine showed an efficacy of 95% (95% CI, 90.3%–97.6%) in halting COVID-19 (Baden *et al.* 2021, Polack *et al.* 2020). Both of them are mRNA vaccines that necessitate three doses for vaccination completion (CDC 2022). Though the effectiveness of these two vaccines was demonstrated to be substantial in RCTs, there is not much information on their probable impact on population-level on the COVID-19 pandemic. An investigation that approximated vaccine effectiveness utilized data from nationwide mass vaccination in Israel outlined the efficacies of the Pfizer vaccine to be 46% (95% CI, 40 - 51%) after the first dose and 92% (95% CI, 88 - 95%) after the second dose for the infections that were recorded (Dagan et al., 2021). An approximation of 63% (95% CI, 33 - 79%) following the first dose of vaccination was reported by another study that assessed the effectiveness of the Pfizer vaccine among American residents in skilled nursing facilities (Britton *et al.* 2021).

Though administration of the vaccine has been going on in Bangladesh for approximately two years, the effect of vaccination is not yet to be evaluated. There have been no studies regarding the impact of vaccination in Bangladesh. The correlation between the increasing vaccinated population and the newly infected population is essential to be found for understanding the effectiveness of the vaccine at the population level and the formation of herd immunity among the general inhabitants of Bangladesh.

Study design: The study collected division-level daily infection and vaccination data of Bangladesh (DGHS 2020), and globally (Mathieu *et al.* 2021) from March 08, 2020, to May 31, 2022. All figures show a timeline of the development of COVID-19 during this period and the timeline of vaccination. The variable utilized to evaluate the impact of vaccination on the pandemic is reduction of total infections. Other variables included the total number of first doses of vaccine administered, the total number of second doses of vaccine administered, and the total number of third doses of vaccine administered. Figures exhibit the negative correlation between the cumulative vaccination coverage and the growth rates of new infections. The first cases of COVID-19 infection of SARS-CoV-2 among Bangladeshi citizens were reported by the Institute of Epidemiology Disease Control and Research (IEDCR) on May 8, 2021 (Moona *et al.* 2021).

Results and Discussion

The study collected daily infection data and vaccination data globally and Bangladesh from March 08, 2020 to May 31, 2022. It was analyzed that these data has been affected by different factors. The population fraction infected over time is represented by the blue curve on the left y-axis (Figs. 1-10). It displays the amount of afflicted people every two months. The population's cumulative vaccination coverage with the first doses, second doses and third doses of vaccine is represented by the orange curve, the green curve and the yellow curve respectively on the right y-axis.

Based on daily data, it was observed that the national average growth rate of COVID-19 cases was increasing from April 03 to June 02, 2020 (Fig. 2). Then the infection rate started to decrease and somewhat remain steady till mid of November 2020 and again continued to rise for a short time. After that, a gradual decrease in the infection rate was seen till the third week of February 2021. According to the divisional data, the highest growth rate was in Dhaka (Fig. 3), while the lowest growth rate was recorded in Mymensingh (Fig. 7) and Sylhet (Fig. 10). The number of confirmed cases per day is defined as rate growth. The first dose of vaccine administration began on January 27, 2021, and continued (AlJazeera 2021, Baden *et al.* 2021). As a result, the accumulated number of vaccinated populations increased with time, and a gradual and notable decrease in infection rate was seen from the first week of August 2021 to the end of December 2021.

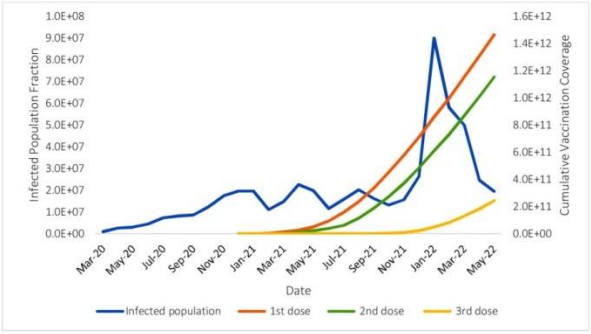

Fig. 1. Global COVID-19 events and vaccination schedule from March 2020 to May 2022 (Mathieu *et al.* 2021).

