

Brief Report

Cite this article: Cuschieri S, Cuschieri A, Farrugia E, *et al.* A case for cross-border governance? A comparative trend assessment of COVID-19 transmission, vaccination, and outcomes among 35 nations in Europe across 18 months. *Disaster Med Public Health Prep.* doi: <https://doi.org/10.1017/dmp.2022.108>.

Keywords:

coronavirus; Europe; morbidity; mortality; mass vaccinations; epidemiology

Corresponding author:

Andrea Cuschieri,
E-mail: andrea.cuschieri.19@um.edu.mt

A Case for Cross-Border Governance? A Comparative Trend Assessment of COVID-19 Transmission, Vaccination, and Outcomes Among 35 Nations in Europe Across 18 months

Sarah Cuschieri MD, PhD¹ , Andrea Cuschieri² , Elysia Farrugia², Emily Diacono², Elaine Balzan², Miguel Grupetta², Alessia Vella², Catriona Cutajar², Martina Formosa², Matthias Barbara², Franziska Mintoff², Conor Shaw², Samuel Fleri-Soler², Norbert Borg², Gillian Pace², Lauren Vella², Robert Pisani², Tamara Attard-mallia², Mattea Gouder², Rosie Attard², Nicole Grixti², Mark Scicluna², Timothy Borda², Katya Bartolo², Ruben Chircop², Etienne Degabrielle-Ferrante², Mariah Mallia², Miguel Attard², Naomi Frendo², Gianluca Gatt², Greta Damato², Nicole Riolo², Lorna Muscat-Baron², Matteo Galea² and Elizabeth Grech²

¹Department of Anatomy, Faculty of Medicine & Surgery, University of Malta, Msida, Malta and ²Faculty of Medicine & Surgery, University of Malta, Msida, Malta

Abstract

Objective: Coronavirus disease 2019 (COVID-19) spread globally, including across Europe, resulting in different morbidity and mortality outcomes. The aim of this study was to explore the progression of the COVID-19 pandemic over 18 mo in relation to the effect of COVID-19 vaccination at a population level across 35 nations in Europe, while evaluating the data for cross-border epidemiological trends to identify any pertinent lessons that can be implemented in the future.

Methods: Epidemiological data were obtained from European Centre for Disease Prevention and Control and Our World in Data databases while Ministry of Health websites of each respective country and local newspapers were used for COVID-19-related vaccination strategies. Case, mortality, and vaccination incidence comparative analyses were made across neighboring countries.

Results: Similar morbidity and mortality outcomes were evident across neighboring countries over 18 mo, with a bidirectional relationship evident between cumulative fully vaccinated population and case fatality rates.

Conclusion: Countries' COVID-19 outcome is related on national mitigative measures, vaccination rollouts, and neighboring countries' actions and COVID-19 situations. Mass population vaccination appeared to be effective in reducing COVID-19 case severity and mortality rates. Vaccination equity and pan-European commitment for cross-border governance appear to be the way forward to ensure populations' return to "normality."

The declaration of COVID-19 as a pandemic by the World Health Organization (WHO), led governments and public health officials to consider different governance approaches and to implement various degrees of non-pharmaceutical interventions across time, to contain viral spread while following test-trace-and-isolation protocols. From the early onset of the pandemic, clinical trials for a COVID-19 vaccine were set in motion, as a vaccine was envisaged to be the solution to end this global crisis,¹ based on the past success of inoculation drives in decreasing morbidity and mortality of transmissible diseases in a cost-effective manner.² A European Union (EU) joint procurement agreement between member states was set up early in 2020 to ensure a fair distribution of vaccines among countries (Supplementary Material 1). The aim was to explore the progression of the COVID-19 pandemic over 18 months in relation to the effect of COVID-19 vaccination at a population level across 35 nations in Europe, while evaluating the data for cross-border epidemiological trends to identify any pertinent lessons that can be implemented in the future.

Methods

This study was a longitudinal observational study across countries within the European continent. For the purpose of this study, 35 countries were considered including the EU-27 countries, the European Economic Area (EEA) countries, Switzerland, and the UK nations.

Data Sources

All data collected covered the period from the onset of COVID-19 in Europe until August 1, 2021 (ie, week 30), unless stated otherwise. Epidemiological data (weekly COVID-19 cases stratified by age groups, weekly mortality, and weekly swabbing) and vaccination data (weekly cumulative 1 dose and second dose both stratified by age groups) for all EU/EEA countries were obtained from the European Centre for Disease Prevention and Control (ECDC) database. The fully vaccinated population for the EU/EEA countries was taken to mean as those having had the second dose of Pfizer-BioNTech, Moderna, and AstraZeneca vaccine or the 1 dose of Johnson & Johnson vaccine.

