

## IMPACT OF COVID-19 VACCINATION ON MORTALITY RATE - LESSONS FROM THE WORLD

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### ABSTRACT

*The acute respiratory disease (COVID-19) caused by SARS-CoV-2 has been a pandemic, causing severe consequences on mental and physical health and all aspects of society. Countries around the world have been issuing and updating policies and recommendations to minimize the potential of the infection. To evaluate the correlation between countries' policies and epidemiological factors, the study used primary and secondary data from five countries including, the United States, the United Kingdom, Israel, India, and Singapore. Based on correlation analysis and visualization using heatmap graphs, the research showed a relationship between vaccination and epidemiological factors affecting new infections and mortality, then related to the vaccination program and the proposal for the post-lockdown process, opening the economy in Vietnam.*

**Keywords:** *correlation analysis, COVID-19, mortality rate, reopening policy, vaccination*

### INTRODUCTION

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was discovered at the end of 2019, and within two years, this virus has spread around the world, causing severe acute respiratory syndrome. These severely influence the health, mental health of citizens, and all aspects of society. As of mid-September 2021, the coronavirus disease of 2019 (COVID-19) pandemic has committed 219 million cases and 4.5 million deaths (Data, 2021). The emergence of SARS-CoV-2 variants is a major threat to human health in most nations. Currently, there are four variants of concern classified by the World Health Organization (WHO), consisting of Alpha (B.1.1.7), Beta (B.1.351), Gamma (P.1), and Delta (B.1.617), which were first detected in the United Kingdom (UK), South Africa, Brazil, and India (Kingdom, 2021d), respectively. In December 2020, the Delta variant (B.1.617.2) was identified and quickly spread globally, including Vietnam, and became the main variant causing the outbreaks in recent times (Initiative, 2021; Prevention, 2021). People infected with the Delta variant had a viral load in the nasal cavity 1,000 times higher than those infected with other variants and a high degree of transmission of this new variant (Li et al., 2021).

Countries and regions around the world have been issuing and updating policies and recommendations to minimize the potential of the infection. One of the efficacy and comprehensive solutions is wearing masks in public areas, which reduces the transmission of SARS-CoV-2 and contributes to controlling the source of infection and preventing exposure (Leung et al., 2020; Liang et al., 2020). In addition, the citizens are encouraged to wash their hands regularly using hand sanitizer containing at least 60% alcohol and to keep personal respiratory hygiene (Hirose et al., 2020; Rahimi & Talebi Bezmin Abadi, 2020). In areas with community transmission, the governments apply social and physical distance to prevent close contact with people infected with the virus, which is the high possibility of being exposed to SARS-CoV-2 (Rubin et al., 2020; Wang et al., 2020). Other contagion reduction strategies consist of closing schools, places, and non-essential businesses, banning crowd gathering, travel

restrictions with immigration monitoring, identifying and isolating confirmed cases, contact tracing and isolation. In addition to the physical methods that have been applied since the first outbreak, vaccines are considered the most viable strategy to prevent the pandemic. Pfizer/BioNTech and AstraZeneca have been shown to reduce the likelihood of family transmission from people diagnosed with COVID-19 by 40-50% (Harris et al., 2021).

Studies show that many factors can act separately or concurrently for severe illness or complications in COVID-19 patients. According to Nguyen et al., the statistical results among 161,206 males and 146,804 females infected with SARS-CoV-2 show that men have a higher in-hospital mortality rate than women. (13.8% vs 10.2%,  $p < 0.001$ ) (Nguyen et al., 2021). The study by Yanez et al. on data from 16 countries also demonstrated that patients over 65 who died from COVID-19 accounted for 86.2% of all deaths and had a mortality rate 7.7 times higher than the group of people 55-64 years old (Yanez, Weiss, Romand, & Treggiari, 2020). Comorbidities namely cardiovascular disease, hypertension, diabetes, obesity, respiratory disease and cancer contribute to the poor outcome of the patients (Dessie & Zewotir, 2021). Moreover, low socio-economic status, large households, lack of health care services, and inability to work from home have been shown to increase exposure risk (Mena et al., 2021).

In addition to the above factors, vaccination is considered to significantly influence the COVID-19 mortality rate. In the UK, an estimated 10,400 deaths were avoided by the COVID-19 vaccination program by the end of March 2021 (Kingdom, 2021b). At the same time, vaccination against COVID-19 also markedly reduced adverse outcomes, with non-ICU (intensive care unit), ICU hospitalization and mortality decreasing by 63.5%, 65.6% and 69.3%, respectively (Moghadas et al., 2021). These provide evidence that the COVID-19 vaccination program has had a great impact on severe COVID-19 cases (Pritchard et al., 2021). Vaccines to prevent COVID-19 infection are seen as the most promising approach to pandemic control amid the Delta variant wave.

