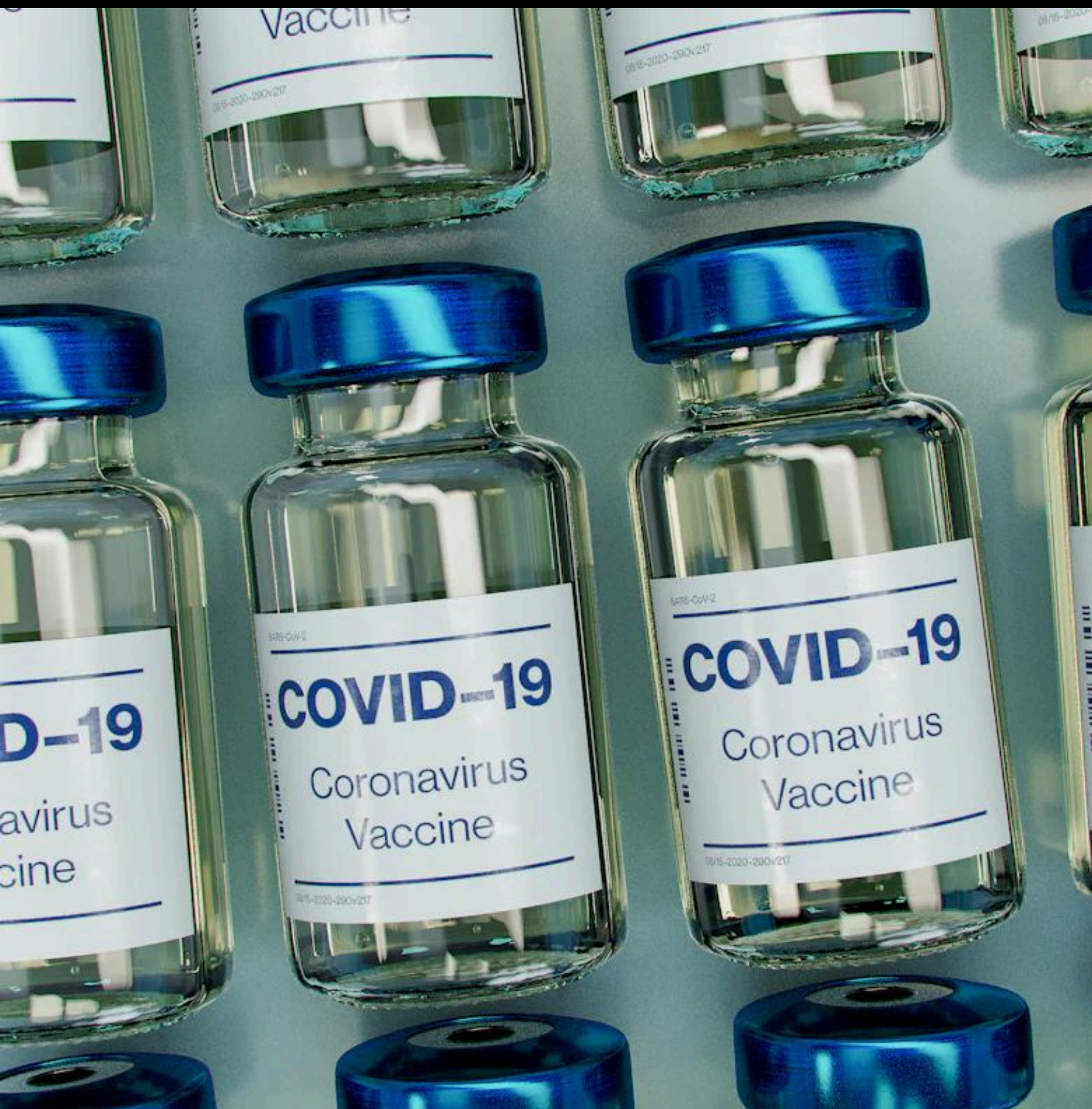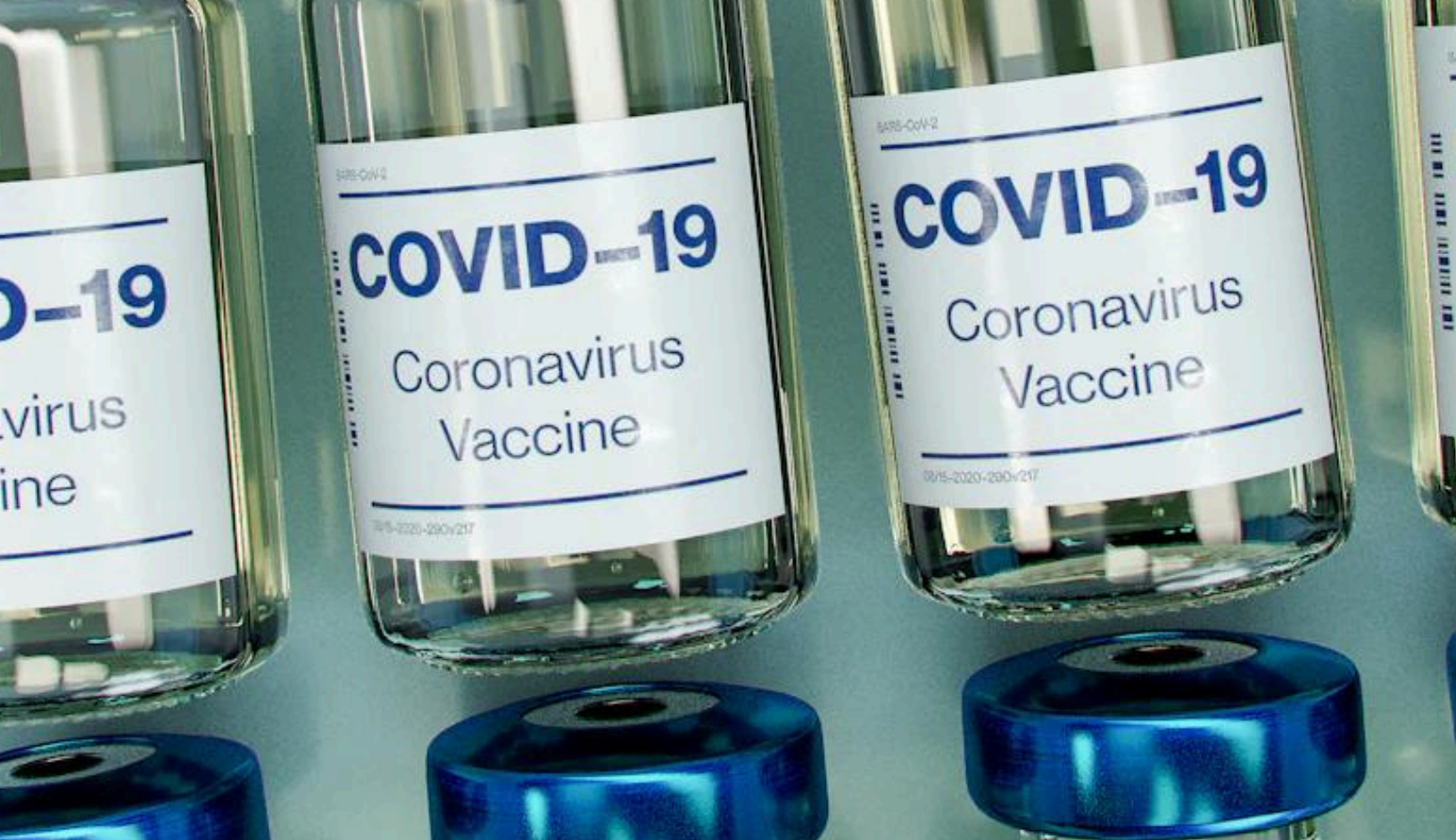# COVID-19
POST PANDEMIC CASE ANALYSIS

Group 99

Data Visualization and
Narratives

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⁂ **UTS**

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Abstract

The COVID-19 pandemic is the latest global health challenge that pressured healthcare systems worldwide and left an imprint to the way people live post-pandemic. With the wide availability of related data, numerous studies have been conducted pre-pandemic to project the effects of the virus.