The “Our World in Data” (OWID) database was used to obtain the weekly COVID-19 cases, weekly mortality and total vaccinated data for Switzerland. While the UK governmental website was used for epidemiological and complete vaccination data for England, Scotland, Wales, and Northern Ireland. Of note, epidemiological data stratified by age group were not identified for: (i) Bulgaria for COVID-19 cases; (ii) Germany and England for vaccination data; (iii) Lichtenstein, Switzerland, Scotland, Wales, and Northern Ireland for COVID-19 cases and vaccination data.

Data Analyses

The weekly COVID-19 positive cases and deaths for each country/nation were combined to follow a fiscal month distribution. Both monthly cases and deaths were converted to incidence rates per 100,000 population. Comparative analysis between monthly COVID-19 cases in neighboring countries were carried out. Neighboring countries were defined as countries that are geographically adjacent to each other, or which are landlocked. With regard to the 3 EU/EEA islands of Cyprus, Iceland, and Malta, these were compared with their closest country/countries, ie, Cyprus with Greece, Iceland with the Nordic countries, and Malta with Southern European countries. Similar comparisons were followed for the monthly mortality incidence.

Cumulative fully vaccinated population data were converted to incidence rates per 100,000 population and comparisons were made between countries through a heatmap for the months of January, March, May, and July 2021. The monthly cumulative fully vaccinated population per 100,000 population was also compared with the monthly case fatality rates (CFR). The CFR was calculated by dividing the number of deaths by the number of confirmed infective cases (for each month) multiplied by 100. The comparisons between CFR and vaccination rates was analyzed using Pearson correlation coefficient testing at a country level using Statistical Package for the social sciences (SPSS) software (V.27.0, SPSS Inc., Chicago, IL). The vaccination prioritization group strategies implemented by each country were also compared.

Results

COVID-19 Epidemiology Across 35 Nations in Europe

Over 18 months (January 2020 until August 1, 2021) a total of 39,776,383 positive cases and 921,737 deaths were reported across the EU-27/EEA, Switzerland, and the United Kingdom. The most affected age group in terms of infection was the 25 to 49 y. Supplementary Material 2 provides an overall comparison analysis of the epidemiological COVID-19 situation across all countries under study, up until the week 30 of 2021 (July 26 to August 1).

Similar COVID-19 transmission and morbidity patterns could be observed across neighboring countries, with an overall lower population morbidity and mortality rate during the first wave (January to June 2020) as opposed to the preceding waves, as shown in Figure 1. The period between early November 2020 and early January 2021 saw high transmission rates across all countries, whereas a high mortality rate was reported across the 35 nations between the end of November 2020 and the end of January 2021, (Figure 1). Some countries experienced another high transmission peak in March to April 2021, with similar patterns across the neighboring countries. This also translated into a peak in mortality rate in the affected countries. Of note, the delta variant started to be detected across these countries from around April 2021 onward, with the variant gaining predominance in Summer 2021, as shown in the heatmap found in Supplementary Figure 3. Indeed, most countries started to re-experience a rise in COVID-19 transmission (with some exceptions) in July 2021. Although unlike in the previous COVID-19 peaks, the mortality rate was not observed to be on the incline this time round, except for the UK nations (England, Scotland, Wales, and Northern Ireland).

COVID-19 Vaccination and Outcomes

A similar vaccination prioritization strategy was implemented across the 35 nations, as seen in Supplementary Material 4, where the elderly, at high-risk populations and health-care workers/frontline workers were given priority. However, considering similar prioritization strategies and vaccination procurements, different vaccination rollout speeds could be observed, as shown in Supplementary Material 5. Indeed, up until August 1, 2021, Malta had the quickest vaccination rollout, with 74% of the population fully vaccinated while Bulgaria had fully vaccinated the lowest population proportion (14%), as shown in Supplementary Material 2. A bidirectional relationship between fully vaccinated population and CFR was observed between January and July 2021. This is depicted in Figure 2, which demonstrates that, as vaccination rate increases, the CFR decreases, with some exceptions for Bulgaria and Romania. Both countries experienced a peak in CFR between May 31 and July 5, 2021, before a rapid decline in CFR occurred. Up until August 1, 2021, most countries had fully vaccinated approximately 50% or more of the over-50 age groups, with some exceptions, as shown in Supplementary Material 2. Of note, only Iceland and Malta had managed to fully vaccinate more than 70% of the whole adult population (18+ y) by August 1, 2021. Moreover, comparative analysis demonstrated that as the rate of fully vaccinated individuals increased, the CFR decreased. It needs to be noted that a negative comparison was evident between vaccination and CFR for 6 countries only, as shown in Supplementary Material 6.

