

The Role of Global Vaccine Distribution in Preventing Variants

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Abstract:

The upsurge of cases brought about by the COVID-19 pandemic (caused by SARS-CoV-2) proved the necessity for equitable access to vaccines on the global level in order to prevent a pandemic and limit the spread of variants. High-income nations vaccinated populations rapidly, whereas low- and middle-income countries experienced holdups because of a lack of opportunities, supply chain interruptions, and problems with logistics. The ensuing gaps prolonged the end of worldwide accidents in health and allowed the creation of variants that threatened vaccines' efficiency. This study explores the effects of global vaccine equity in stopping viral mutations and reversing the spread of ever more infectious or resistant strains. Using the figures for the distribution of vaccines, data on variant monitoring, and real-world experience, this research proposes a framework for describing the relationship between coverage of immunities and the emergence of variant strains. The paper further underscores the need for global cooperation, robust health infrastructure, and all-encompassing policies to demystify immunization plans. It is shown that fast global and inclusive vaccination measures, irrespective of socioeconomic aspects, are essential in reducing mutation probability and ensuring durable control over pandemics. This work calls for updated health policies and fair distribution strategies for vaccines with health as a global necessity.

Keywords: Global vaccine equity, COVID-19 variants, SARS-CoV-2, vaccine distribution, viral mutation, global health.

1. Introduction

1.1. Importance of Vaccine Distribution

Public health responses are vital, especially when dealing with widespread infectious diseases like COVID-19. Prompt and fair distribution of vaccines is critical for arresting the ongoing pandemic and reducing the chance of new variants that carry more negative implications. By causing the immune system to react to specific pathogens, vaccines weaken diseases, lessen hospitalizations simultaneously, and decrease overall death rates. However, effective and fair distribution of vaccines to populations is the only way to harness their full benefits. That is, unless vaccines are very quickly and fairly given to all populations, vulnerable groups are still being put at risk, allowing the virus to continue, develop, and create a higher probability for Variants of Concern to emerge. Worldwide initiatives on the distribution of COVID-19 vaccines have been a long way from fair, as the richer states have managed to get hold of the majority of the available doses while poorer countries are suffering significant impediments to access to the vaccine. [1-4] Unequal distribution of vaccines has undermined global efforts towards COVID-19 and created conducive settings for variant development. Due to the lack of vaccines in many places, the emergence and spread of variants such as Delta and Omicron were more likely to occur in low-vaccination

settings. When vaccines are not distributed effectively, social and economic disparities increase since countries with vaccine shortages face protracted outbreaks, increased load on medical systems, and economic consequences. The poorest countries are hardest hit as the healthcare systems in these countries cannot accommodate a wave of infections. Alternatively, if effective, vaccine distribution will ensure that everyone from all backgrounds, whether rich or poor and in urban or semi-rural cities, can access and enjoy these vaccinations. Also, equitable methods of vaccine distribution may reduce the number of infected people, control virus spreading, and prevent the occurrence of new variant strains. Beyond what mass vaccination does directly to people's health, mass vaccination is essential in allowing the global community to get over the pandemic. It contributes to business recovery, the gradual rehabilitation of social routines and the preservation of public health infrastructures. Ultimately, making vaccines accessible is more important than individually working on health. It is related to all people around the world and has significantly contributed to securing the proper health of the general population for many years all over the world.

1.2. The Role of Global Vaccine Distribution in Preventing Variants

Equitable access to vaccines worldwide is a prime means to control the spread and reduce new variants of infectious diseases, in particular, COVID-19. [5,6] It is up to the vaccines to prevent the virus from having access to additional avenues of mutation since an increase in the spread of the virus offers it more pathways for mutation. Some such mutations can result in allowing the virus to take these mutations, which can produce variants which are more transmissible, dangerous, or resistant to immunity. This equal and expanded vaccine distribution greatly reduces the threat of new variants by reducing viral circulation and curtailing outbreaks in low-vaccination areas.