COVID-19 pandemic has both directly and indirectly impacted community health, economic, political and social aspects (Shang, Li, & Zhang, 2021). The world has to face a severe economic decline, causing damage to many countries (Sułkowski, 2020). The global economy is separated into two phases: before and after the WHO's announcement about the pandemic (Zhang, Hu, & Ji, 2020).

Our study was conducted to overview vaccination campaigns of some nations, to assess the relationship between vaccination campaigns and the effectiveness of disease reduction through factors and mortality rate in COVID-19 patients. From there, relate the post-lockdown process, open the economy and propose a strategy for the vaccination program during the forth wave of the pandemic in Vietnam.

## **Method**

### ***Materials***

Our team accessed and categorized primary and secondary data from Our World In Data database, including epidemiology statistics of new cases, new deaths each day, and vaccination progress in five countries, namely the United States (US), the UK, Israel, India, and Singapore. We also collected the number of COVID-19 patients in hospitals and ICU of the US, the UK, and Israel. The study used significant evidence and research to provide context on socio-economic development in these countries and Vietnam.

### ***Statistical analysis***

The study performed statistical data based on the vaccination rate of at least one dose, two doses from December 2020 to September 2021, the number of new cases and deaths in five countries between January 2020 and September 2021. Our team performed descriptive statistics using line graphs to visualize metrics and heatmaps to analyze correlations between factors above using

Python 3.7 software. We used Pearson's correlation coefficient value to define the direction and strength of correlation.

### ***Limitation of the research***

Some significant limitations in our study should be considered. First, the data published on Our World in Data can fluctuate by days and moderate from the actual number. In addition, data of some countries was not available or unable to access. Thus, our correlation analysis can only conduct on the US, the UK, and Israel because they provide sufficient data. Second, each country might face different pandemic waves in each stage. Evaluation of vaccination programs on COVID-19 mortality over the same period creates inconsistency in data. Moreover, there are fundamental differences between countries in economic potential, health systems, disease control policies, and people's consensus on vaccination that also make a notable difference. Finally, correlation analysis could not prove the cause-and-effect relationship between four variables, including the vaccination rate of at least one dose, two doses, the number of daily new cases and deaths.

### **Overview of a vaccine campaign**

While COVID-19 has become a worldwide public health emergency, vaccines against acute respiratory infectious disease have rapidly developed, with 112 candidates undergoing clinical trials and 183 candidates in the preclinical trials stage. To date, many pharmaceutical entrepreneurs have succeeded in vaccine production, of which seven vaccines have been authorized for emergency use by WHO, and 13 vaccines are under review (BIO, 2021). Several vaccines have been allowed in use since late 2020 seems to be a turning point in the global response to the pandemic. This effort to public health will soon be addressed through national immunization campaigns.

#### ***The United States***

The US is a focal point in researching and manufacturing COVID-19 vaccines, with more than 10 billion dollars investment in the Warp Speed campaign to ensure rapid deployment of vaccination (Ho, 2021). On December 11, 2020, the Pfizer/BioNTech vaccine was authorized for emergency use by the Food and Drug Administration (FDA), and the US becoming the first country to implement a worldwide vaccination policy. To ensure equitable distribution of the COVID-19 vaccine, the federal government has developed programs to help high-risk communities directly and rapidly. This measure might support vaccine coverage goals and distribute vaccines equally in every community across the United States (Services, 2020). States receive vaccine allocations based on their total adult population. Each state plans to get those vaccines through county clinical offices, hospital systems, pharmacies, mass vaccination points, and mobile clinics. Vaccination rates peaked in early April at more than 3 million COVID-19 shots per day (Dyer, 2021).

#### ***The United Kingdom.***

During the pandemic, the UK Government has set a goal to manage local outbreaks across the UK, and this is the priority to ease the restriction (Kingdom, 2021c). The UK has made significant progress in 2021 with the National Health Service vaccine strategy, giving the UK a great position on the vaccination track. More people got vaccinated in the UK than in any other country in Europe, and doses per capita are higher than in any other Group of seven nation (G7) (Data, 2021). On account of the successful vaccination program, the Government and the Devolved Administrations are able to ease lockdown restrictions (Kingdom, 2021c).

Vaccines are significantly reducing the association of infections with severe illness and death (Kingdom, 2021a). As the initial roadmap set out in the COVID-19 Response – Spring 2021, with a sufficiently high proportion of the population vaccinated, the UK can learn to adapt to COVID-19 without severe economic and social restrictions (Kingdom, 2021c).

### ***Israel***

Israel is one of the countries known for its rapid and effective universal vaccination campaign. After Pfizer/BioNTech's COVID-19 vaccine was authorized for emergency use by the FDA, Israel achieved an agreement with Pfizer/BioNTech and launched its vaccination campaign at the same time as leading countries in vaccine production such as the US or the UK.