Limitations

Several limitations need to be acknowledged. The COVID-19 cases reported in this study are dependent on the sources' accuracy and data reporting. Some data variables were not identified in the ECDC database leading us to resort to cross-referencing of country data between ECDC and OWID databases. It needs to be pointed out that mild or asymptomatic individuals tend to opt not to undergo swabbing, leading to under-representation of the COVID-19 situation. This also holds true for mortality, where deaths from COVID-19 might have been missed, especially if the deaths occurred in private residential homes. Data on hospital



Figure 1. COVID-19 transmission and mortality patterns across neighboring countries (February 2020 – August 2021).

admissions and intensive care unit admissions were lacking for most countries which prevented us from evaluating the impact of COVID-19 on the health-care systems. In addition, individual

countries' mitigative restrictions and varying vaccine rollout efforts might have confounded the analysis of epidemiological trends achieved in this study. England, Scotland, Wales, and Northern

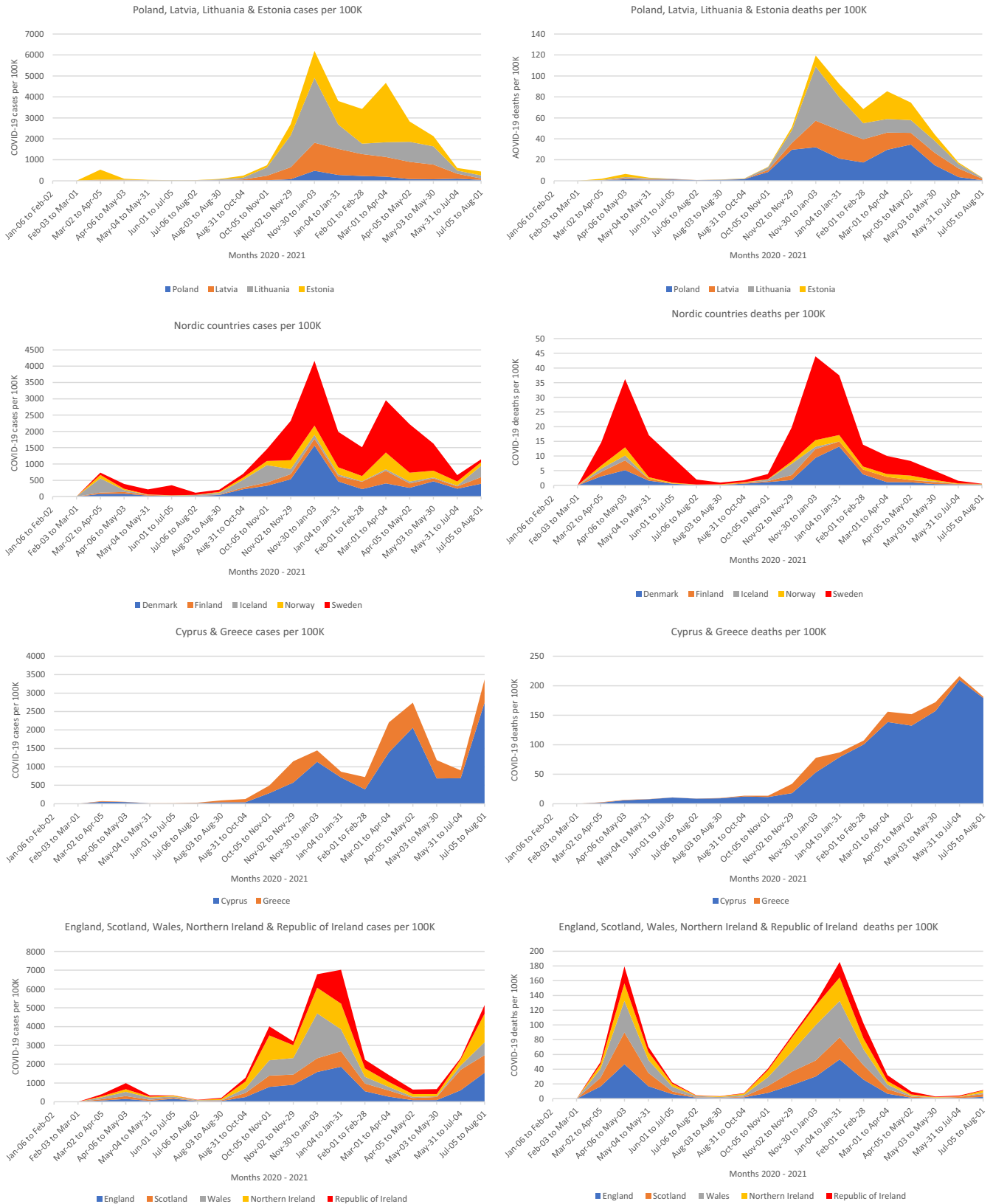


Figure 1. (Continued).