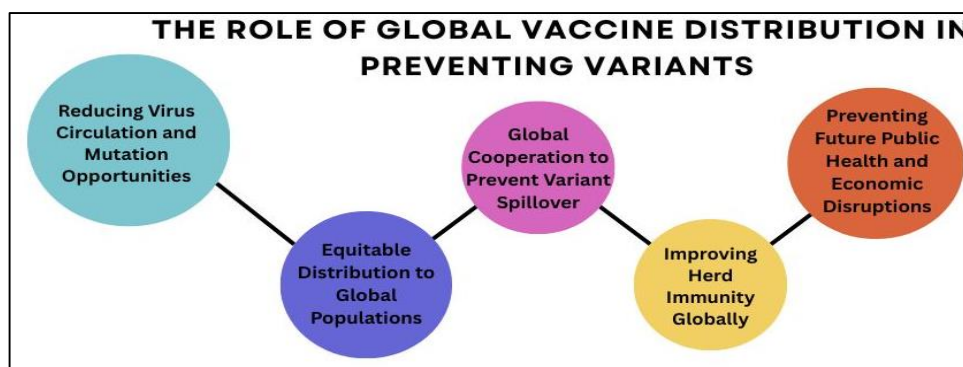


Figure 1: The Role of Global Vaccine Distribution in Preventing Variants

- **Reducing Virus Circulation and Mutation Opportunities:** Vaccinations mainly prevent the emergence of new variants by reducing the vast spread of the virus. COVID-19 immunization is a way of building immunity, which either stops infection or softens its symptoms. When fewer individuals are infected with COVID-19, the virus has less chance to replicate and mutate. High-speed viral spread, especially among unvaccinated individuals, raises the possibility of genetic mutations and the development of new variants presenting various traits. When we see that there are high levels of vaccination, we can help maintain the virus, which has a low probability of mutation and further development.

- **Equitable Distribution to Global Populations:** Worldwide vaccination campaigns can only succeed in halting new variants if this is done in a fair manner. In the initial phase of the COVID-19 pandemic, there was a high concentration of vaccine allocation to high-income countries, whereas low-income countries had poor availability. Thus, vaccines were a major challenge for low-income countries in Africa and Southeast Asia. This resulted in long-standing viral outbreaks that facilitated widespread viral mutation and initiated variant construction, including the Beta variant in South Africa and the Delta variant in India. Ensuring that every region and every country – irrespective of their resources, can access vaccines plays a major role in containing the spread of the virus worldwide, thereby reducing the risk of new variants developing in these overlooked regions.
- **Global Cooperation to Prevent Variant Spillover:** The stretch of the international communities means that any variant can move around the world rapidly, and as we all know it now, the world was able to feel Delta and Omicron. In this reality, contingency through universal vaccination is indispensable for all countries. When certain nations do not have universal vaccination, they become origins of new variants that may spread to other countries to affect it. Providing worldwide access to vaccines, all populations can be shielded from which no variants can spread globally.
- **Improving Herd Immunity Globally:** High levels of vaccination worldwide are a good contributor to the building of herd immunity, a condition whereby a significant part of the population is immunized against infections either by the use of a vaccine or by virtue of having previously suffered an infection. Establishing herd immunity implies that the virus experiences few potential new hosts, thus suppressing its potential to mutate. Despite differences in herd immunity provisions based on the virus's transmissibility and the vaccine's efficacy, targeting high levels of global vaccination is critical to slowing down virus transmission. Enhancing vaccination activities globally increases our ability to achieve herd immunity globally, reducing the possibility of the emergence of variant viruses.
- **Preventing Future Public Health and Economic Disruptions:** More than offering short-term health benefits, equitable global access to vaccines is crucial to averting economic and public health emergencies caused by surges fuelled by new variants. Variants that are more readily transmissible or able to avoid immunological detection may result in more cases, use up more health care provision, and disrupt recovery of economic activity. Mass vaccination programs must be undertaken to slow the virus's spread, allow economies to reopen, and keep healthcare systems from becoming overwhelmed. Globally, high vaccine coverage improves the chances of returning to normal life, reducing the pandemic risk due to variants that positively impact health and the economy.