This paper, written through a post-pandemic lens, validates the findings of initial COVID-19 studies through the comprehensive review of the latest available COVID-19 data using trend and statistical analysis through Tableau and Python. The results of these analyses are then used to generate insights that can be leveraged by the global health decision-makers in building a policy that will help prepare all the countries for similar crises.

The results of the study have reinforced the magnitude of deaths induced by the virus and how the positive impact of vaccination in mitigating the effects of COVID-19, especially on the degree of critical and moderate cases, projected mortality levels, and recovery to the pre-pandemic state. Moreover, the project has also analysed the substantial lifestyle changes brought by the pandemic, which includes the decline in office occupancy due to the rise of remote work, a reduction in public transport usage, and an increase in traffic, indicating a shift toward private transportation.

Keywords: COVID-19, pandemic, mortality rate, vaccination, societal impacts, public health, global health policy

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Introduction

Overview

On January 30, 2020, the World Health Organization (WHO) designated COVID-19 as a Public Health Emergency of International Concern. The virus has brought an unprecedented health challenge to the worldwide health system that by the end of 2020, over 80 million confirmed cases and nearly 1.8 million deaths globally were reported (World Health Organization, 2020).

The numbers continued to rise, as the virus spread, and new variants emerged. By mid-2021, the total documented cases and deaths accumulated to over 200 million and 4 million, respectively, emphasizing the devastation brought by the pandemic to the global population (Johns Hopkins University & Medicine, 2021).

With the influence of the pandemic felt globally, numerous research were conducted to understand the virus and its effects. Multiple studies, especially those done during the peak of the pandemic, have attempted to project the impact of the pandemic on each nation.

This paper adopts an 'after-the-pandemic' view. The project team, referencing earlier COVID-19 research, attempted a holistic analysis of the COVID-19 pandemic through a detailed examination of available COVID-19 data, including the reported cases and deaths, the global vaccine distribution, and the quantified socioeconomic factors comparing the state of countries pre-pandemic.

Through the meticulous review of comprehensive pandemic information created from the combination of the COVID-19 datasets, the team thoroughly deliberated the effects of the virus's spread, the impact of the vaccines developed to mitigate the virus, and the progress of the nations in their recovery back to their pre-pandemic state.

With this undertaking, the team documented the historical implications of the pandemic and offered insights that can be leveraged by the global health decision-makers in building a policy that will help prepare all the countries for similar crises, ensuring that the lessons learned are integrated into the creation of a more resilient global health system and that the avoidable losses suffered are mitigated if not fully controlled.

Research Questions

To achieve its objective, the paper aims to address the following questions:

How serious was COVID-19 and what are the main factors leading to its spread?

Asia, where the novel coronavirus SARS-CoV-2 was first identified, experienced diverse impacts from COVID-19, with varying cases and deaths across its countries. Initially, China faced an early surge, but stringent measures lead to early successes in South Korea and Singapore through rapid response, testing, and contact tracing. Despite these efforts, new variants and differing responses caused challenges in subsequent waves. India, for example, experienced a devastating wave in 2021, overwhelming health care systems. The variance in outcomes highlights the complexities of managing a pandemic in density populated regions and underscores the need for international cooperation and robust public health interventions (Dowd et al., 2020; Zhou et al., 2020)

What was the role of Vaccinations in putting the pandemic to an end?

Henry et al. (2021) found that COVID-19 vaccines are highly effective in preventing severe complications and deaths, including against the Delta variant, with two doses required for substantial protection. Governments relied on these vaccines, using certificates to control access to public spaces, which accelerated vaccination rates and improved public health and economies in countries like France, Germany, and Italy (Oliu-Barton et al., 2022).

However, vaccine distribution was unequal, with high-income countries accessing most supplies, delaying vaccination in developing economies and hindering global recovery (Ghosh et al., 2021; Suarez-Alvarez et al., 2022). Effective national vaccination plans were still crucial for maximizing benefits, as shown in Japan's study on vaccine allocation and economic impact (Sunohara et al., 2021).

Has the world returned to "normal" after the COVID-19 pandemic?

Post-COVID-19, several lifestyles have changed from the pandemic are expected to persist or evolve. Remote and hybrid work models have redefined workplaces, offering flexibility and reducing the need for physical office spaces (Kramer & Kramer, 2020). Education systems are blending online platforms with classroom learning to improve access and quality (Wiliamson et al., 2020). The shift towards online shoping continues, driven by safely and convenience (Sharma & Singh, 2020). Health and fitness trends emphasize personal well-being tnd home-based routines (Kutana et al., 2023). Travel and tourism are rebounding cautiously with a focus on health security and sustainability (Capello & Caragliu, 2021).

To quantify the return to pre-pandemic life, the Normalcy Index tracks changes in behavior across three domains: transport and travel (public transport, traffic congestion, flights), recreation nand entertainment (time spent outsize, cinema revenues, sports event attendance), and retailing and work (shop footfall, office occupancy) (The Economist, 2021).

Data Exploration

Datasets Overview

The following datasets are used to answer the research questions:

Dataset	Source	Data Description	Attributes
1	Our World in Data (OWID)	Comprehensive global COVID-19 data including cases, deaths, hospitalization, vaccination. Dataset is still being continuously updated.	10 columns, 395,000+ rows Still being updated
2	OWID	Vaccination progress in terms of additional vaccinations, full vaccinations, and boosters per country both in absolute and in daily numbers. Dataset is still being continuously updated.	16 columns, 191,890 rows
3	The Economist	Documentation of various socioeconomic metrics (e.g., office occupancy, public transport levels) during the pandemic. Last update was on August 2022.	11 columns, 46,213 rows

Table 1. Dataset Description

Dataset 1 will be mainly used to evaluate the impact of COVID-19 on global mortality. Dataset 2 was combined with the first dataset to assess the relationship between vaccination progress in various expected impacts (i.e., mortality, level of critical and moderate cases, and return to normalcy). Dataset 3 was reviewed to identify changes in people's lifestyles due to COVID-19.

In addition to the three main datasets, the team also utilized auxiliary datasets such as the COVID-19 vaccine brand dataset. This dataset extracted from OWID was used to provide information on the most used global vaccine and whether there are differences in the vaccine most used between the countries.

Data Exploration

Due to difficulty in fully documenting the effects of the pandemic, the majority of the datasets have null values in its rows. In some columns, null values were replaced with '0' to be statistically evaluated while some columns were dropped in favor of the 'smoothed' columns generated by OWID. These 'smoothed' columns factor in periods when data are not available (e.g., not reported) to project probable numbers based on historical data.