From the start, Israel's vaccination strategy was clear and specific. People in high-risk groups for COVID-19, including those over 60 years old, healthcare workers, and people with severe underlying medical conditions, are prioritized for vaccination. After that, the vaccination campaign was expanded to people 55 and older, 40 and older, 16-18 years old, and 35 and older (Israel, 2021c, 2021d). At the beginning of February 2021, the Israel Ministry of Health (MOH) allowed all individuals from 16 years and older to be eligible for the COVID-19 vaccine.

By the end of February 2021, approximately 50% of the population had received the first dose and more than 36% of those got fully vaccinated. Israel is also the first country to deploy the third dose for those over 60 years old and then extended to allow people over 12 years old to receive a boost dose (Bar-On et al., 2021; Israel, 2021a). As of mid-September 2021, 1-dose, 2-dose, and 3-dose vaccination coverage of Israel correspond to 65.11%, 59.82%, and 31.9% of the population, respectively.

### ***India***

As of September 14, 2021, India has injected 752,714,069 doses, of which 571,662,310 people received at least one dose and 181,051,759 people received at least two doses, equivalent to 28% and 13% of the population (Thiagarajan, 2021). According to the National Expert Group on the Administration of COVID-19 Vaccines (NEGVAC), priority groups at the early stages of the vaccination campaign include health care workers and people over 50 years old or people under 50 years old with comorbidities. In the first phase of the vaccination program (from January 16, 2021 to April 30, 2021), states and union territories conducted free vaccinations for local priority groups and provided private health system support to accelerate the vaccination rate (India, 2021). However, ensuring vaccination for a country with a developing economy and the second-largest population in the world is not easy and faces many difficulties.

### ***Singapore***

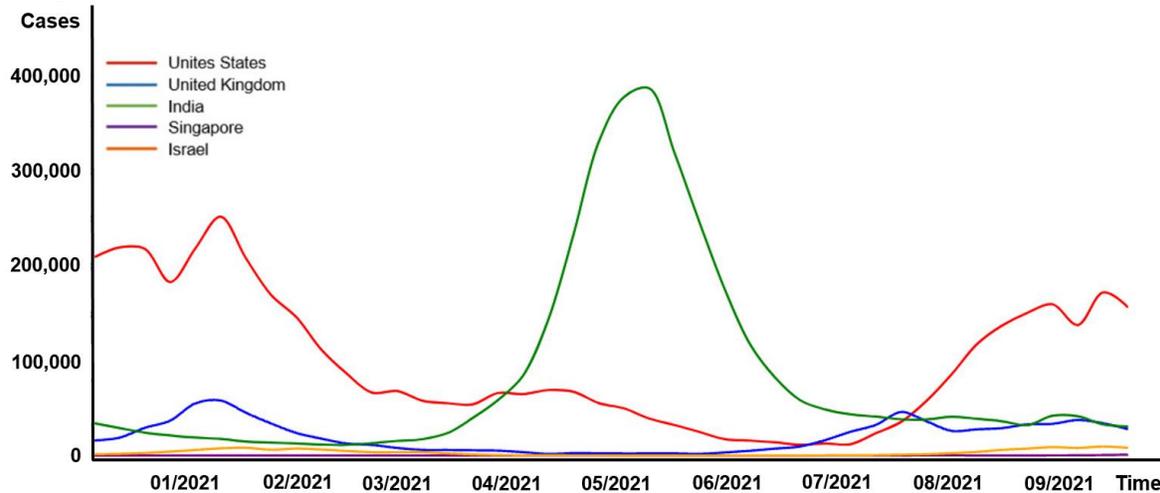
Singapore is a country that has transformed from a "zero transmission" to a "recovering from COVID" strategy in the cautious reopening of the country. The Singapore government outlines a road map for the economy, assuming COVID-19 will persist for many years, and identifying reopening will tie to vaccinations.

Singapore's immunization strategy was outlined through phases. As of mid-September 2021, 79.6% of Singapore's population had completed two doses, and 81.6% of the population had received at least one dose (Singapore, 2021c). The Singapore MOH has implemented a booster vaccination program for people with immunodeficiency diseases and people aged 60 years and over (Singapore, 2021b). Singapore's COVID-19 vaccination campaign aims to protect citizens and protect businesses, workers, and economic activities. All Singaporeans and permanent residents in Singapore are vaccinated free of charge (Singapore, 2021a).