2. Literature Survey

2.1. Studies on Vaccine Efficacy and Variant Evolution

A plethora of research by healthcare institutions (WHO, CDC, and many peer-reviewed publications) consistently proves that high levels of vaccination correlate with reduced appearance of new variants of COVID-19. [7-10] New evidence shows that strong vaccination efforts suppress the virus's mutations and adaptation, thereby suppressing the emergence and spreading of new variants. We have observed variations in the effectiveness of vaccines against various virus strains. The Alpha variant was surprisingly vulnerable to current vaccines by March 2023, with over 90% efficacy rate for both Pfizer-BioNTech and

Moderna. Nevertheless, the level of protection afforded by these vaccines declined with the emergence of the Delta variant and dropped even further with that of the Omicron variant, with the efficacy of most vaccines ranging from 30%-60%. These results highlight how difficult it is to maintain the efficacy of a vaccine because that virus continues to evolve, and there is an urgent need for regular booster shots and vaccine updates.

2.2. Global Disparities in Vaccine Access

An important problem identified by Gavi and UNICEF is the huge disparity in the distribution of vaccines worldwide, with most poor countries receiving little doses. Less than 10% of Low-Income Countries will be able to access any COVID-19 vaccine by the middle of 2022. This asymmetry is exacerbated by a constellation of problems, including a lack of supply of vaccines, difficulties getting the vaccine to the furthest reaches of the planet, limitations on intellectual property rights, and domestic agendas of health in the richest states. The insufficient and delayed rollout of vaccines prolongs the life cycle of the health crisis in poorly vaccinated nations, at the same time extending opportunities for mutation of the disease and increased risks of international spread of vaccine-resistant strains.

2.3. Case Studies

The localized emergence of plentiful COVID-19 variants in different countries has been indisputable evidence about how vaccination outreach and public health activities shape virus evolution. In India, the Delta variant prevailed at a point when vaccines were more abundant, but widespread inoculation was not yet feasible. With an average vaccination rate of less than 5% in South Africa, the emergence of the beta variant showed that the probability of the emergence of variants increased in areas with low vaccination rates. However, the United Kingdom, proud of stable genomic tracking, experienced the Alpha variant's emergence before the country could observe widespread vaccinations. These cases show how even the most sturdy health systems countries can be vulnerable to variant emergence without immediate and vigorous vaccination.

2.4. Gaps in Literature

Although a vast amount of research has clarified vaccine effectiveness and interactions between emerging variants, research neglects global interconnectivity and instead analyses isolated national situations. The degree to which unequal vaccine distribution between countries facilitates the course of the pandemic has not been fully system-analysed. A more complete understanding of these transnational aspects is critical for informing the building of strong global health measures.