After performing a brief statistical analysis of the first dataset, the team was able to find out that throughout the pandemic, the average daily case increase is at 8,500 while daily average deaths tally to 76. However, these metrics has considerable deviation of 237,096, and 1,409. The magnitude of the deviation compared to the mean indicates the level of variability in the reporting per country.

	new_cases	new_deaths	total_cases	total_deaths	weekly_cases	weekly_deaths	biweekly_cases	biweekly_deaths
count	3.846180e+05	384954.000000	3.566920e+05	3.342860e+05	3.833830e+05	383719.000000	3.816540e+05	381990.000000
mean	8.543600e+03	76.515007	7.471564e+06	9.023134e+04	5.999527e+04	537.290124	1.205292e+05	1079.386811
std	2.370964e+05	1409.023212	4.441918e+07	4.585231e+05	6.258462e+05	3700.617585	1.205724e+06	7372.258072
min	0.000000e+00	0.000000	1.000000e+00	1.000000e+00	0.000000e+00	0.000000	0.000000e+00	0.000000
25%	0.000000e+00	0.000000	9.405000e+03	1.330000e+02	0.000000e+00	0.000000	2.000000e+00	0.000000
50%	0.000000e+00	0.000000	7.967800e+04	1.391000e+03	1.110000e+02	0.000000	2.450000e+02	1.000000
75%	0.000000e+00	0.000000	8.669710e+05	1.256700e+04	2.653000e+03	26.000000	5.486000e+03	55.000000
max	4.423623e+07	103719.000000	7.753359e+08	7.045569e+06	4.423623e+07	103719.000000	7.196893e+07	204689.000000

Fig 1. Statistical Summary – Dataset 1 (COVID-19 Cases and Mortality)

To assess whether the vaccinations are relevant to the documented COVID-19 impact, the team combined the vaccination progress dataset with the first dataset. Then to minimize issues encountered with null values, the team decided to create a sample of the data using the top 10 most populous countries. After creating this new dataset, the correlation between the total vaccinations (the total number of vaccines used) and metrics that measure mortality and criticality were computed. This leads to the identification that total vaccination has a negative correlation with most of the metrics, signaling that the increase in vaccination may lead to a downward trend in new deaths, projected mortality, critical (ICU patients), and moderate cases (hospital admissions). However, the weak positive correlation with the reproduction rate (i.e., the rate at which the virus was being spread) indicates that the vaccine may not have an effect in actually stopping the virus from being spread out.
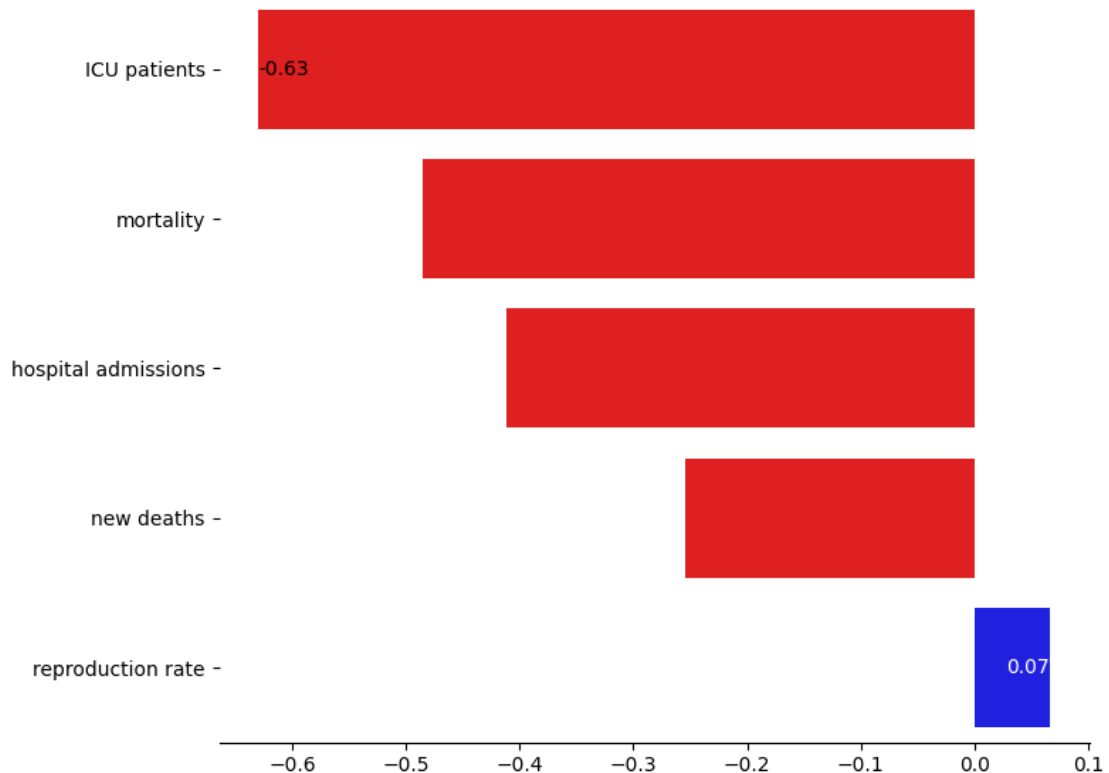

Fig 2. Correlation of Total Vaccinations with COVID-19 metrics (Dataset 2)

To dive deeper into how people's life has changed, the third dataset was explored by itself. The dataset consists of 7 different variables reflecting people's lifestyles, such as time spent outside, retail footfall, and public transport footfall. All of those variables equally contribute to the final "Overall" normality. The dataset was updated daily from February 28th ,2020, until August 28th, 2022. Although it is not current, the last update occurred as the pandemic was nearing its end, and clear recovery signs and trends had emerged. Thus, analyzing this dataset can provide valuable insights into today's situation.

	cinema	flights	office_occupancy	public_transport	retail_footfall	time_outside	traffic	overall
count	41443.000000	41445.000000	42597.000000	43742.000000	45300.000000	45300.000000	42481.000000	46213.000000
mean	29.859504	37.092004	77.954743	73.382029	85.591859	92.231208	71.811280	65.118017
std	37.200370	28.471480	18.226830	25.448916	22.562760	6.941171	28.233108	19.641786
min	0.000000	0.298771	16.233845	8.785714	8.571429	59.071429	1.159837	14.324900
25%	0.129881	14.740391	67.428571	57.214286	74.357143	88.714286	52.129308	50.958651
50%	14.901290	27.342632	77.258198	72.581966	89.071429	93.428571	73.225656	64.374794
75%	50.582097	56.256268	88.642857	87.714286	99.500000	96.928571	92.821742	79.338239
max	300.000000	194.119394	143.000000	198.642857	170.785714	111.428571	161.413881	128.880241

Fig 3. Statistical Summary – Dataset 3 (Socioeconomic Metrics during COVID-19)