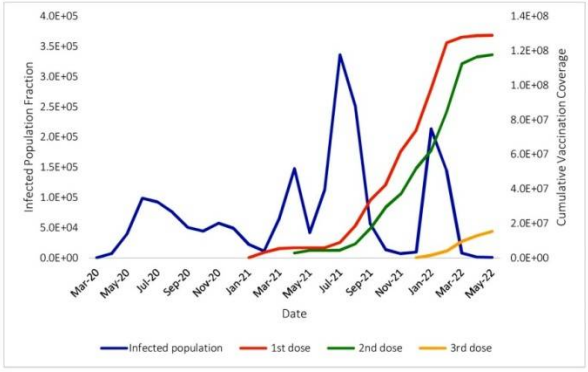

Fig. 2. The COVID-19 vaccination schedule and events in Bangladesh spanning from March 2020 to May 2022 (DGHS 2020).

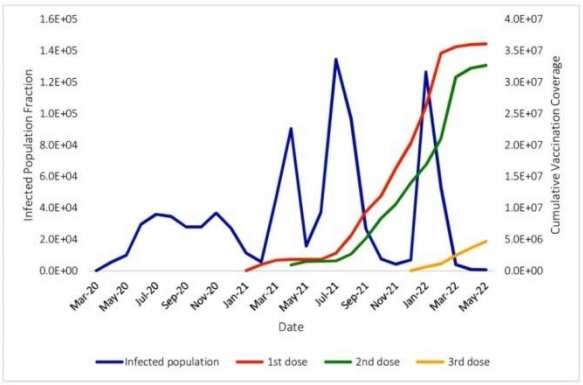

Fig. 3. Events related to COVID-19 and the vaccination schedule in Dhaka division from March 2020 to May 2022 (DGHS 2020).

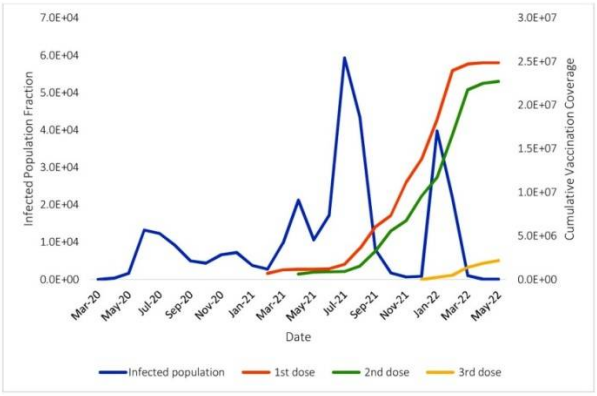

Fig. 4. Events related to COVID-19 and the vaccination schedule in Chittagong division from March 2020 to May 2022 (DGHS 2020).

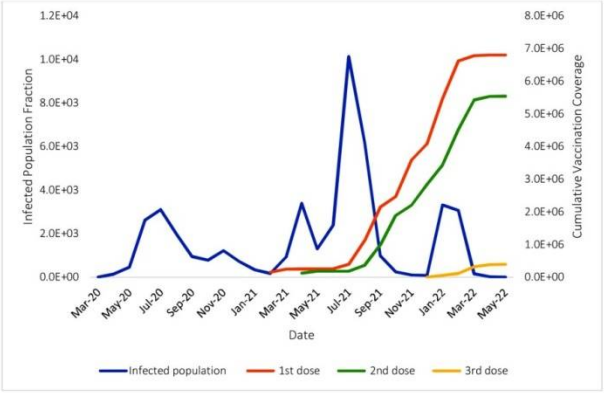

Fig. 5. Events related to COVID-19 and the vaccination schedule in Barishal division from March 2020 to May 2022 (DGHS 2020).