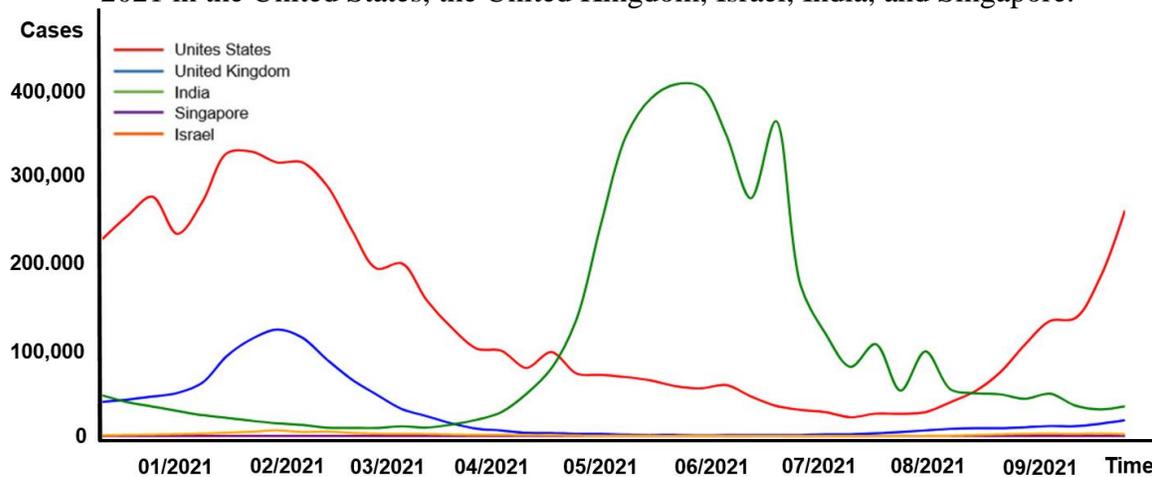
### **Result and discussion**

In December 2020, the US, the UK, and Israel experienced the COVID-19 wave of the pandemic, with the number of cases recorded at the beginning of January 2021 peaked at 250,000, 60,000, and 8,500 cases per day, respectively (see Figures 1 and 2). Additionally, these countries witnessed a dramatic climb in hospital and ICU patients, and the confirmed deaths significantly rose compared to previous pandemic waves. By the end of January 2021, the number of deaths peaked with more than 3000 cases per day in the US and nearly 1300 cases per day in the UK, while the confirmed cases are lower in the three remaining countries. The

UK had gone through the third lockdown, while the US and Israel implemented border controls on passengers from countries where the alpha strain was dominated. The results showed that the border restriction policy and lockdown effectively reduced the number of new infections and deaths for the alpha variant. Since the start of the global vaccination campaign in December 2020, the US, the UK, and Israel have led in vaccine coverage which was a prerequisite for the UK, and Israel started to lift restrictions and offer a route back to normal life (Israel, 2021b; Kingdom, 2021c).



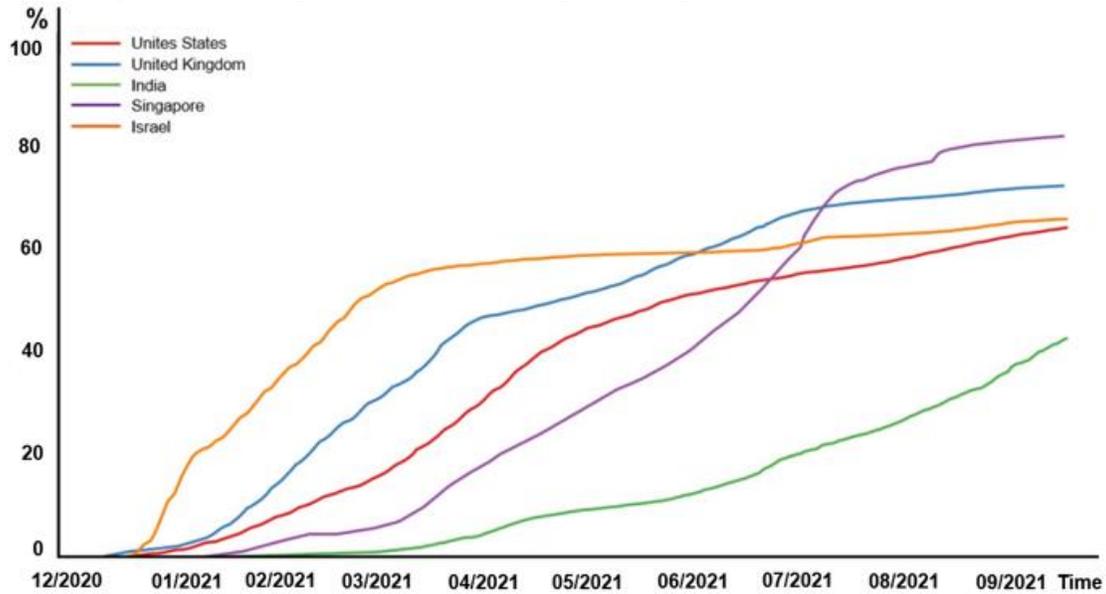
**Figure 1:** The rolling 7-day average of daily new cases from December 2020 to September 2021 in the United States, the United Kingdom, Israel, India, and Singapore.