Ireland were grouped together for comparative analysis due to the nature of source data. In addition, the number of fully vaccinated individuals at the end of each fiscal month was used to conduct

comparative analysis. This approach was used to ensure congruency between the data for vaccinations, cases, and deaths. However, this may have resulted in bias because it may not be

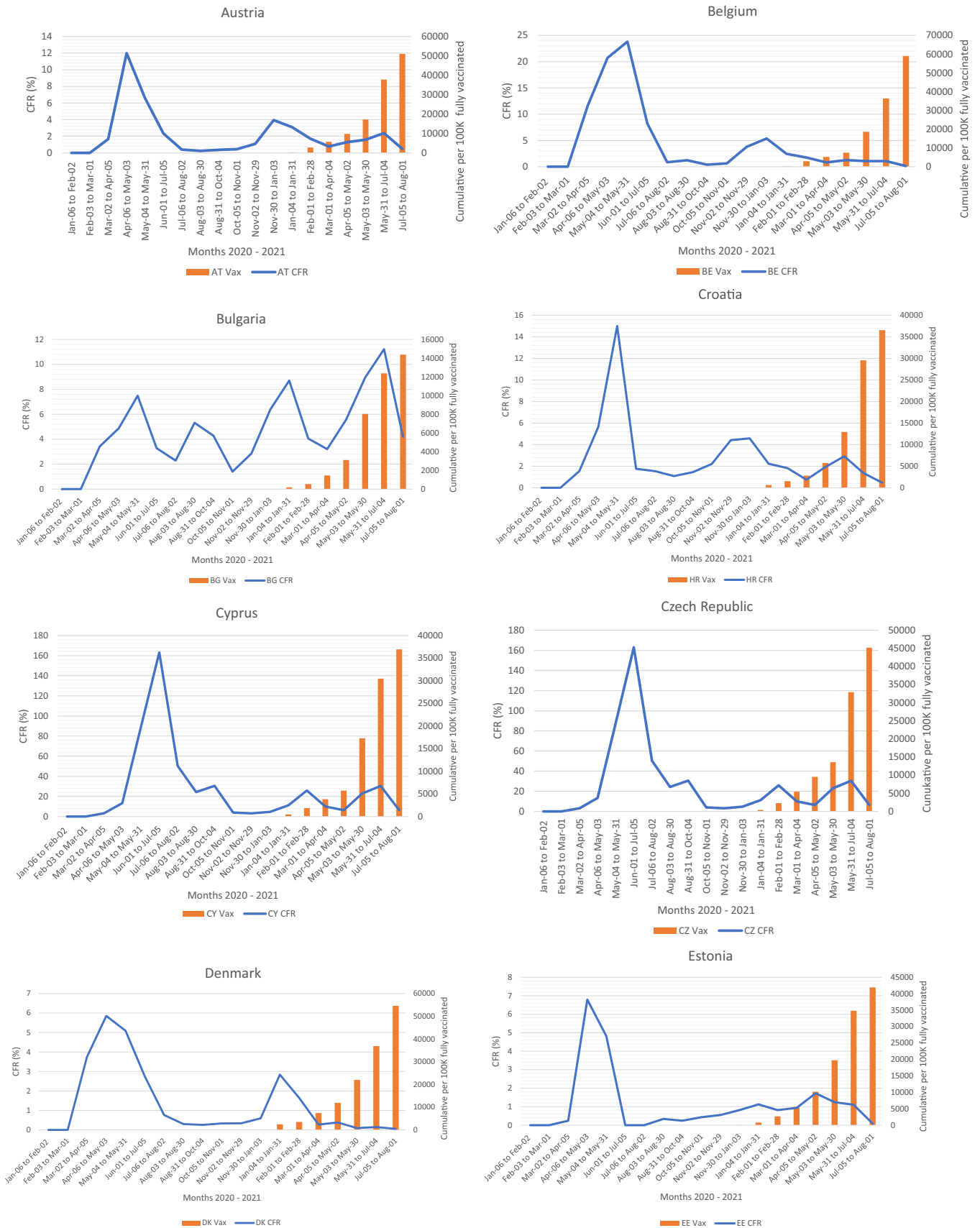


Figure 2. Comparative analysis between case fatality rates (CFR) and cumulative fully vaccinated per 100,000 population across each of the 35 countries. VAX, cumulative fully vaccinated persons per 100,000 population; CFR, case fatality ratio.