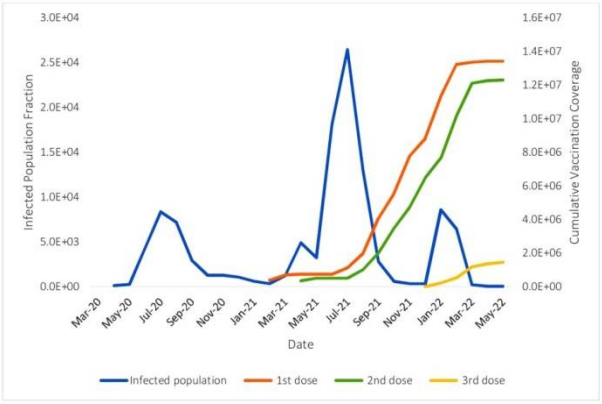

Fig. 6. Events related to COVID-19 and the vaccination schedule in Khulna division from March 2020 to May 2022 (DGHS 2020).

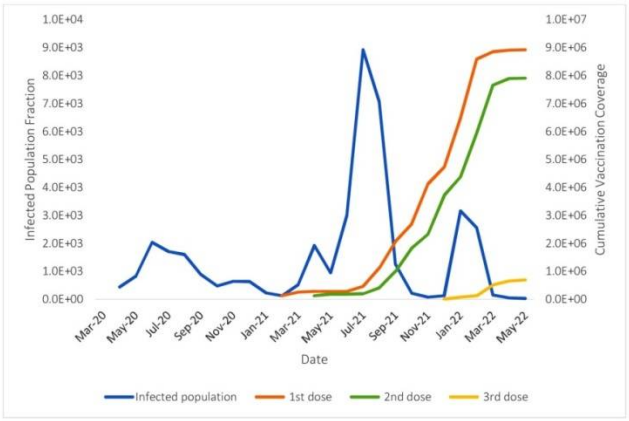

Fig. 7. Events related to COVID-19 and the vaccination schedule in Mymensingh division from March 2020 to May 2022 (DGHS 2020).

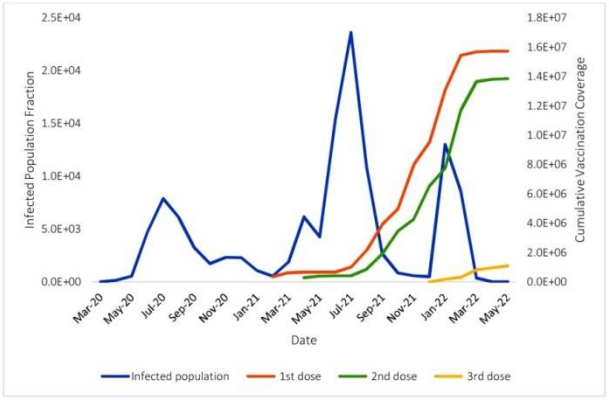

Fig. 8. Events related to COVID-19 and the vaccination schedule in Rajshahi division from March 2020 to May 2022 (DGHS 2020).

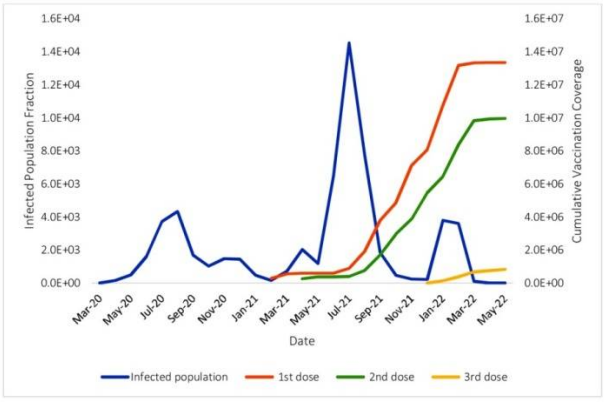

Fig. 9. Timeline of COVID-19 incidents and vaccinations in Rangpur division, March 2020–May 2022 (DGHS 2020).