Findings

COVID-19 Mortality & Spread

Each year saw a rise in the number of COVID-19 cases and deaths. 2021 has shown the highest increase in COVID-19 related deaths while 2022 has shown the highest annual increase in cases and vaccinations. The number of new cases has been steadily rising since 2020, the start of the pandemic, with a significant surges in cases noted in January 2022 and December 2022. The occurrence of new deaths has been decreasing since the start of the pandemic with the highest peak noted in January 2021. During 2021, the increase in public awareness of COVID-19 has led to a surge in vaccinations which peaked during 2022. However, even with the expected decrease in number of vaccinations in 2022 to 2023 (Fig 4), the rate of new deaths continued to slow down.
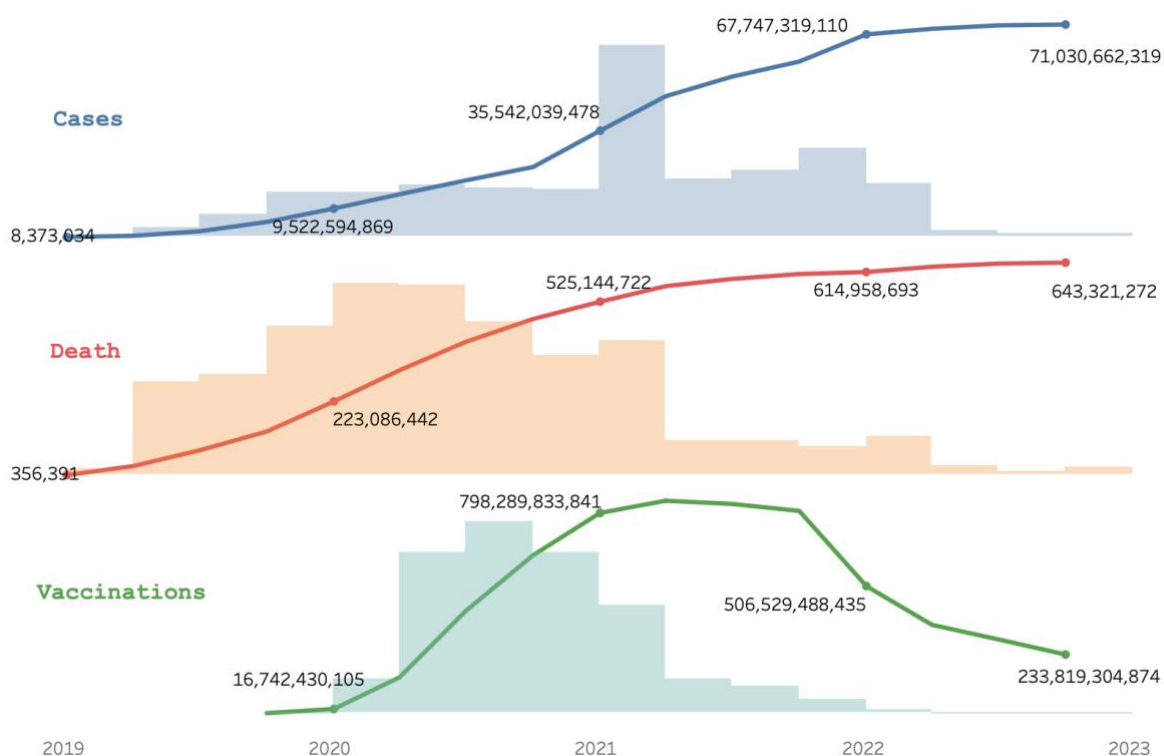
Fig 4. Cases, Deaths, and Vaccinations per Year

"Excess Mortality Cumulative Per Million" and "Total deaths per Million" both increased over time, reflecting the ongoing impact of the COVID-19 pandemic. This cumulative measure accounts for the additional deaths compared to expected mortality rates, indicating the broader and sustained effects of the pandemic. Despite fluctuations in daily death rates, the cumulative totals continued to rise due to delayed reporting, indirect effects of the pandemic.
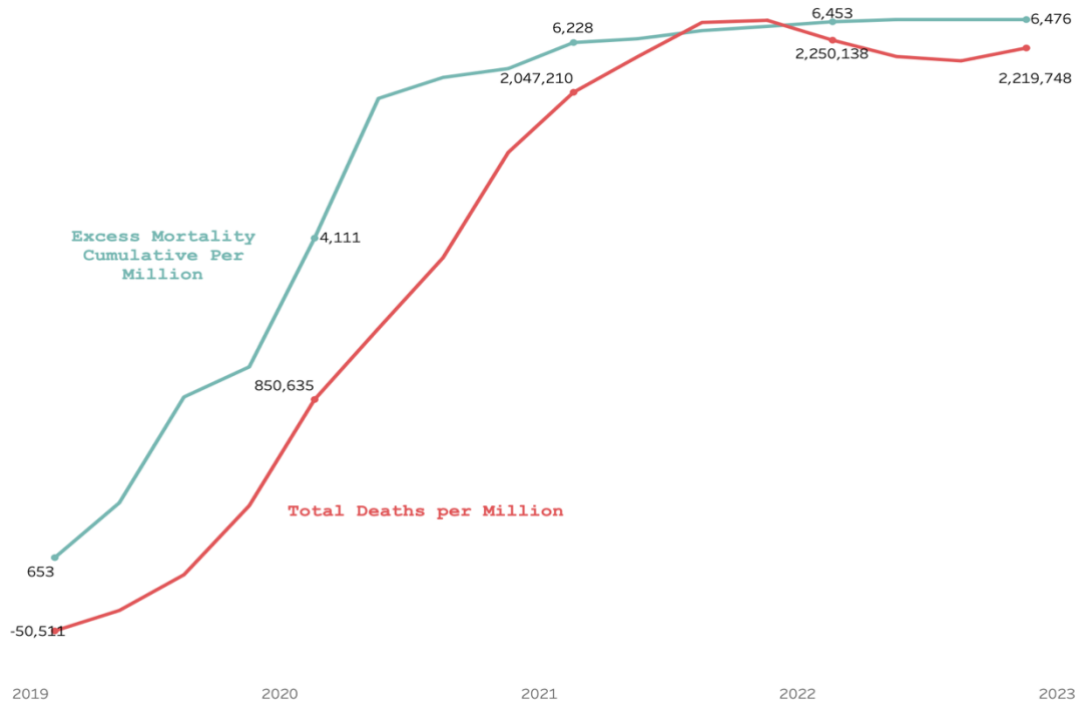
Fig 5. Excess Mortality Cumulative and Total deaths over time (monthly, per Million)