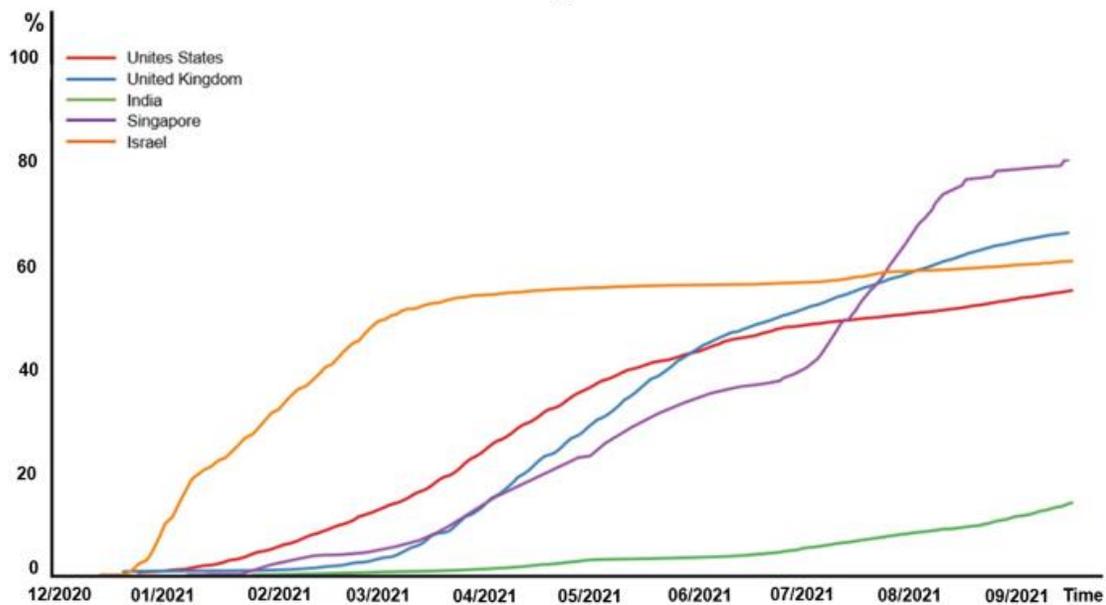
**Figure 2:** The rolling 7-day average of daily new deaths from December 2020 to September 2021 in the United States, the United Kingdom, Israel, India, and Singapore.

In December 2020, on account of the Indian government's policy and actions since the beginning of the pandemic, the circumstance was under control, and the number of new cases decreased significantly (Lancet, 2021). In February 2021, India only recorded 8,000 new cases a day (equivalent to 8 cases per 1 million people, see Figure 1). On January 14, 2021, the Indian government promoted vaccination by implementing a national COVID vaccination program (Ministry of Health and Family Welfare, 2020). With the achievement after the first outbreak, Prime Minister Narendra Modi announced that India ended the pandemic and gained herd immunity, leading to vaccination as well as epidemic prevention measures to be neglected (Lancet, 2021). During the reopening period from April to May 2021, only 2% of the population received injection doses and the Delta was classified as a variant of concern with twice as

contagious as previous variants (Data, 2021). Hence, India witnessed a substantial escalate in the number of new cases and recorded more than 414 thousand cases on May 6, 2021 (298 cases per 1 million people), following a sudden increase in the daily deaths from around April 2021 and peaking in the mid-May with more than 5000 deaths per day (Data, 2021). Since then, India has changed its strategy by accelerating the vaccination rate and returning to the lockdown. By September 2021, the population receiving at least one dose rose from 8% to 45% and fully vaccinated up to 16% compared to 2.1% of the previous period.