3. Methodology

3.1. Sources Data

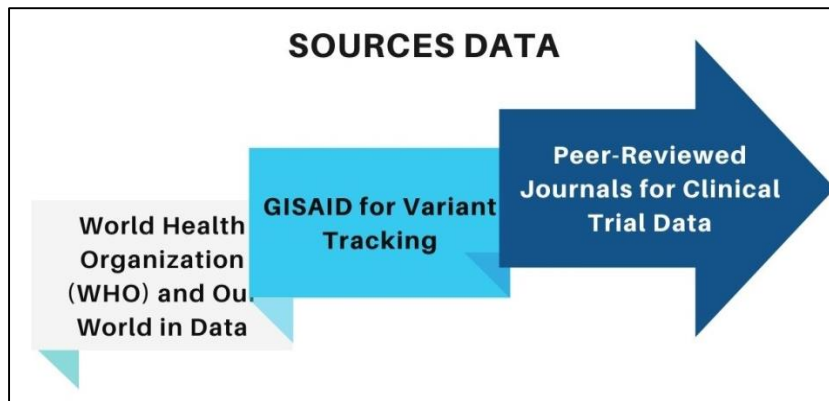


Figure 2: Sources Data

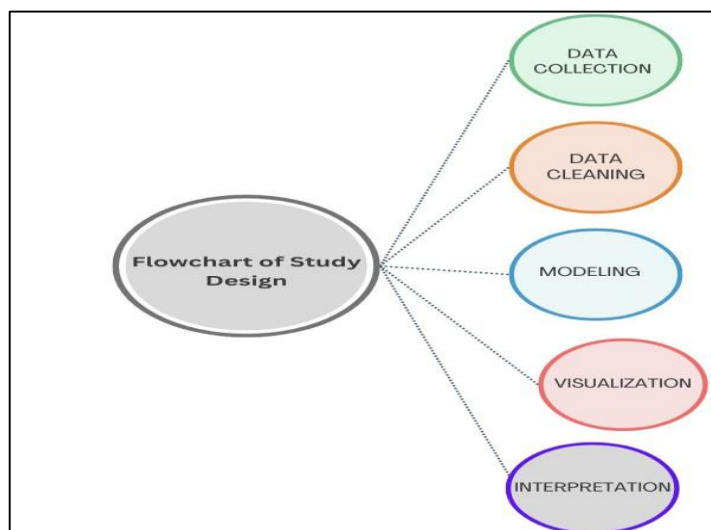
- **World Health Organization (WHO) and Our World in Data:** The two main sources of current global vaccination statistics are WHO and Our World in Data. Statistics of the national health ministry provided to WHO help to conduct a holistic analysis of vaccination coverage, distribution trends, and policy implementation. [11-14] Our World in Data also collates data from authenticated sources that help make intuitive cross-country and historical comparisons on vaccination statistics. Such platforms are crucial for understanding the variety and trends in vaccination programs between countries.
- **GISAID for Variant Tracking:** GISAID, Global Initiative on Sharing Avian Influenza Data, is the best source for the following SARS-CoV-2 strains. It compiles a complete, continuous set of viral genomic sequences submitted by researchers in all parts of the world. In making this resource accessible to scientists, one can track mutation trends, variant distribution and emergence patterns in various regions, which informs the analysis of how vaccine coverage affects variant evolution.
- **Peer-Reviewed Journals for Clinical Trial Data:** Information from trustworthy journals obtained from strict clinical trials is essential in terms of how vaccines work or function through different demographics and variants. Mostly, journals such as The Lancet and New England Journal of Medicine and Nature share results of Phase I–III clinical trials, as well as observational studies and evaluations of the real-world effectiveness of the vaccine. Scientific evidence drawn from these articles is important to determine how effective vaccines are concerning well-established and emerging variants.

3.2. Analytical Approach

Researchers used statistical correlation analyses to examine which correlation exists between the levels of vaccination coverage and the appearance of Variants of Concern (VOCs). This approach involved obtaining vaccination rate data from reputable sources (WHO and Our World in Data) to create a continuous series of vaccinations and rates of emergence of variants (based on data from GISAID).” The study aimed to find out if vaccination-deficient areas were more likely to experience the emergence or rapid spread of major VOCs like Alpha, Beta, Delta and Omicron. The correlation coefficients measured how vaccination coverage and increased variant infections are associated. Closely considering time-lag effects – appreciating that the emerging variants are often detected long after their appearance – the research method was adopted. During the analysis, both temporal and spatial data were used as tools to facilitate the consideration of differences in sequencing capacity, healthcare systems, and public health. Case studies from eminent circumstances (e.g. India’s Delta instance, the early Beta spread in South Africa) were included, supporting quantitative evidence and providing strong insights on determinants of variant emergence. In addition, the framework accounted for variables related to population density, travel movement, and health regulations (lockdowns or distribution of masks) in order to control for their possible unique effects on variant emergence or spread. The in-depth case studies, combined with numerical evidence, made it possible to have a more holistic interpretation of how the variants evolve under different contexts. Taken as a whole, these findings showed the part that under-vaccination plays in increasing the worldwide risk of variant development and continued to show the need for concerted global efforts to promote equitable vaccine distribution.