Normalized graphs were generated to display the relationship between new cases, new deaths, and new vaccination. The normalized graph of new cases and new deaths has shown that even if the cases rapidly increased during 2022, deaths still steadily decreased. Thus, it can be inferred that as time passes, the increase in cases has a decreasing impact on the number of new deaths.
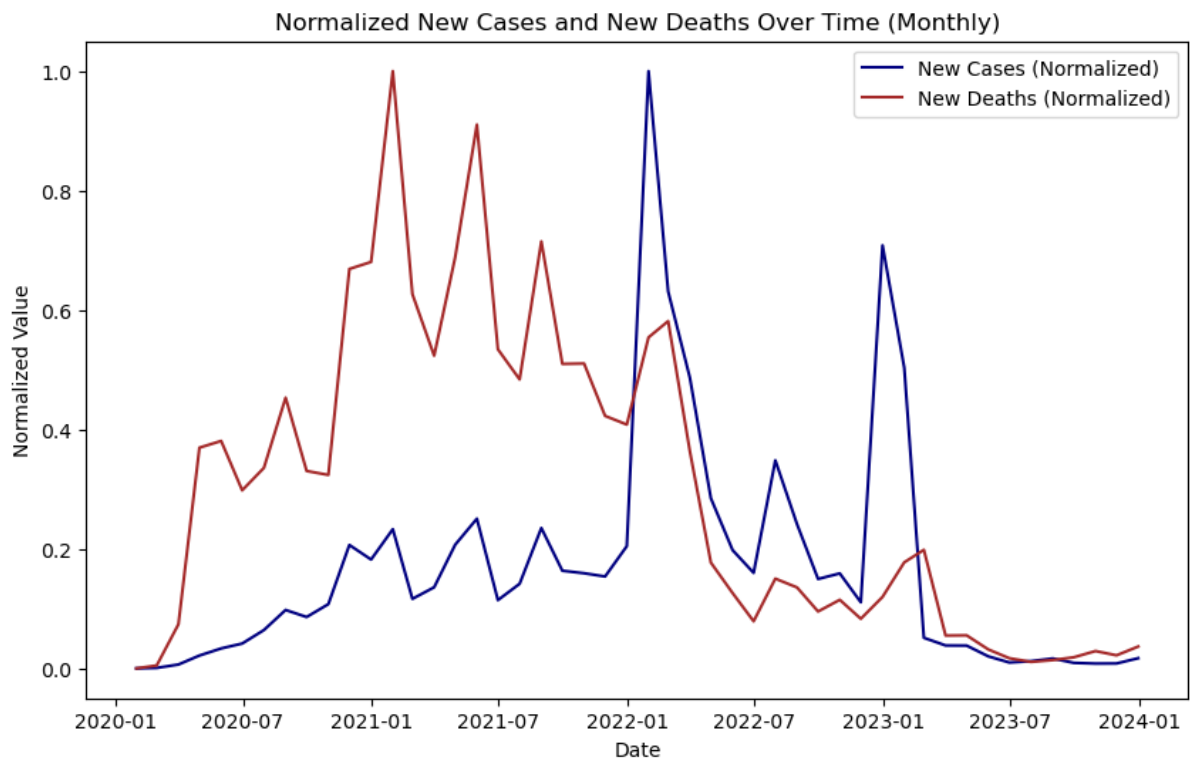

Fig 6. Normalised new cases and deaths distribution

On the other hand, the chart plotting vaccination rates and the number of cases has shown that even when vaccination rates increased in 2021, a sudden surge in cases was still observed in 2022. This might signal that vaccinations may not lead to an overall decrease in number of COVID-19 cases.
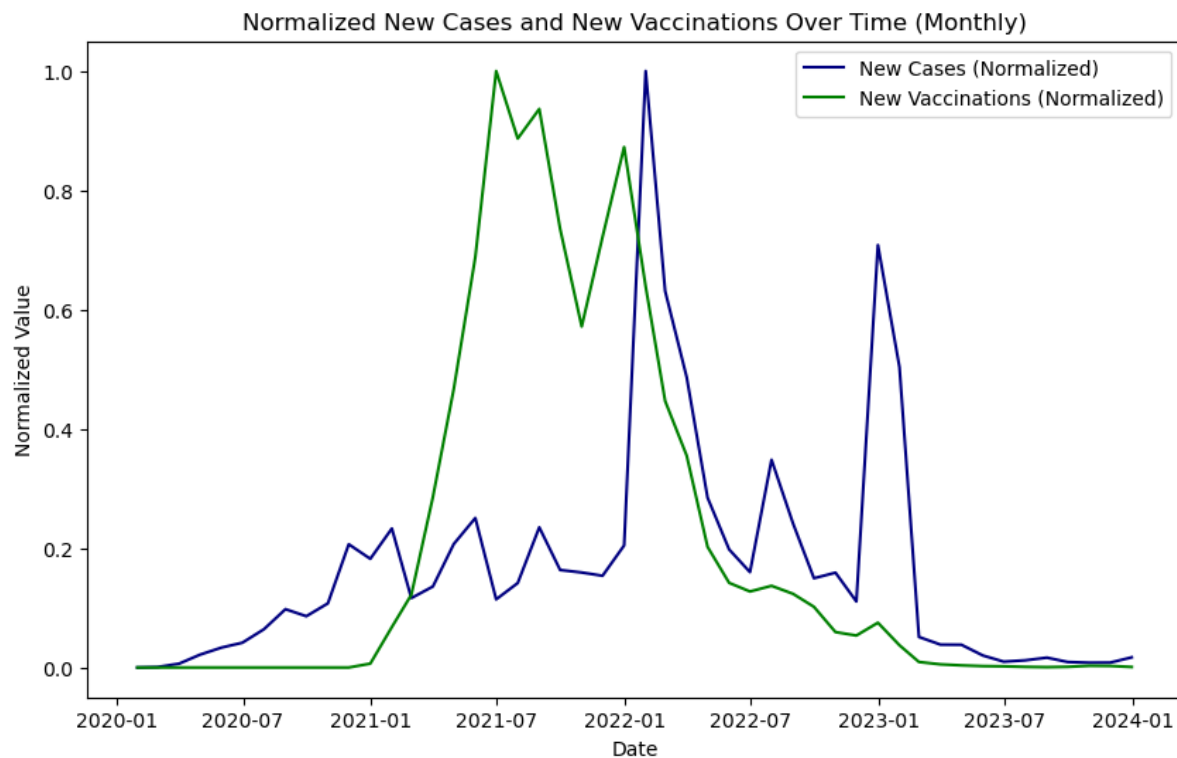
Fig 7. Normalised new cases and vaccination distribution

Breaking down the COVID-related deaths by country as of the global peak number of cases of COVID-19 (2022), the United States (US) recorded the highest number of fatalities, followed by Brazil, India, and Russia. The order mirrored the population sizes of these countries, except for India, which had a higher population, but a lower death toll compared to the US and Brazil.

Fig 8. New Deaths across countries (2020-2022). The top four countries with the highest deaths were marked with the number of recorded deaths.

Population

India	2,233,464,837,120
United States	529,761,914,496
Brazil	336,319,693,248
Russia	226,042,193,344

Fig 9. Population of the Top Four Countries with Highest Number of COVID-19 Deaths

Analysing the number of deaths actually reported during 2022, China and the US recorded the most number of deaths globally.
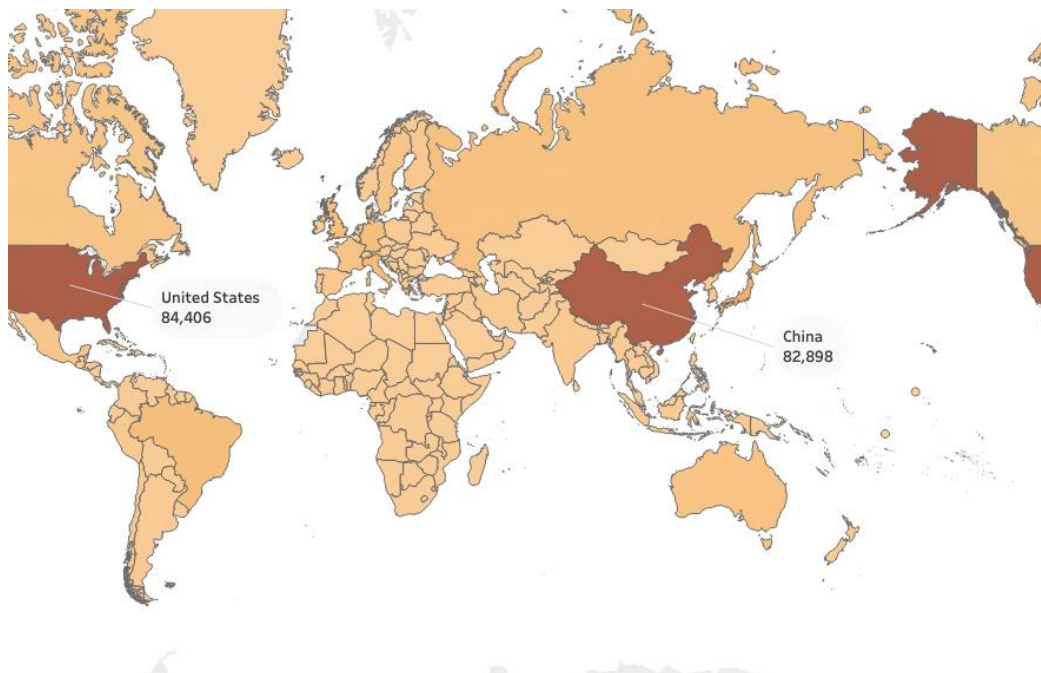

Fig 10. Global Heatmap of COVID-19 related deaths (2022)

China continued to tally the highest number of deaths in 2023, which could have led to Asia recording the highest number of deaths during this year. Another explanation in the continent's sudden rise in number of deaths is the surge in cases noted during December 2022.