A

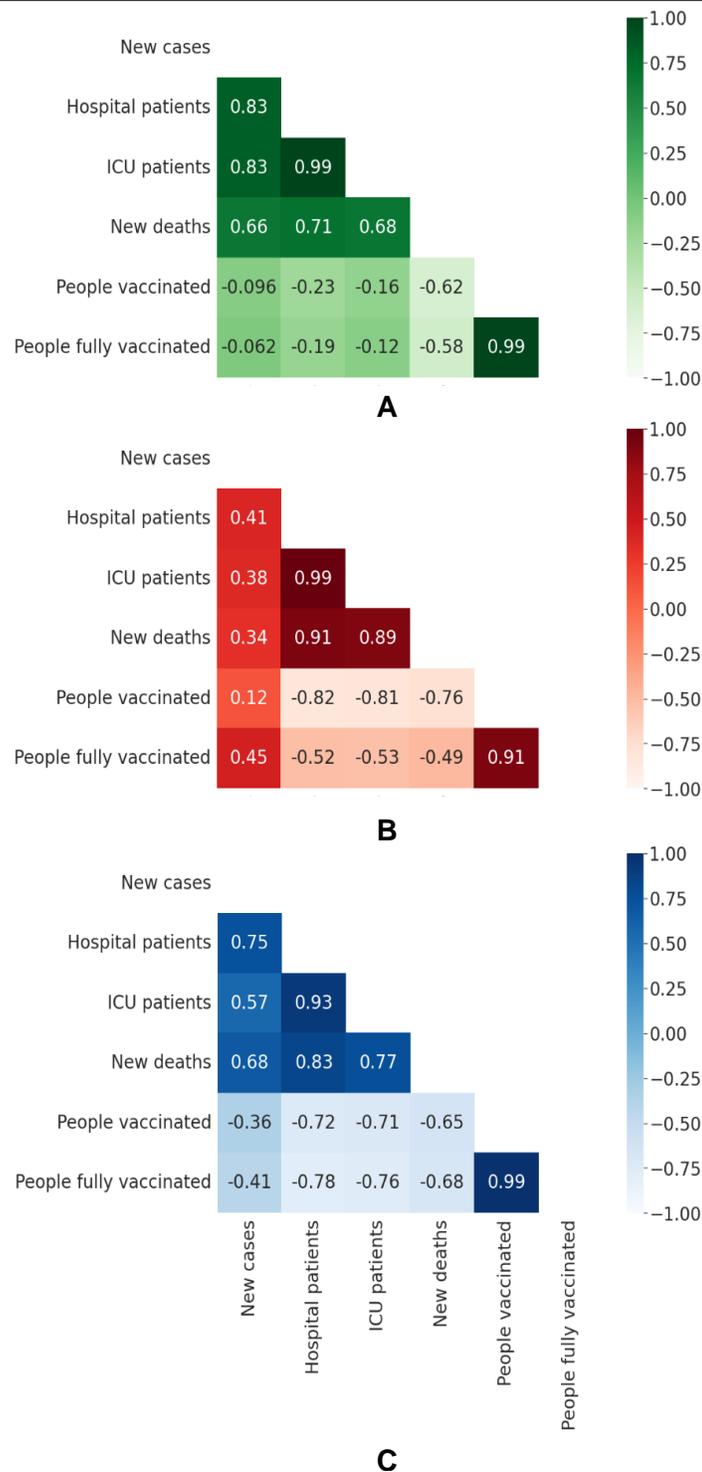


B

**Figure 3:** The number of people who received at least one vaccine dose (A) and fully vaccinated (B), divided by the total population of the United States, the United Kingdom, Israel, India, and Singapore from December 2020 to September 2021. During May 2021, the number of infections in the UK and Israel remained stable and low, while the number of cases in the US increased slightly. However, during that time, the vaccine

campaign in Israel and the US had signs of slowing down. In particular, within six months from March to September, the percentage of the Israeli population receiving a single dose of vaccine increased from just over 50% to 68% (see Figure 3). One of the main reasons is the hesitancy of Arabs, Orthodox Jews and young people in vaccination or difficulty accessing health services (Mallapaty, 2021; Rosen, Waitzberg, Israeli, Hartal, & Davidovitch, 2021). Achieving herd immunity is a challenge in the US because of the skepticism, hesitation, and apathy of a significant population (Aschwanden, 2021). On July 4, 2021, 67% of adults in the US were vaccinated, far behind the goal with 70% coverage. In June 2021, the transmission of the Delta variant recorded an increase in the number of infections. We cannot predict the future epidemiological situation; however, the number of infected cases in the US in September 2021 seems to peak, about 170,000 cases per day, less than the records in the December wave (see Figure 1). In the UK, the number of infections increased by 50,000 cases per day in June, then decreased modestly, fluctuating around 35,000 until now. In addition, the US and the UK witnessed the rise of new deaths, hospital and ICU cases but not as high as the 2020 winter wave (see Figure 2). In Israel, the daily number of infected people during the 2021 summer wave was approximately 9,000, which has not decreased compared to the previous outbreak. However, the in-hospital and ICU patients and the daily confirmed deaths were lower than the previous wave.