3.3. Flowchart of Study Design

Figure 3: Flowchart of Study Design



- **Data Collection:** The study started with a systematic gathering of information from a number of reliable sources. The database had vaccination rate data from the World Health Organization (WHO) and Our World in Data, which ensured complete and accurate global coverage. [15-18] GISAID provided the study with real-time genomic sequencing data that tracked the emergence and transmission of Variants of Concern (VOCs). Published articles in scientific literature reviewed and published by peers have been used to collect vaccine efficacy and trial results from clinical

trials. The peer-reviewed articles provide information, including the vaccine's efficacy and results from clinical trials published in articles in scientific literature. In consolidating these resources, researchers created the framework that would be used in further analysis.

- **Data Cleaning:** After data collection, a thorough data cleaning was undertaken to test for consistency, completeness and reliability. Measures were taken to eliminate redundancies, harmonize country designations and timelines, and correct or exclude missing data points. Each outlier was scrutinised to differentiate genuine anomalies from possible data-collection errors. To maintain the reliability of the analysis, only accurate and reliable information was provided for the study.
- **Modeling:** The purified datasets were subjected to statistical analysis to explore the correlation between vaccination rates and the emergence of Variant of Concerns (VOCs). Statistical analysis, such as the correlation model, was used to determine associations, while time-series contrasting was used to identify the progression of patterns as time went on. Geospatial analysis methods were used to determine how the emergence of novel variants was geographically differentiated. During modeling, the team was also able to systematically test hypotheses and generate evidence-based results.
- **Visualization:** To generalize people's understanding, the researchers developed proximity-based visual aids through charts, graphs, and heat maps. Visual aids highlighted important correlations like the association between poor vaccination uptake and the increased emergence of variants and changes in vaccine effectiveness by variant type. The difference that visualization tools made in enabling complex data relationships to communicate clearly and effectively for specialists and general readers cannot be overemphasized.
- **Interpretation:** The outcomes of the models and visualizations were reflected with reference to the recent scientific evidence and pertinent real-world case studies. During this stage, the researchers examined the effects of vaccination on the evolution of variants, identified shortcomings of the research, and proposed some changes to the policymaking. Interpreting the findings, we linked the data-driven insights to practical public health problems.

3.4. Simulation

For the evaluation of how levels of vaccination may or may not influence the transmission of COVID-19 variants, agent-based modeling (ABM) simulations were done. These models are useful for studies of infectious diseases because they allow researchers to recreate complex interactions among individuals by simulation in a confined environment considering behavior, movement, and disease spread. The agents used in this study included age, medical condition, vaccination level, and observance of public health measures. Field epidemiological factors, including variant transmissibility, effectiveness against different strains, and the recovery rate, were incorporated into the simulations. Simulation settings of different types were created to accommodate the differences in vaccination rates, from highly vaccinated populations of over 70% to underserved areas with below 20% coverage and regional differences regarding access to the vaccine. Simulations were held with defined time schedules, noting changes in new variants' appearance and distribution under various situations. Continuously, the simulations indicated that the higher the global vaccination rate, the fewer chances of new variants emerging and the slower spreading worldwide. On the contrary, with unequal or constrained access to a vaccine, there was an acceleration of variant emergence and its spread and an amplified likelihood that they would be resistant to present vaccines. The findings

confirmed that providing global vaccine equity is essential to population health and global control of infectious diseases. Moreover, simulations identified that even a small variation in the levels of vaccination in the individual region could be sufficient to jeopardize the effectiveness of the world responses with regard to the fact of international travelling and global chain supply. Such dynamic modelling gave insights regarding the effects of diverse vaccination strategies, emphasizing the importance of global partnership towards equitable vaccine access. The simulation component greatly enhanced the predictive abilities of the study and provided an executable guide for public health intervention decisions.