Breaking the fatality numbers, the deaths were mostly recorded by China in early 2023, particularly in February and January, followed by a significant drop in March. This is a distinct pattern against the pandemic's trajectory for that year.
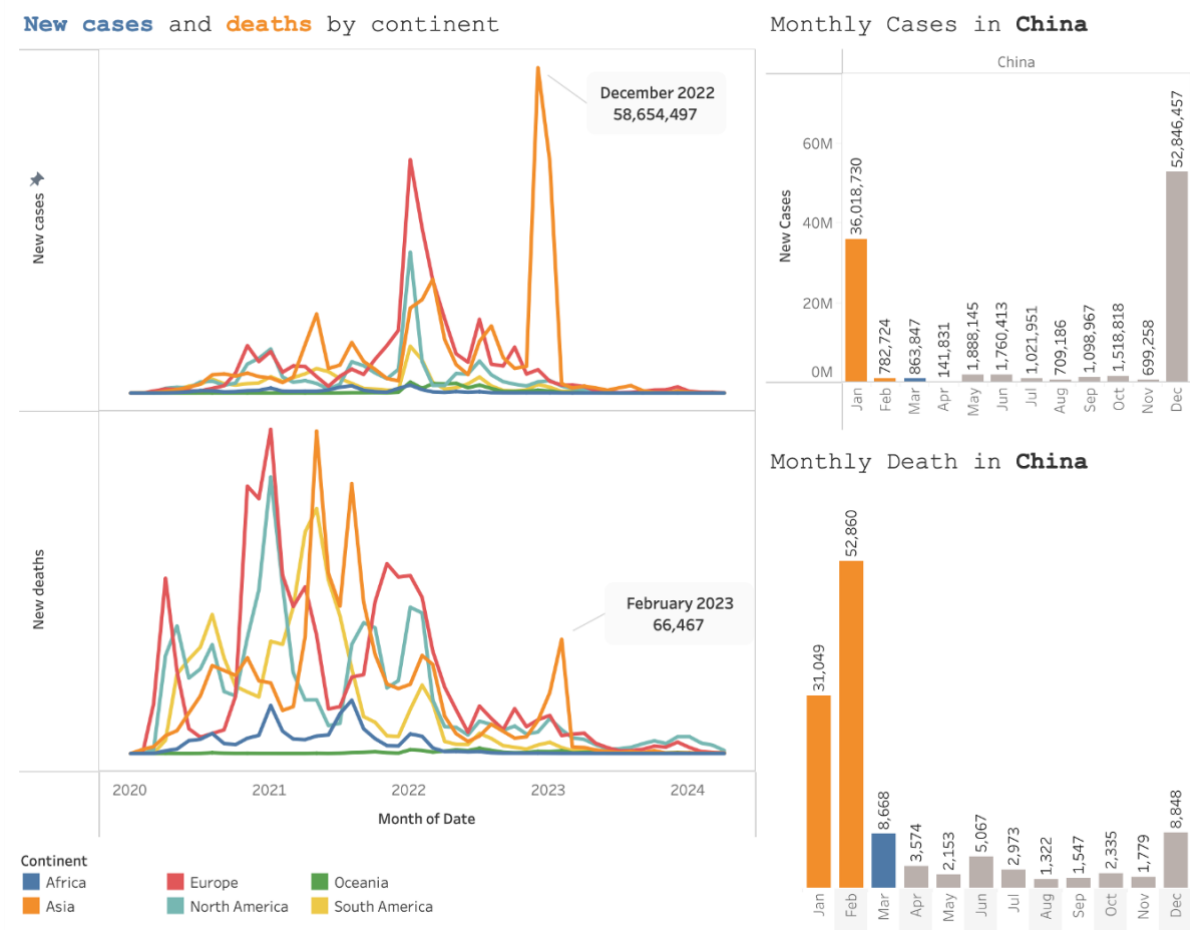

Fig 11. A Dashboard of the glimpse of Covid-19

Assessing the impact of COVID-19 to date, Europe emerged as the continent with the highest death toll from COVID-19. On the other hand, Oceania had the lowest mortality rates.
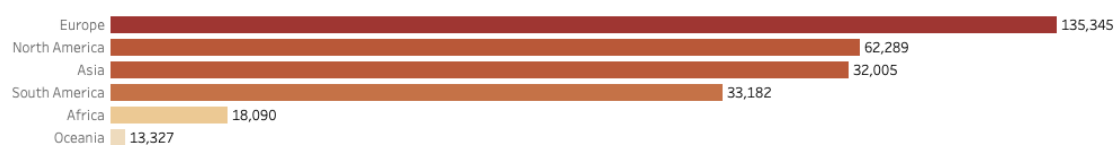

Fig 12. New deaths by Continent

Delving deeper on the numbers experienced by Europe, Russia, Germany, and France tallied the highest numbers of deaths. However, analysing the deaths in terms of the country's population, Bulgaria, Bosnia Herzegovina, and Hungary were the most affected countries in Europe. Thus, it can be inferred that percentage of COVID deaths per population might not be directly correlated with the actual population of the countries
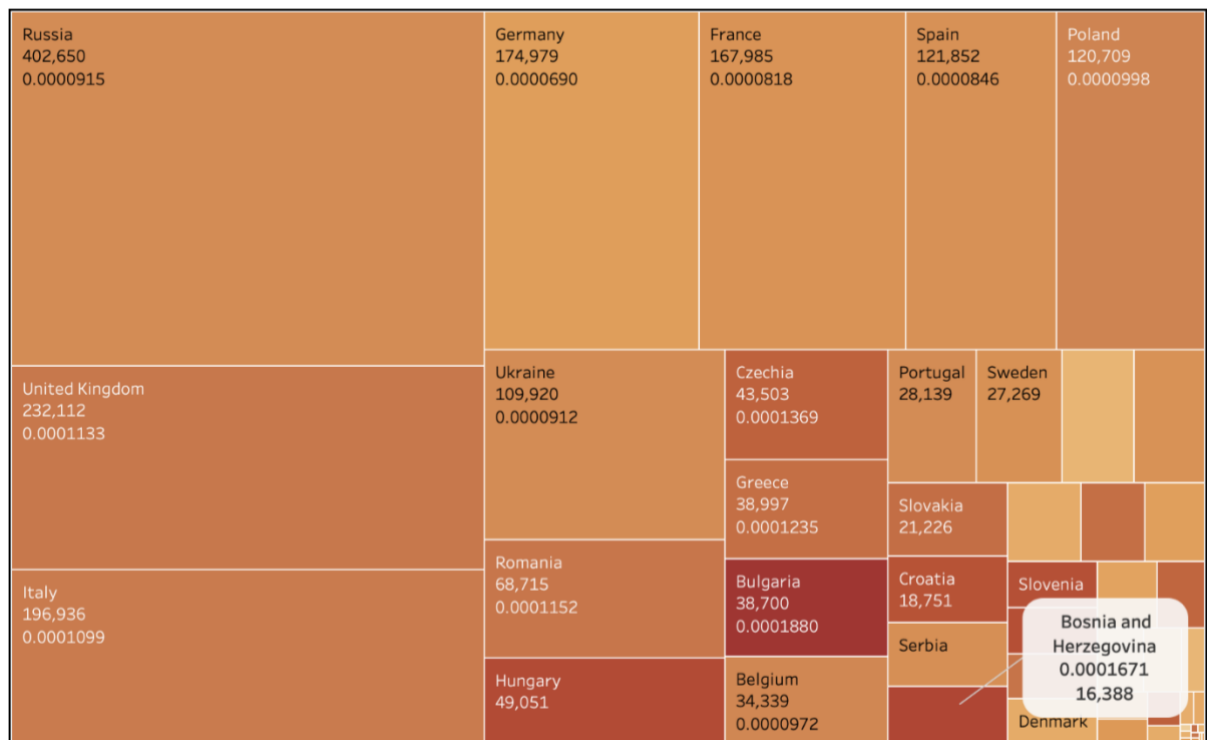