According to the correlation analysis, the data of the US was the most disparate compared to the UK and Israel. The weak negative correlation coefficient between vaccine coverage (at least one dose and two doses) and the number of new cases, new hospitalizations, and new severe cases in the US (both greater than -0.2 and above 0, see Figure 4A) indicated low effectiveness of the vaccine on the number of new cases mentioned above. However, there was a significant correlation between vaccine coverage and the number of new deaths with correlation coefficients of -0.62 and -0.58, respectively. In the UK, there was a strong negative correlation between people who received at least one dose and hospital admissions, new severe cases, and new deaths with correlation coefficients of -0.82, -0.81, and -0.76 (see Figure 4B). However, this value was low (0.12) between people vaccinated and new cases. Fully vaccinated for the new cases mentioned above gave the moderate correlation coefficient. With high vaccination rates and coverage, the UK showed a high potential for reducing hospitalizations, severe transfers, and deaths. The correlation analysis for Israel had a slightly strong correlation coefficient between one dose of vaccination and the number of new hospital admissions, new severe cases, and deaths were -0.72, -0.71, and -0.65, respectively (see Figure 4C). Based on the heatmap of Israel, the correlation coefficient between people vaccinated and new cases was higher than in the US and the UK (-0.36 compared to -0.096 and 0.12), although it remained in a weak range. This difference may be due to other external factors in each country impacting the number of new cases (lockdown policy, travel restrictions, people's agreement towards the government roadmap). In general, the vaccination campaign in the US had not a clear impact on the number of new cases, new hospitalizations, and severe cases, but this correlation increases for new deaths. The larger population of the US might be the factor that affected the differences. The UK and Israel demonstrated the effectiveness of vaccine coverage for new hospitalizations, new severe cases, and new deaths, though the correlation being lower for new cases. It can be explained by the consistent rate of vaccination and high vaccine coverage in these two countries. Overall, there was no obvious correlation between vaccine coverage and the number of new cases. However, there was a negative correlation between vaccine coverage and in-hospital, ICU patients and daily deaths in the US, the UK, and Israel. It suggests that vaccination might positively influence poor outcomes caused by COVID-19.



**Figure 4:** The correlation heatmap between new cases, hospital patients, ICU patients, new deaths, people vaccinated and people fully vaccinated per day of the United States (A), the United Kingdom (B) and Israel (C).

In the first half of 2021, the number of new cases and the death rate of Singapore were recorded to be stable at low levels due to the lockdown policies of the Singapore Government during the COVID-19 wave of Delta variant increasing worldwide. The vaccination rate of Singapore quickly grew and reached about 79% of the population received one dose, and 77% received two doses (see Figure 3A and B). However, Singapore witnessed a sudden increase in new cases,

with more than 1000 cases per day in the last days of September when implementing a gradual reopening policy. The implementation of reopening caused the number of new cases to increase exponentially and saw the number of new infections increase to 1,000 people per day. However, among fully vaccinated instances in the past 28 days, 99.2% of infections were asymptomatic or mildly symptomatic, suggesting the role of high vaccine coverage in the community. In the current period, Singapore is still gradually opening up its economy, recommending vaccination, and improving the health system's quality to cope with the new wave of disease (Singapore, 2021d).

### **Overview of the pandemic condition and challenges in Vietnam**

Currently, the fourth wave caused by the Delta variant brought Vietnam experienced several months of significant community transmission. Vietnam deployed tight measures against the pandemic, including travel restrictions, compulsory quarantine, and nationwide school shutdown. Ho Chi Minh City has continued to report high daily cases with multiple clusters in many places.

In Vietnam, the lockdown policy was considered an effective response to COVID-19 in 2020. However, this restriction was not enough against the delta variant crisis when new infections increased for an extended period (Le, Vodden, Wu, & Atiwesh, 2021). This maximum social distancing strategy has dramatically affected citizen's lives. In addition, the healthcare system faces some difficulties, especially running out of beds, oxygen cylinders, ventilators, monitors, and human resources.

### ***Vaccination campaign in Vietnam***

The Vietnam MOH has implemented a COVID-19 vaccination goal for the 2021-2022 period to cover 40% population by the end of 2021 (Government, 2021b). As of September 16, 2021, the proportion of fully immunized people worldwide is 32%, and the percentage of people who have received a single dose of the vaccine is 45%. Meanwhile, this figure is 7.8% and 30%, respectively, in Vietnam, with the two regions with the highest vaccination rates being Hanoi and Ho Chi Minh City. In general, vaccine coverage of Vietnam is lower than the world average. On September 13, 2021, Minister of Health Nguyen Thanh Long chaired a discussion meeting with leading scientists and medical staff to roadmap overall strategy of the COVID-19 pandemic prevention and control back to normal in Vietnam next year (Government, 2021a). The meeting focused on addressing issues such as vaccination, treatment, and enhance the capacity of the health care system.

### ***Suggestion for Vietnam actions***

#### ***Evaluating the circumstances***

The COVID-19 pandemic in Vietnam has penetrated deeply into the community and become an endemic, especially in enormous cities like Ho Chi Minh City and Hanoi, which means that challenging to remove COVID-19 from the community altogether. Therefore, managing methods that were hash in 2020 and earlier in no vaccine and isolated people testing positive for COVID-19 (F0) from the community ("zero COVID-19") are no longer suitable for infectious disease outbreaks such as Ho Chi Minh City in the current period. In addition, it is clear that the fight against COVID-19 is a long-term campaign, and living together in an environment with COVID-19 is inevitable.

#### ***Lessons from other countries' reopening schedules***

The UK is one of the leading countries to set out clear and factual policies to lift out the pandemic. The preparation for future scenarios is focused and carefully considered by the UK Department of Health. Israel's accelerated pace of vaccine coverage demonstrates the benefits of vaccination campaigns against the effect caused by COVID-19. Besides, the country's reopening is one of the urgent steps to save the economy from struggling due to COVID-19.