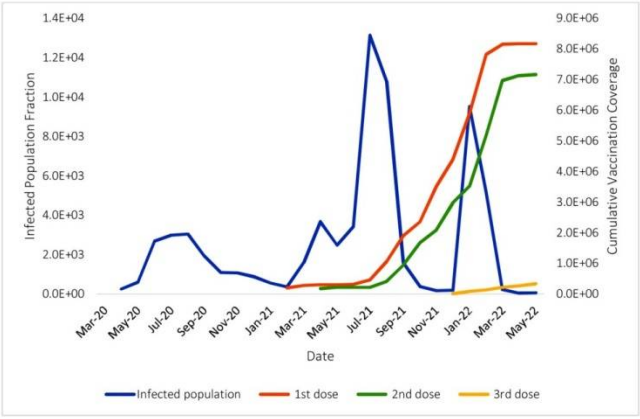

Fig. 10. Events related to COVID-19 and the schedule for vaccinations in Sylhet division from March 2020 to May 2022 (DGHS 2020).

On July 06, 2021, the second dose of vaccine was administered (Kamruzzaman 2021). A rise in the infection rate was observed from the first week of January 2022 to the end of January 2022. By this time, the amount of both administered first and second doses of vaccine have reached a substantial number. A significant and gradual decrease in infection rate has been observed (Fig. 2). Impact of vaccination has been remarkably reduced the growth of total COVID-19 cases in Bangladesh. This pattern was noticed in both urban and rural settings, and across a range of age groups. As the study analyzes the data it was noticed that the retention time of the increasing COVID-19 case rate gets shorter with vaccination. After the first dose of vaccination, the retention time of increasing COVID-19 cases was less than when no vaccination was administered. But after the second dose of vaccination, the retention time of the increasing COVID-19 case rate was even less than previously obtained. This reflects the effect of vaccination in lowering the retention time of increasing COVID-19 cases. The third dose of vaccine administration was initiated on December 28, 2021, and continued (Michot *et al.* 2020). The number of individuals that received the third doses of vaccine is not much compared to the first and second doses. Therefore, its effect in impacting the COVID-19 growth rate is not discussed. The effects of vaccination having two

doses appear higher, with a decrease in the total cases growth rate. Vaccination further decreased the number of new cases. Our results focus on the correlation between the average growth rate of new COVID-19 cases and the impact of vaccination on this. This effect may be diverse in character across divisions that have varied traits. Some evidence demonstrates that the COVID-19 prevalence varies across different age groups, where older adults bear the highest risk *(Davies et al.* 2020; Mueller *et al.* 2020).

A common trend is viewed that a faster vaccination pace enable Bangladesh to reach herd immunity. This outcome can be explained as more people obtaining immunity from vaccines than from infections by the virus if the vaccination pace raises. Our predictions of obtaining herd immunity quickly assume a continuation of vaccine uptake. Nonetheless, a few potential factors could affect this uptake. A distinct proportion of the population might not take the vaccine because of vaccine hesitancy. Moreover, some people are disinclined to get vaccines because of the perceived risks versus benefits, a lack of faith in government, and specific religious beliefs (Kestenbaum and Feemster 2015). Another issue with obtaining herd immunity is the vaccine effectiveness, against new variants of coronavirus (Mahase, 2021). The effectiveness of the vaccine is lower against the Omicron variant in comparison with the Delta variant (Andrews *et al.* 2022, Lopez Bernal *et al.* 2021, Nasreen *et al.* 2022). A greater portion of vaccine-dubious people caused lower vaccination coverage leading to more infected people with COVID-19 at herd immunity. Generally, higher vaccine hesitancy leading to lower vaccine effectiveness delay herd immunity.

Previous studies demonstrated how the protection provided by vaccines against COVID-19 reduces with time (Cohn *et al.* 2021). The impact of vaccination against Delta variant was significant in 2021 (Chemaitelly *et al.* 2021). In contrast, other investigations have exhibited that the vaccines have lower effectiveness against the Delta variant (Lopez Bernal *et al.* 2021, Nasreen *et al.* 2022). Moreover, researchers' approximation of the Delta variant infectiousness is to be 40-60% greater than former variants, having longer median duration (18 vs 13 days) as well as lower recovery rate (calculated as 1/duration) (SPIMO, 2021). Since individuals may also obtain immunity through rapid infection, the effect of a higher infection rate is unclear. Other limitations include discontinuation of the non-pharmaceutical intervention and changes in attitudes of people towards the pandemic situation.