Fig 13. Breakdown of COVID deaths in Europe stated in Cumulative Deaths (first number) and Percentage of Deaths per Population (second number)

The Role of Vaccination

As of Q1 2024, five billion people were estimated to be vaccinated with around two billion vaccinated in China or India.
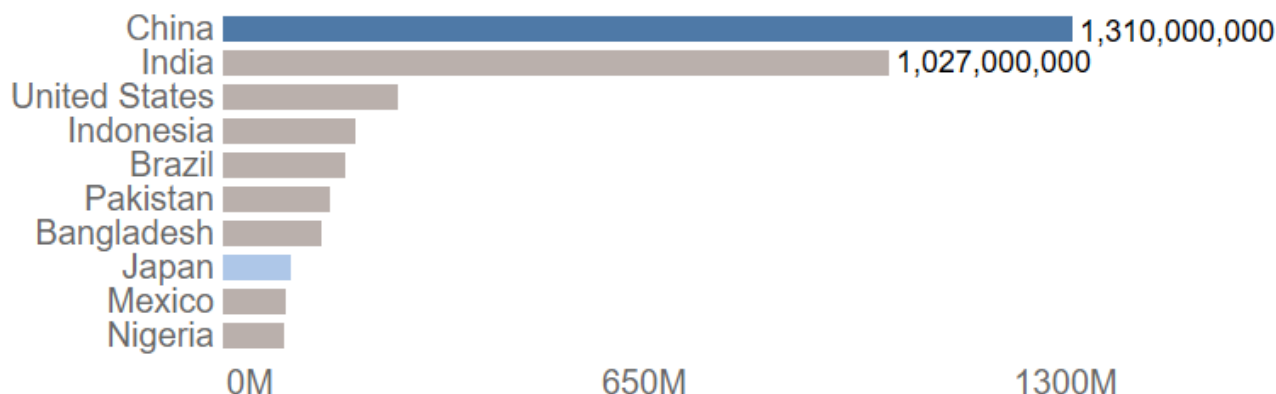

Fig 14. Number of People Vaccinated (Top 10 Countries)

Accordingly, the top ten countries in terms of number of people vaccinated almost correspond to the top 10 countries in terms of population. The exceptions were Russia, the ninth most populous country, was ranked 12th overall in terms of the number of people vaccinated, and Japan, which was among the top 10 countries but not among the top 10 most populous countries.

With respect to the type of vaccines distributed, there are fifteen (15) brands documented in terms of distribution. Four brands originated from the US, three were from China and the United Kingdom (UK) respectively. The earliest COVID-19 vaccine authorized for usage was CanSino, a vaccine from China.

Vaccine Brand	Country of origin	First authorization
CanSino	China	June 2020
Sinovac	China	August 2020
Sputnik V	Russia	August 2020
Pfizer–BioNTech	Germany, United States	December 2020
Sinopharm/Beijing	China	July 2020
Moderna	United States	December 2020
Oxford–AstraZeneca	United Kingdom, Sweden	December 2020
Covaxin	India	January 2021
Janssen (Johnson & Johnson)	United States,	February 2021
Sputnik Light	Russia	May 2021
Skycovione	South Korea	June 2022
Novavax	United States	December 2021
Medicago	Canada, United Kingdom	February 2022
Valneva	France, Austria	April 2022
Sanofi–GSK	France, United Kingdom	November 2022

Table 2. Vaccine Brands

The vaccine developed by Pfizer (originated from US) was the top vaccine distributed globally. Pfizer was the top vaccine used in North America, the European Union, Japan, and Korea. On the other hand, Ecuador and Peru mostly used Sinovac while Argentina used Sinopharm the most. The dataset used for this analysis was not able to capture the most distributed vaccine brands in China and India.
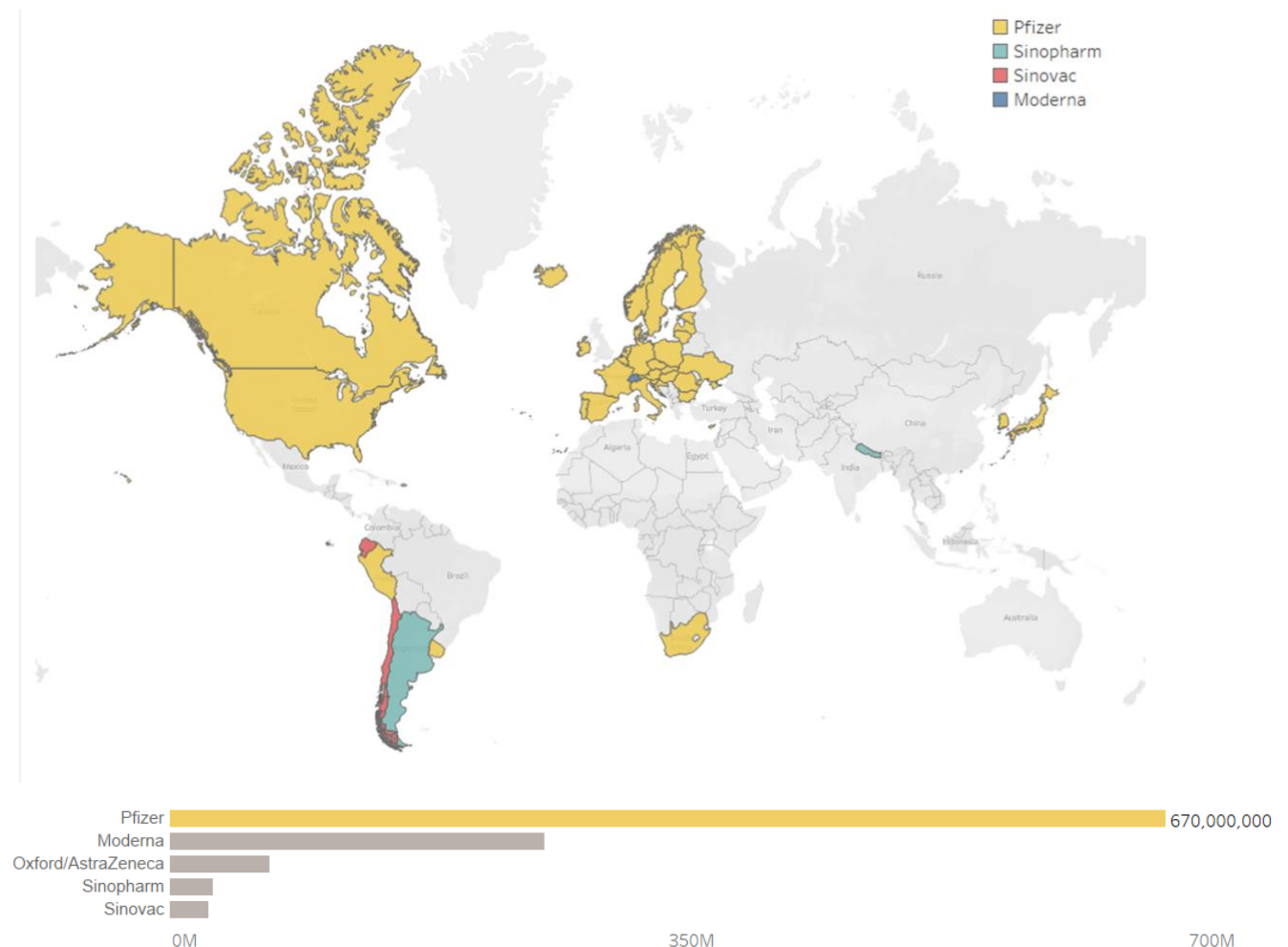