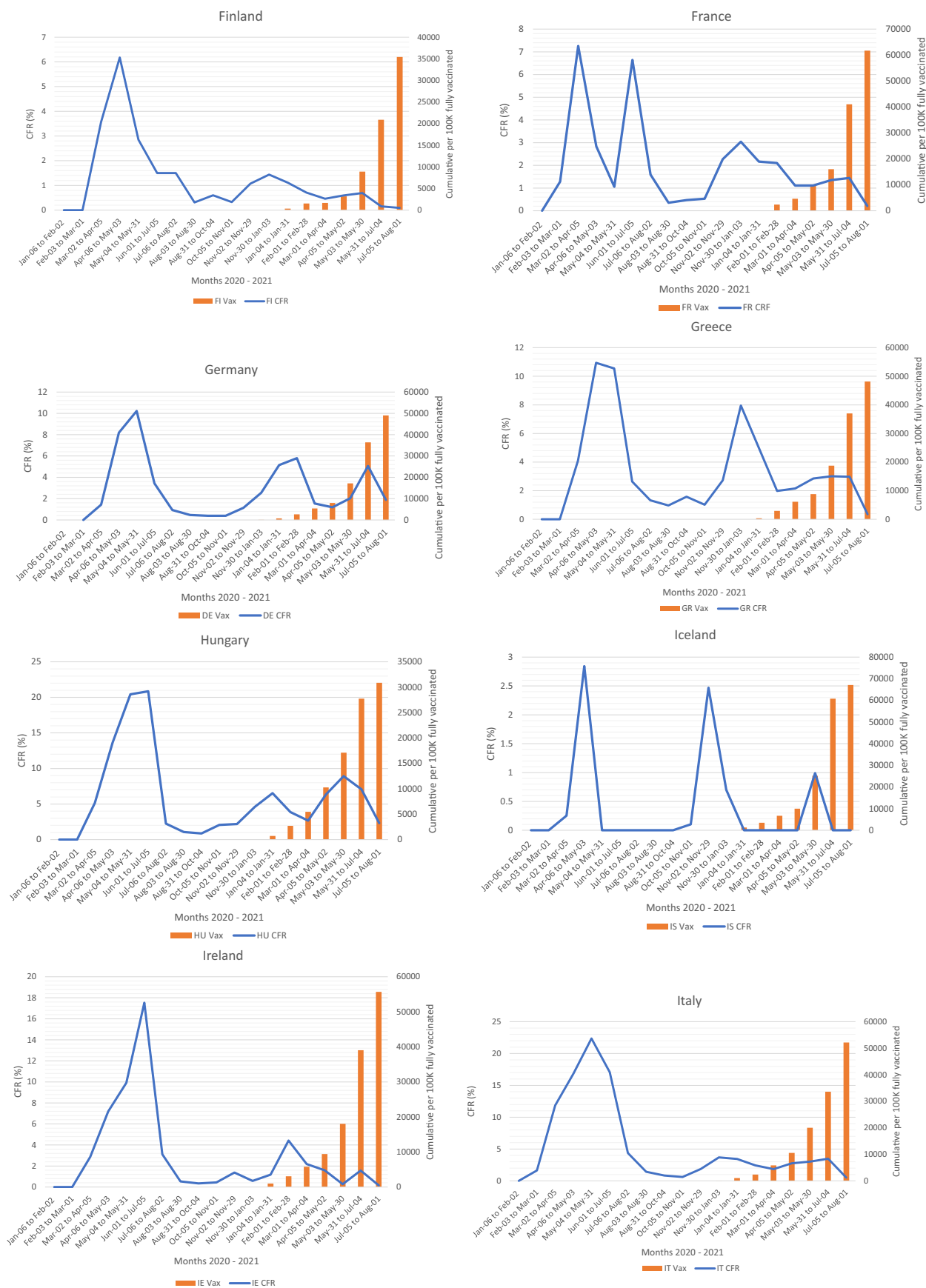


Figure 2. (Continued).