4. Results and Discussion

4.1. Correlation Between Vaccination and Variant Emergence

Analysing the relationship between the vaccination rate and the timeline for the emergence of VOCS, it is clear that a high vaccination rate is associated with a low risk of new variants. Volatility in lower vaccination rates at the outbreak of variants increases the risk that countries become epicentres for new variants, thus underscoring the importance of vaccination in controlling the virus's evolution.

Table 1: VOC Emergence Timeline vs National Vaccination Coverage

Country	Vaccination Rate (%)
South Africa	2.5%
India	3.2%
United Kingdom	6.5%

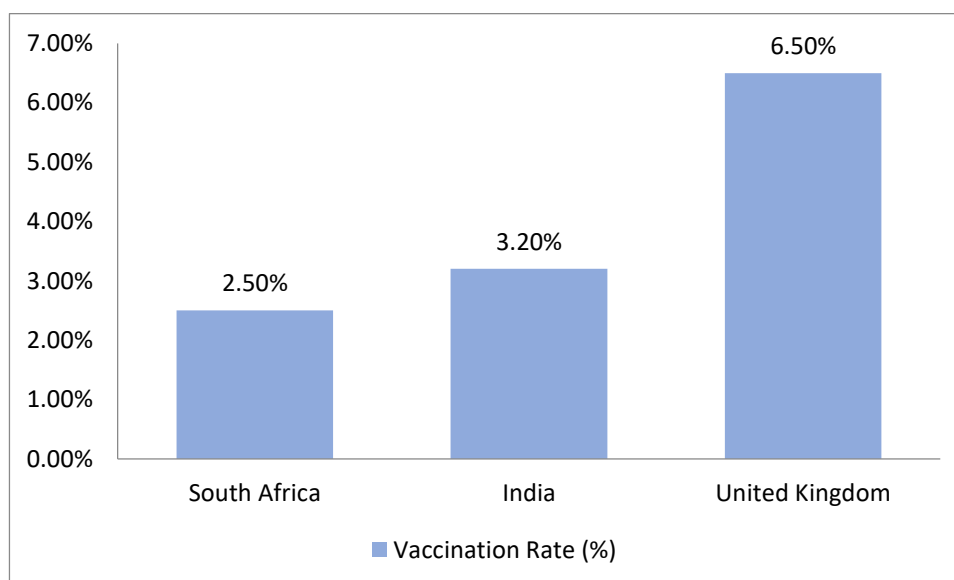


Figure 4: Graph representing VOC Emergence Timeline vs National Vaccination Coverage

- **South Africa - Beta Variant (May 2021):** The first beta variant was discovered in South Africa in May 2021, and it had increased transmissibility and limited resistance to immunity caused by vaccines. South Africa distinguished itself by relying on an exceptionally low vaccination rate, especially when only 2.5% of the population was inoculated by May 2021. The high deviation

between vaccination rates and the emergence of variants implies that not fully immunizing people allowed the development of a more potent virus that could disseminate rapidly.

- **India - Delta Variant (April 2021):** The Delta variant, which resulted in India during April 2021, came rapidly to dominate as one of the most widespread and scarifying around the globe. In India, where 3.2 % of the population was vaccinated, professional dissemination of the delta variant coincided with a wave of infections and overworked medical systems on the verge of collapse. The appearance of the Delta variant in the era of suboptimal vaccination rates is a sign that lower immunity is fertile soil for variants to mutate and win the regulatory measure, leading to more severe pandemics.
- **United Kingdom - Alpha Variant (December 2020):** In late 2020, the United Kingdom detected the Alpha variant – months ahead of mass vaccination programs being fully rolled out. In those days, 6.5 percent of people in the UK were vaccinated. Despite being in a better-vaccinated country compared to South Africa and India, its early identification highlights that a 50% vaccination level coupled with the behaviors and genetics in the community will not ensure the control of new highly contagious types. Such early origins prove that developed healthcare infrastructure cannot prevent the spread of SARS-CoV-2 without widespread vaccination. The presented experiences in South Africa, India, and the United Kingdom prove the importance of reaching high vaccination rates to stop the outside and quick propagation of dangerous virus variants. Nations with reduced vaccine coverage experienced the emergence of VOCs, underscoring the need for prompt, worldwide immunization against variants.