Singapore is one of the countries that has taken measures to ease and reopen the country very carefully. From the analysis of the epidemic situation, the difficulties faced, and the solutions that five mentioned countries are implementing, it is easy to see that the combination of non-treatment measures and treatment measures is an optimal step for many countries that want to control the pandemic. However, the country's potential, including the strength of the health system and strategies for the future, are factors of great concern.

#### *Vaccination*

To bring Vietnam out of the fourth wave and reopen, the essential point is to vaccinate the entire population, focusing on high-risk groups (older people, people with underlying medical conditions). The top criteria ensure sufficient vaccine supply for two doses and coverage over 80% of the population. In addition, it is necessary to develop an appropriate vaccination policy. In Vietnam, 40% population in urban areas where the Delta variant is mainly attacked is concentrated. Therefore, with the current limited vaccine resources, the Government should prioritize the distribution of vaccines to these areas and high-risk groups to narrow vaccine coverage time for densely populated urban areas. It is also advisable to start implementing the vaccination plan for people under 18 years of age.

#### *Strengthen the healthcare system*

The healthcare network is critical in pandemic responding and control, so long-term investment is required. Currently, overcrowding in facilities treating COVID-19 patients puts high pressure on the system and medical staff. The Government has responded to this situation by increasing the investment budget in medical infrastructure and equipment and providing support policies to ensure the life of medical staff who are directly treating COVID-19 patients in the hospital. When living with COVID-19 is inevitable, the trace and isolate F0 in the community might not be a great strategy. Instead, treatment of mildly symptomatic F0 at home should be emphasized to reduce the medical burden. An easy-access online healthcare concept should be developed for patients and medical staff to manage heal. Accurately managing a patient's health record and correctly diagnosing COVID-19 symptoms assists in classifying patients and reduce pressure on hospitals properly. To date, MOH issued criteria to classify four risk levels of people infected with SARS-CoV-2, including green, yellow, orange, and red, corresponding to low, moderate, high, and very high-risk groups (Vietnam, 2021b). The proper stratification helps identify different risk groups of the infected, thereby helping to identify the suitable treatment and support needs for each subject, improving the effectiveness of the treatment while saving health and society resources. Currently, vaccination is slower than the spread of the disease, and vaccines do not fully guarantee immunity against SARS-CoV-2. Therefore, antiviral drugs will be an essential key to reducing morbidity and mortality in patients with COVID-19 and contributing to the pandemic control. The MOH has officially used the antiviral drug Molnupiravir in a strategy to support F0 treatment at home (Vietnam, 2021a, 2021c). In addition, Pfizer announced that PF-07321332/ritonavir, an oral antiviral SARS-CoV-2-3CL protease inhibitor, has excellent synergies with vaccine effectiveness in the fight against the disease (Pfizer, 2021). In addition, domestic antiviral drug researches for COVID-19 treatment and prevention is a remarkable solution to ensure pharmaceutical logistics.

#### *Cautiously lifting restrictions*

Besides epidemiological issues, it is necessary to pay attention to the economic recovery after reopening. The reopening of the country or critical cities based on safety and preparation of ready-made conditions is urgent to save the current economy. To open up the country, the first condition is vaccine coverage; the second is risk prevention after the social distance is closed and the number of cases increases. That is evident in the UK's reopening pandemic response strategies and Singapore's policy flexibility to cautiously reopen. The Government considers

developing a project, giving a roadmap to restructure sectors and industries according to the local development orientation. In addition, financial support packages and tax incentives are also essential for businesses to recover after the pandemic.

### **Conclusion**

We conducted an overview of the pandemic condition and analyzed new cases, deaths, hospital patients, ICU patients, and vaccination strategies of the United States, the United Kingdom, Israel, India, and Singapore during the COVID-19 pandemic since the appearance of the Delta variant. The apparent negative correlation from the analyses, especially the significant correlation between vaccine coverage and the number of new deaths in the UK and Israel, showed that higher vaccine coverage could lead to less damage caused by COVID-19. From the analysis, vaccines are still the essential key for the world to return to normal and accept the virus as a part of life. In addition, developing new drugs for treatment and prevention is also potential strategies to help suppress the pandemic. Each country needs to have short-term and long-term plans to deal with the pandemic situation and other pandemics that may appear in the future.

### **LIST OF ABBREVIATIONS**

COVID-19	Coronavirus disease of 2019
F0	People testing positive for COVID-19
FDA	Food and Drug Administration
ICU	Intensive care unit
MOH	Ministry of Health
NEGVAC	National Expert Group on the Administration of COVID-19 Vaccines
NHS	National Health Service
SARS-CoV-2	Severe acute respiratory syndrome coronavirus 2
UK	United Kingdom
US	United States
WHO	World Health Organization

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