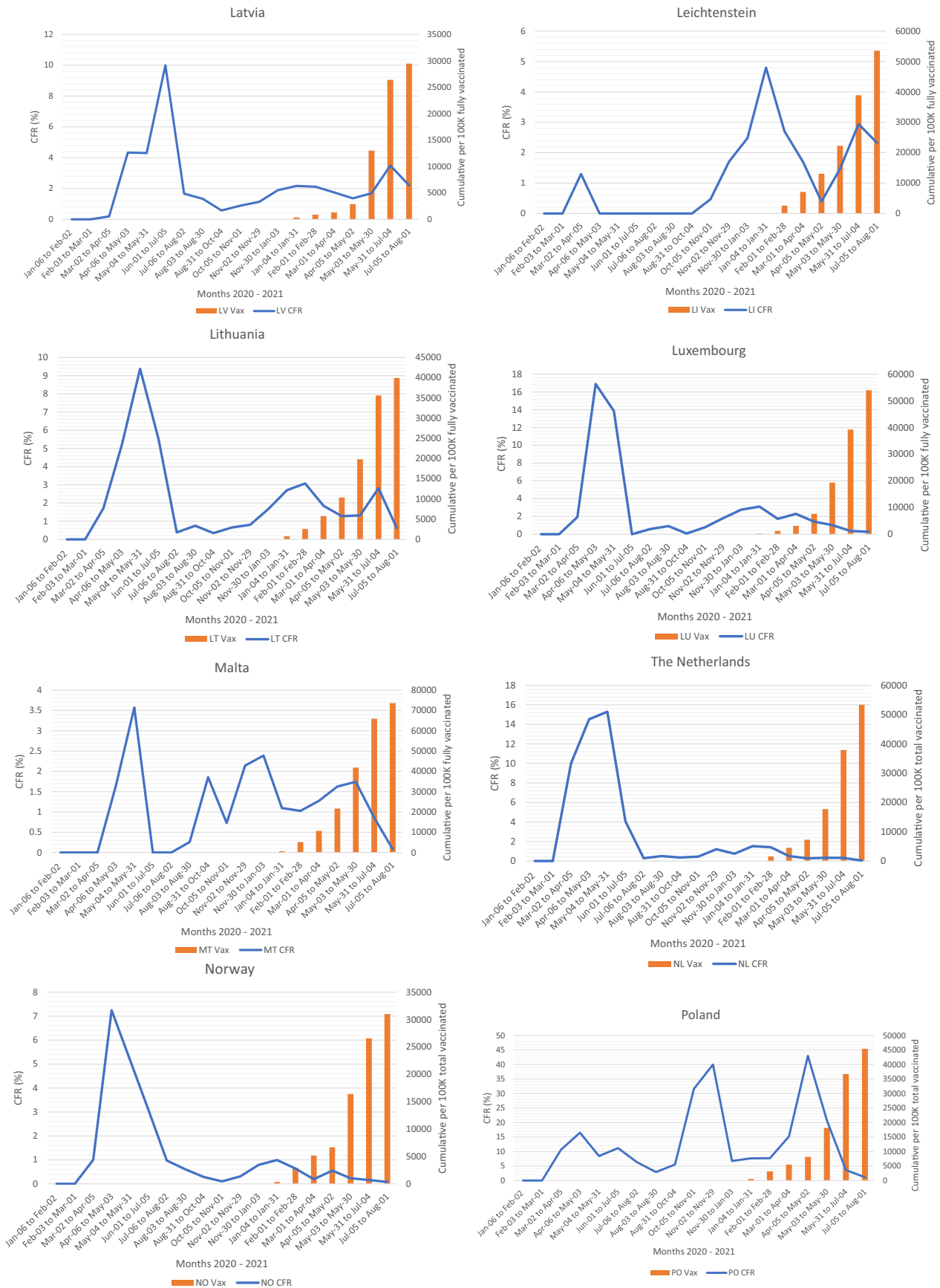


Figure 2. (Continued).



Figure 2. (Continued).