4.2. Regional Disparities

In late 2020, the United Kingdom detected the Alpha variant – months ahead of mass vaccination programs being fully rolled out. In those days, 6.5 percent of people in the UK were vaccinated. Despite being in a better-vaccinated country compared to South Africa and India, its early identification highlights that a 50% vaccination level coupled with the behaviors and genetics in the community will not ensure the control of new highly contagious types. Such early origins prove that developed healthcare infrastructure cannot prevent the spread of SARS-CoV-2 without widespread vaccination. The presented experiences in South Africa, India, and the United Kingdom prove the importance of reaching high vaccination rates to stop the outside and quick propagation of dangerous virus variants. Nations with reduced vaccine coverage experienced the emergence of VOCs, underscoring the need for prompt, worldwide immunization against variants.

4.3. Impact on Healthcare Systems

The introduction of new COVID-19 variants (especially Delta) put pressure on the healthcare system of communities with low vaccination rates and exacerbated their inherent weaknesses. In India, the delta variant's introduction in the spring of 2021 led to a huge surge of COVID-19 cases that left hospitals overworked nationwide. ICUs hit their full capacity, and the country was left with a dire shortage of oxygen, ventilators, and staff. The aftermath was such that no healthcare facility could cope with the requirements; many people could not be provided proper medical treatment, which led to a sharp increase in deaths. It was during the crisis that the deep divides regarding access to healthcare were apparent, with the case being rural communities, where the already stretched and not well-prepared healthcare facilities were completely overrun. In large parts of Africa, a combination of underfunded facilities, a lack of

medical supplies and limited distribution of vaccines left the health care woefully compromised. The lack of vaccines and basic protective equipment left the healthcare workers exposed, and hospitals were already overtaxed and unable to cope with mounting severe cases. Furthermore, the lack of well functioning public health system crippled efforts to track, trace, and curtail the spread of outbreaks. This led to a sequence of horrific epidemics that greatly increased mortality and negated major achievements in population health attained during the previous few decades. Overcoming and managing chronic diseases such as malaria and tuberculosis was hampered because people's attention and resources were diverted in the fight against the COVID-19 pandemic. Low-income countries have been faced with huge economic and social challenges brought about by the soaring cases of COVID-19 disease. Pushing pressures of the healthcare system halted normal medical services, delayed non-COVID care and disrupted the march towards the economic recovery. The negative effect of decades of healthcare development was most severe in countries with well-structured fragile health systems. This justified the importance of maintaining equitable access to vaccines and strengthening global healthcare stability in any public health plan.

4.4. Policy Implications

The research emphasizes the urgent need for international cooperation to thwart possible waves propagated by variants and minimize the impact of new mutations. Providing equal access to vaccines is a needed public health measure and a pivotal factor in international economic and political balance. Implementing these crucial policy measures will be required to ensure a fair and sustainable way out of future pandemics.

- **Prioritization of Vaccine Manufacturing Hubs in the Global South:** Central to policy should be vaccine manufacturing decentralization to establish the said facilities in developing districts of the global South. This policy would reduce dependence on international supply chains, which suffered from their vulnerabilities at the onset of the COVID-19 pandemic. Reply In addition, forming regional manufacturing hubs would promote self-sufficiency, optimise vaccine delivery and allow countries to address regional health challenges better.
- **Enforcement of TRIPS Waivers:** A second critical policy implication is incorporating Trade-Related Aspects of Intellectual Property Rights (TRIPS) waivers. The numerous impediments to vaccine equitable distribution due to IP rights have been a key factor in ensuring inequitable distribution, especially in those countries with lower economic capabilities. Allowing an exempted privilege of IP requirements on COVID-19 vaccines would allow the countries to produce generic replacements that do not have legal implications from those with IP commitments. Such a policy would help significantly enhance the vaccine supply globally, especially for countries where the high costs of the vaccines are not sustainable. Expanding access to technology and encouraging collaboration with a TRIPS waiver would enable local manufacturers to quickly improve vaccine supply.
- **Strengthening the COVAX Initiative:** It is imperative to strengthen the COVAX programme, one of the most important coalitions that promise that vaccines will be appropriately distributed among countries. COVAX was key in delivering vaccines to low-income economies, although funds, political intricacies and supply chain restrictions constrained its activity. There is a great need for increased funding and logistical infrastructure for improved performance. An increase in the ability of COVAX would enable vaccine distribution to nations that experience economic and logistical challenges in achieving access to vaccines so that, in the future, no country will be left