Conclusion

Our investigation provides the evidence that vaccination has effectively reduced COVID-19 cases in Bangladesh. According to the vaccination trends between September 2021 and onwards, it is predicted that the herd immunity can be obtained earlier by vaccination with rapid pace and lower hesitancy. It is also important to note that vaccine hesitancy remains a challenge in Bangladesh, and efforts are needed to improve vaccine uptake and public awareness. Nevertheless, some factors including moral hazard as well as the SARS-CoV-2 virus variants may lead to alterations along with uncertainty concerning if herd immunity can be obtained ultimately.

References

Ai T, Yang Z, Hou H, Zhan C, Chen C, Lv W and Xia L, 2020. Correlation of Chest CT and RT-PCR Testing for Coronavirus Disease 2019 (COVID-19) in China: A Report of 1014 Cases. Radiology **296**(2): e32-e40.

AlJazeera, 2021. Bangladesh starts COVID vaccination drive use. Al Jazeera.

Andrews N, Stowe J, Kirsebom F, Toffa S, Rickeard T, Gallagher E and Lopez Bernal J. 2022. Covid-19 Vaccine Effectiveness against the Omicron (B.1.1.529) Variant.

Baden LR, El Sahly HM, Essink B, Kotloff K, Frey S, Novak R and Zaks T. 2021. Efficacy and Safety of the mRNA-1273 SARS-CoV-2 Vaccine. N Engl. J. Med. **384**(5): 403-416.

Britton A, Jacobs Slifka KM, Edens C, Nanduri SA, Bart SM, Shang N and Parikh S. 2021. Effectiveness of the Pfizer-BioNTech COVID-19 Vaccine Among Residents of Two Skilled Nursing Facilities Experiencing COVID-19 Outbreaks-Connecticut, December 2020-February 2021. MMWR Morb Mortal Wkly Rep, **70**(11): 396-401.

CDC. 2022. COVID-19.

Chemaitelly H, Tang P, Hasan MR, AlMukdad S, Yassine HM, Benslimane FM and Abu-Raddad LJ. 2021. Waning of BNT162b2 Vaccine Protection against SARS-CoV-2 Infection in Qatar. New England J. of Medicine, **385**(24): e83.

Cohn BA, Cirillo PM, Murphy CC, Krigbaum NY and Wallace AW. 2021. SARS-CoV-2 vaccine protection and deaths among US veterans during 2021. Sci.**375**(6578): 331-336.

Creech CB, Walker SC and Samuels RJ. 2021. SARS-CoV-2 Vaccines. Jama **325(**13): 1318-1320.

Dagan N, Barda N, Kepten E, Miron O, Perchik S, Katz MA and Balicer RD. 2021. BNT162b2 mRNA Covid-19 Vaccine in a Nationwide Mass Vaccination Setting. N Engl J Med, **384**(15): 1412-1423.

Davies NG, Klepac P, Liu Y, Prem K, Jit M and Eggo RM. 2020. Age-dependent effects in the transmission and control of COVID-19 epidemics. Nat Med. **26**(8): 1205-1211.

DGHS. 2020. Directorate General of Health Services. Bangladesh COVID-19 info.

Hasell J, Mathieu E, Beltekian D, Macdonald B, Giattino C, Ortiz-Ospina E and Ritchie H. 2020. A cross-country database of COVID-19 testing. Scientific Data **7**(1), 345.

Hossain M, Mannan R, Islam S, Banu LA, Jamee AR, Hassan Z and Azad Khan AK. 2024. Unveiling the occurrence of COVID-19 in a diverse Bangladeshi population during the pandemic. 12.

Hsiang S, Allen D, Annan-Phan S, Bell K, Bolliger I, Chong T and Wu T. 2020. The effect of large-scale anti-contagion policies on the COVID-19 pandemic. Nature **584**(7820): 262-267.

Kamruzzaman M. 2021. Bangladesh begins mass vaccination for 2nd COVID dose.