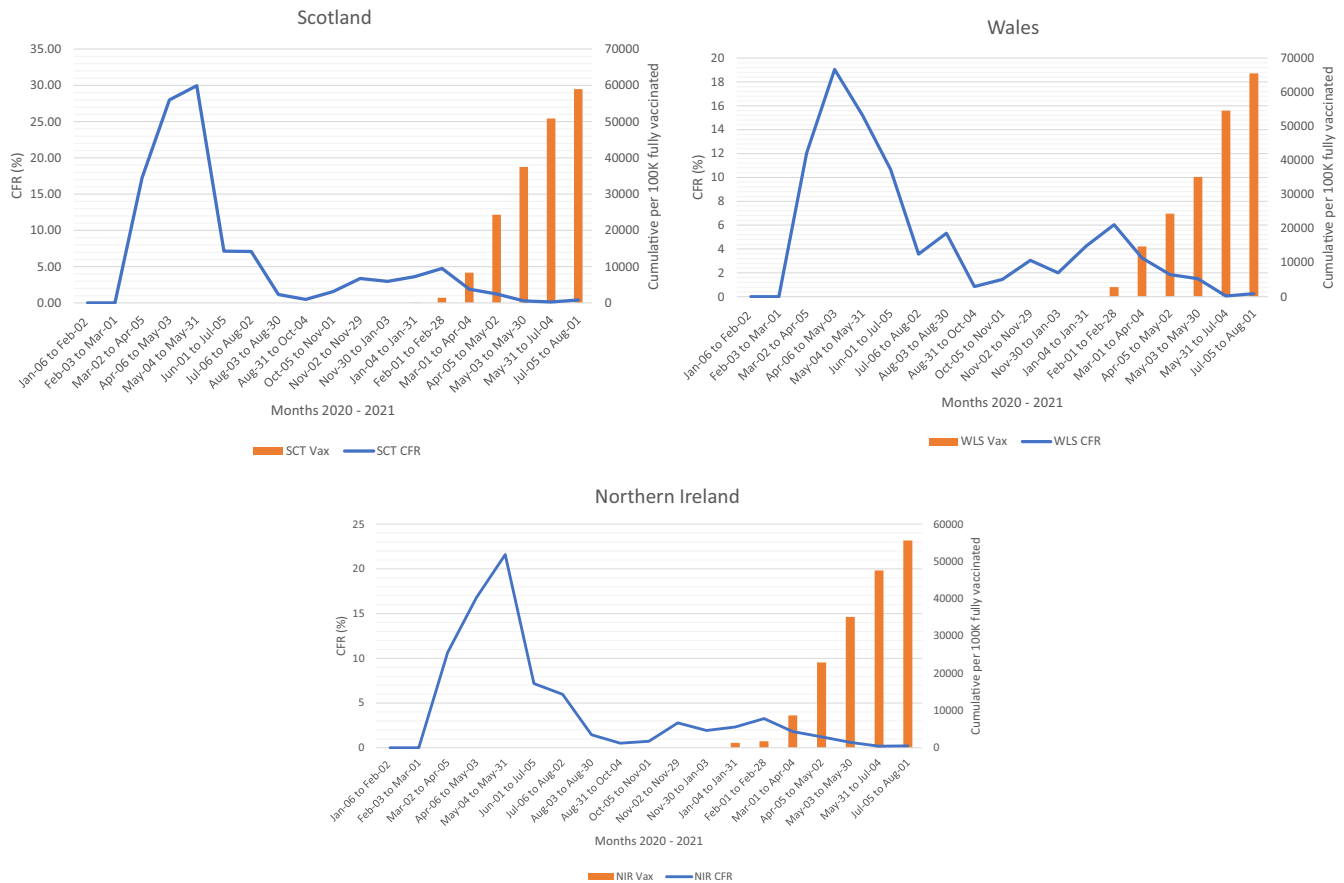


Figure 2. (Continued).

representative of the number of individuals who obtained acquired immunity through inoculation against COVID-19. These limitations might have affected the epidemiological interpretation and may have led to some inaccuracies. Every effort was made by the contributors to identify accurate data originating from reliable sources; however, it does not exclude the possibility of some missing data. In addition, stylistic boundaries hindered the exploration of arguments discussed in further depth.

Discussion

Observing the epidemiological data across 35 nations in Europe over 18 mo, provided evidence that COVID-19 containment requires a pan-European approach. Indeed, cross-border effect was evident for both COVID-19 morbidity and mortality across this timeline. Despite different relaxation measures and public health interventions instituted by each included country coupled with the emergence of new variants and COVID-19 fatigue, similar COVID-19 transmission patterns could still be observed across neighboring countries.³

Similarities among the 35 European nations' vaccination priority strategies were observed, all with the aim to decrease the morbidity, mortality, and the burden on health-care systems. Indeed, it was observed that, as the proportion of fully vaccinated population gained momentum, the CFR decreased, although one needs to keep in mind that other contributing factors might have played a role in this including mitigation measures, seasonality and habitual attitude. Of note, countries with lower vaccinated

populations, such as Bulgaria and Romania, had higher infectivity rates than other European countries. However, it is evident that vaccination outcome, and consequently the COVID-19 situation, varied across countries, even if the vaccination onset and prioritization strategies were similar.

COVID-19 cases started to decrease across countries from around Spring 2021, as vaccination programs were underway, inoculating large proportions of the population. The combination of vaccinating populations and the gradual relaxation of public health measures appeared to be the way forward.⁴ A delicate balance needed to be established between keeping low case numbers, restricting transmission and restarting the economy while increasing individuals' freedom,⁵ especially with the growing population "pandemic-policy fatigue".⁶ In fact, tipping the scales with swift easing of restrictions while proportions of the population were still unvaccinated, could have resulted in the increase in COVID-19 cases at the beginning of Summer 2021. It needs to be noted that, during this period, nonessential travel started to gain momentum with the introduction of the vaccination certificates/passes across countries to facilitate this movement.⁷⁻⁹ Such cross-border travel facilitated the transmission of the delta variant, which, as noted in the heatmap presented in this study, became the dominant circulating COVID-19 strain across Europe by Summer 2021.¹⁰

Implications for Policy and Practice

The success of 1 country in terms of COVID-19 containment and vaccination will be reflected in the neighboring countries'

outcomes and vice versa. It is, therefore, important that countries cease acting as a single entity in the fight against the pandemic and follow a pan-European strategic commitment, to ensure low case and mortality numbers as well as to decrease the burden on the health-care systems. Furthermore, it should be acknowledged that, should a drastic increase in case numbers occur, swift circuit breakers should be promptly instituted across countries or regions to ensure containment of the COVID-19 transmission, while safeguarding their neighboring countries.⁴

It is evident that the highest viral incidence is between the ages of 25 and 49 y. This age group is considered to have a higher daily contact rates than older age groups, giving rise to a higher possibility of transmission of highly transmissible variants.

Conclusions

It is evident that a country's COVID-19 outcome is not only dependent on national mitigations measures and vaccination roll-outs, but also on the actions of neighboring countries and COVID-19 situations. Mass population vaccination appears to reduce the population's COVID-19 case severity and mortality rates, although this is subject to an adequate rollout among other factors. Vaccination equity and pan-European commitment for cross-border governance to keep case numbers low appears to be the way forward to ensure populations' return to "normality."