without the ability to access vaccines. COVAX improvement would ensure fair allocation of vaccines worldwide and reduce the likelihood of a future pandemic exacerbating the existing divide. Adopted as a singular course of action, such measures can enhance global health capacities, reduce the possibilities of the resurgence of the outbreak due to new variants, and motivate nations to join together to prevent future crises.

4.5. Discussion of Limitations

It is imperative to strengthen the COVAX programme, one of the most important coalitions that promise that vaccines will be appropriately distributed among countries. COVAX was key in delivering vaccines to low-income economies, although funds, political intricacies and supply chain restrictions constrained its activity. There is a great need for increased funding and logistical infrastructure for improved performance. An increase in the ability of COVAX would enable vaccine distribution to nations that experience economic and logistical challenges in achieving access to vaccines so that, in the future, no country will be left without the ability to access vaccines. COVAX improvement would ensure fair allocation of vaccines worldwide and reduce the likelihood of a future pandemic exacerbating the existing divide. Adopted as a singular course of action, such measures can enhance global health capacities, reduce the possibility of a resurgence of the outbreak due to new variants, and motivate nations to join together to prevent future crises.

5. Conclusion

This research focuses on the important role of vaccine access in controlling the spread and mutation of COVID-19 variants. The crux of the finding is that regions with low vaccine coverage were susceptible to emerge as breeding grounds for new Variants of Concern. The time lag in vaccine distribution, especially in poor countries, allowed the virus to roam freely, spreading it around and mutating into more transmissible and maybe immune-resistant versions. Conversely, countries with higher vaccination distribution derived lower mutation rates and transmission, representing the protective value of vaccines in checking the evolution of the virus. This inversed relationship brings to the fore that massive vaccination will not only be important for avoiding illnesses but also for preventing new variants from developing and spreading globally. Besides, the study emphasizes global cooperation. Since the pandemic is a global problem, inequitable vaccine distribution in one region will directly affect the whole world. In an interconnected world, no country's safety can be guaranteed unless all countries enjoy fair access to vaccines.

5.1. Future Directions

In the future, the study demands expeditious action to manage the difference in vaccine availability and work on building a preparedness mechanism against pandemics around the world. Among the major developments that would be needed would be the development of developing country vaccine manufacturing and distribution centres. These hubs would also de-centralize vaccine production so that vaccines will be readily available and near notional reliance on global supply chains that can be easily disrupted when the need arises. Besides, strong pandemic preparedness frameworks should be implemented. These frameworks should concentrate on developing infrastructure, creating better surveillance systems, and promoting international collaboration to respond better to future health crises. Consolidating international health treaties like the IHR and the International Health Regulations would

also promote a coordinated global response to pandemics such that, at a given time, all nations will be as prepared as possible to effectively contain future outbreaks.

5.3 Final Remarks

Finally, the study points out the fact that health security is linked. The COVID pandemic has shown that no country can ever be secure until global vaccine equity exists. The disparities in obtaining a vaccine during the pandemic have demonstrated weak points of our global health systems and have demonstrated that the health of any nation depends on the health of others. The common danger of infectious diseases requires collective action in which the interests of all countries are supported, and all possible efforts are undertaken to ensure that vaccine and medical resources are distributed fairly. This global pandemic has shown that attaining global health security is a joint venture that requires solidarity, collaboration and action at the world level. Unity and fair allocation of resources are the only means of warding off future pandemics and minimising their effects.

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