Kestenbaum LA and Feemster KA. 2015. Identifying and addressing vaccine hesitancy. Pediatr Ann, **44**(4): e71-75.

Kissler SM, Tedijanto C, Goldstein E, Grad YH and Lipsitch M. 2020. Projecting the transmission dynamics of SARS-CoV-2 through the postpandemic period. Sci. **368**(6493): 860-868.

Lopez Bernal J, Andrews N, Gower C, Gallagher E, Simmons R, Thelwall S and Ramsay M. 2021. Effectiveness of Covid-19 Vaccines against the B.1.617.2 (Delta) Variant. N Engl J. Med, **385**(7): 585-594.

Lu R, Zhao X, Li J, Niu P, Yang B, Wu H and Tan W. 2020. Genomic characterisation and epidemiology of 2019 novel coronavirus: implications for virus origins and receptor binding. The Lancet, **395**.

Mahase E. 2021. Covid-19: Where are we on vaccines and variants? BMJ. 2021 Mar 2:**372**:n597.

Mathieu E, Ritchie H, Ortiz-Ospina E, Roser M, Hasell J, Appel C and Rodés-Guirao L. 2021. A global database of COVID-19 vaccinations. Nature Human Behaviour, **5**(7): 947-953.

Michot JM, Albiges L, Chaput N, Saada V, Pommeret F, Griscelli F and Stoclin A. 2020. Tocilizumab, an anti-IL-6 receptor antibody, to treat COVID-19-related respiratory failure: a case report. Annals of Oncology, **31**(7): 961-964.

Moona AA, Daria S, Asaduzzaman M and Islam MR. 2021. Bangladesh reported delta variant of coronavirus among its citizen: Actionable items to tackle the potential massive third wave. Infect Prev Pract, **3**(3): 100159.

Mueller AL, McNamara MS and Sinclair DA. 2020. Why does COVID-19 disproportionately affect older people? Aging (Albany NY), **12**(10), 9959-9981.

Nasreen S, Chung H, He S, Brown KA, Gubbay JB and Buchan SA. Canadian Immunization Research Network Provincial Collaborative Network, I. 2022. Effectiveness of COVID-19 vaccines against symptomatic SARS-CoV-2 infection and severe outcomes with variants of concern in Ontario. Nature Microbiology, **7**(3), 379-385.

Pinto Neto O, Kennedy DM, Reis JC, Wang Y, Brizzi ACB, Zambrano GJ and Zângaro RA. 2021. Mathematical model of COVID-19 intervention scenarios for São Paulo-Brazil. Nat Commun, **12**(1), 418.

Polack FP, Thomas SJ, Kitchin N, Absalon J, Gurtman A, Lockhart S and Gruber WC. 2020. Safety and Efficacy of the BNT162b2 mRNA Covid-19 Vaccine. N Engl. J. Med.**383**(27), 2603-2615.

Rima FS, Parvin R and Sugawara A. 2022. Gender and Immunosenescence Dependent Progression of Covid-19 Disease in Bangladeshi Population. Annals Of Diabetes, Metabolic Disorders & Control, **3**(1), 127.

SPIMO. 2021. Consensus statement on COVID-19. The Scientific Pandemic Influenza Group on Modelling, Operational sub-group (SPI-M-O).

The L. 2020. India under COVID-19 lockdown. The Lancet. **395**(10233): 1315.

Van Doremalen N, Bushmaker T, Morris DH, Holbrook MG, Gamble A, Williamson BN and Munster VJ. 2020. Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1. N Engl. J. Med. **382**(16), 1564-1567.

Van Riel D and de Wit E. 2020. Next-generation vaccine platforms for COVID-19. Nat Mater, **19**(8), 810-812.

WHO. 2020. Report of the WHO-China Joint Mission on Coronavirus Disease 2019 (COVID-19); WHO: Geneva, Switzerland

Zhou P, Yang XL, Wang XG, Hu B, Zhang L, Zhang W and Shi ZL. 2020. A pneumonia outbreak associated with a new coronavirus of probable bat origin. Nature **588**(7836): E6.