Author Contributions. Sarah Cuschieri was responsible for the study design, data analyses, writing of article, and data verification. Andrea Cuschieri was responsible for France's data collection, coordination of COVID-19 epidemiological data, producing the heatmaps, reviewing the article, and data verification. Elysia Farrugia was responsible for coordinating United Kingdom's data collection and reviewing the article. Emily Diacono was responsible for Belgium's data collection and coordination of vaccination data. Elaine Balzan was responsible for Romania's data collection and coordination of vaccination data. Miguel Gruppeta was responsible for coordinating Switzerland's data collection and reviewing the article. Alessia Vella was responsible for Ireland's data collection and coordinating mitigation data collection. Catriona Cutajar was responsible for Cyprus's data collection and coordinating mitigation data collection. Martina Formosa was responsible for United Kingdom's vaccination data collection and reviewing the article. Mattias Barbara was responsible for Austria's data collection and reviewing the article. Franziska Mintoff was responsible for Bulgaria's data collection and reviewing the article. Conor Shaw was responsible for Croatia's data collection and reviewing the article. Samuel Fleri-Soler was responsible for Czechia's data collection and reviewing the article. Norbert Borg was responsible for Denmark's data collection and reviewing the article. Gillian Pace was responsible for Estonia's data collection and reviewing the article. Lauren Vella was responsible for Finland's data collection and reviewing the article. Robert Pisani was responsible for Germany's data collection and reviewing the article. Tamara Attard Mallia was responsible for Hungary's data collection and reviewing the article. Mattea Gouder was responsible for Iceland's data collection and reviewing the article. Rosie Attard was responsible for Italy's data collection and reviewing the article. Nicole Gixti was responsible for Latvia's data collection and reviewing the article. Mark Scicluna was responsible for Liechtenstein's data collection and reviewing the article. Timothy Borda was responsible for Lithuania's data collection and reviewing the article. Katya Bartolo was responsible for Luxembourg's data collection and reviewing the

article. Reuben Chircop was responsible for Malta's data collection and reviewing the article. Naomi Frendo was responsible for Slovenia's and Netherlands' data collection and reviewing the article. Gianluca Gatt was responsible for Spain's and Netherlands' data collection and reviewing the article. Etienne Degabriele Fernate was responsible for Norway's data collection and reviewing the article. Mariah Mallia was responsible for Poland's data collection and reviewing the article. Miguel Attard was responsible for Portugal's data collection and reviewing the article. Greta Damato was responsible for United Kingdom's data collection and reviewing the article. Nicole Riolo was responsible for Switzerland's data collection and reviewing the article. Lorna Muscat Baron was responsible for Sweden's data collection and reviewing the article. Matteo Galea was responsible for Slovakia's data collection and reviewing the article. Elizabeth Grech was responsible for Greece's data collection, vaccination analyses and data verification.

Supplementary material. To view supplementary material for this article, please visit <https://doi.org/10.1017/dmp.2022.108>

Conflicts of interest. All authors declare that they have no competing interests, and no funding was used.

Ethical standards. No ethical clearance required as no human or animal subjects were involved. No ethical approval was required to carry out this study. In addition, this study is exempt from institutional review board review because the study was an observational study that did not use human participants.

References

1. Danchin M, Biezen R, Manski-Nankervis J-A, et al. Preparing the public for COVID-19 vaccines: how can general practitioners build vaccine confidence and optimise uptake for themselves and their patients? *Aust J Gen Pract.* 2020;49(10):625-629.
2. Doherty M, Buchy P, Standaert B, et al. Vaccine impact: benefits for human health. *Vaccine.* 2016;34(52):6707-6714.
3. Priesemann V, Brinkmann MM, Ciesek S, et al. Calling for pan-European commitment for rapid and sustained reduction in SARS-CoV-2 infections. *Lancet.* 2021;397(10269):92-03.
4. Leung K, Wu JT, Leung GM. Effects of adjusting public health, travel, and social measures during the roll-out of COVID-19 vaccination: a modelling study. *Lancet Public Health.* 2021;6(9):e674-e682.
5. Bauer S, Contreras S, Dehning J, et al. Relaxing restrictions at the pace of vaccination increases freedom and guards against further COVID-19 waves. *PLoS Comput Biol.* 2021;17(9):e1009288.
6. Petherick A, Goldszmidt R, Andrade EB, et al. A worldwide assessment of changes in adherence to COVID-19 protective behaviours and hypothesized pandemic fatigue. *Nat Hum Behav.* 2021;5(9):1145-1160.
7. ge.ch. COVID-19 certificate. 2021. Cited September 22, 2021. Accessed May 27, 2022. <https://www.ge.ch/en/covid-19-certificate>
8. GOV.UK. NHS COVID pass. 2021. Cited September 21, 2021. Accessed May 27, 2022. <https://www.gov.uk/guidance/nhs-covid-pass>
9. European Commission. EU digital COVID certificate. 2021. Cited September 21, 2021. Accessed May 27, 2022. https://ec.europa.eu/info/live-work-travel-eu/coronavirus-response/safe-covid-19-vaccines-europeans/eu-digital-covid-certificate_en
10. Campbell F, Archer B, Laurenson-Schafer H, et al. Increased transmissibility and global spread of SARS-CoV-2 variants of concern as at June 2021. *Euro Surveill.* 2021;26(24):2100509.