Fig 15. Vaccine Brand Distribution per Location (Top), Vaccine Distribution per Brand - Top 5 (Bottom)

In terms of relating the vaccine with other COVID-19 related metrics being tracked during the pandemic, it appears that vaccinations might not be attributed as one of the factors in bringing down the number of COVID-19 cases due to cyclical surges observed even with the high number of vaccinated population.
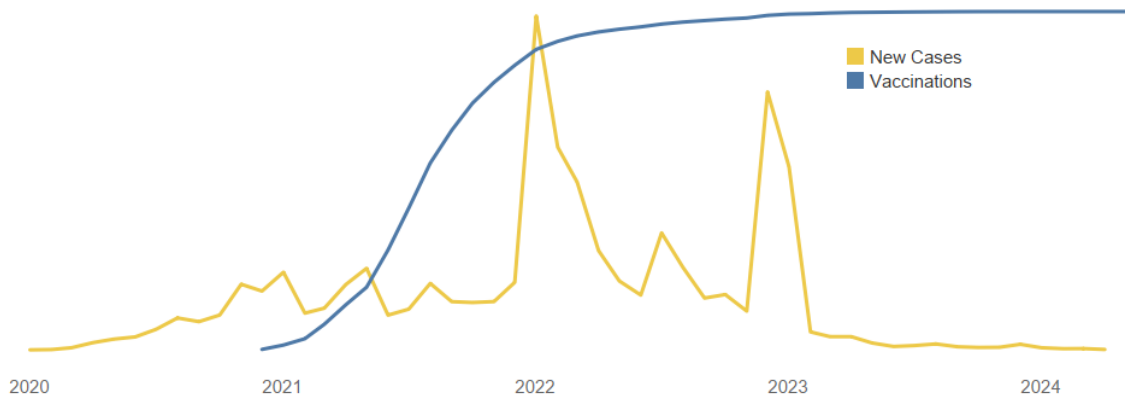
Fig 16. Vaccine Distribution vs. New Cases

A deep-dive through the comparison of vaccinations to metrics that portray the level of critical and moderate COVID-19 cases (e.g., ICU and Hospital Admissions, respectively) has shown that vaccination appears to trend inversely with critical and moderate COVID-19 cases. As more people got vaccinated, there was a decrease in both ICU and Hospital admissions noted.
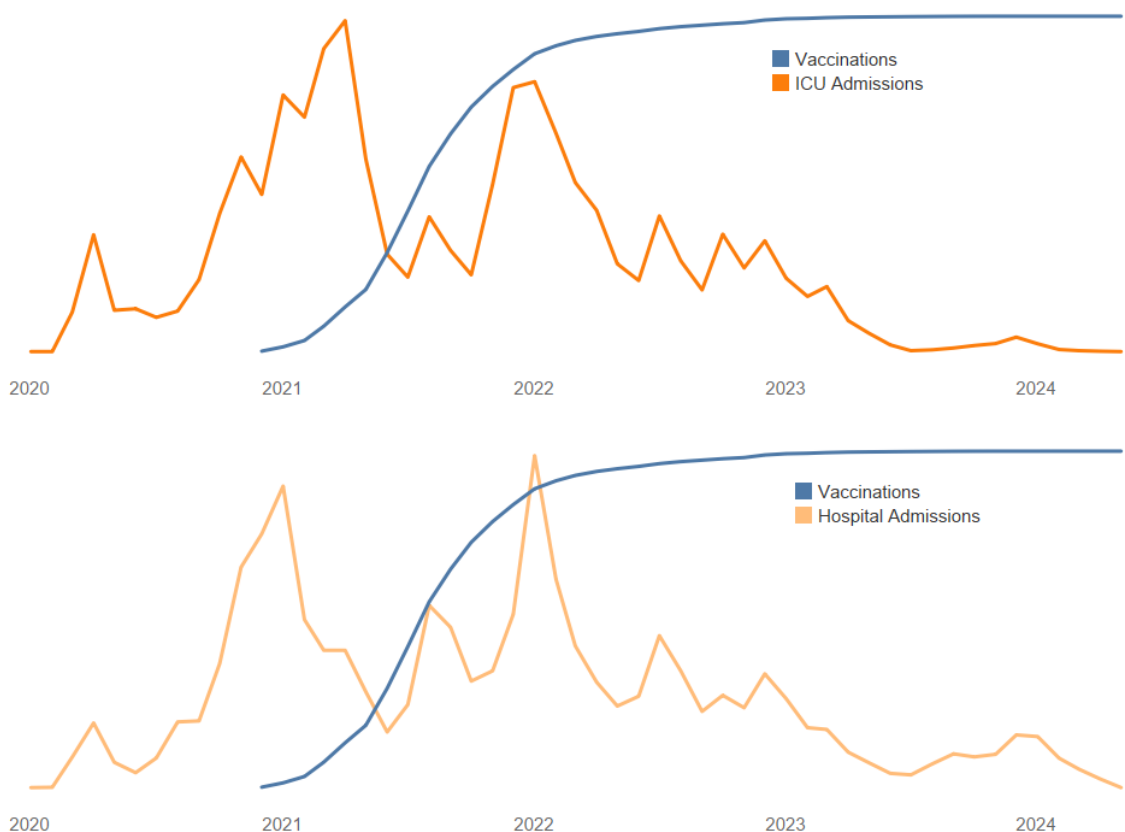

Fig 17. Vaccine Distribution vs. Critical Cases stated in ICU Admissions (Top), and vs. Moderate Cases stated in Hospital Admissions (Bottom)

A similar trend can be observed when comparing vaccination to metrics related to mortality, both in terms of the average number of new deaths and excess mortality (difference between actual deaths and projected deaths due to the pandemic) falls.
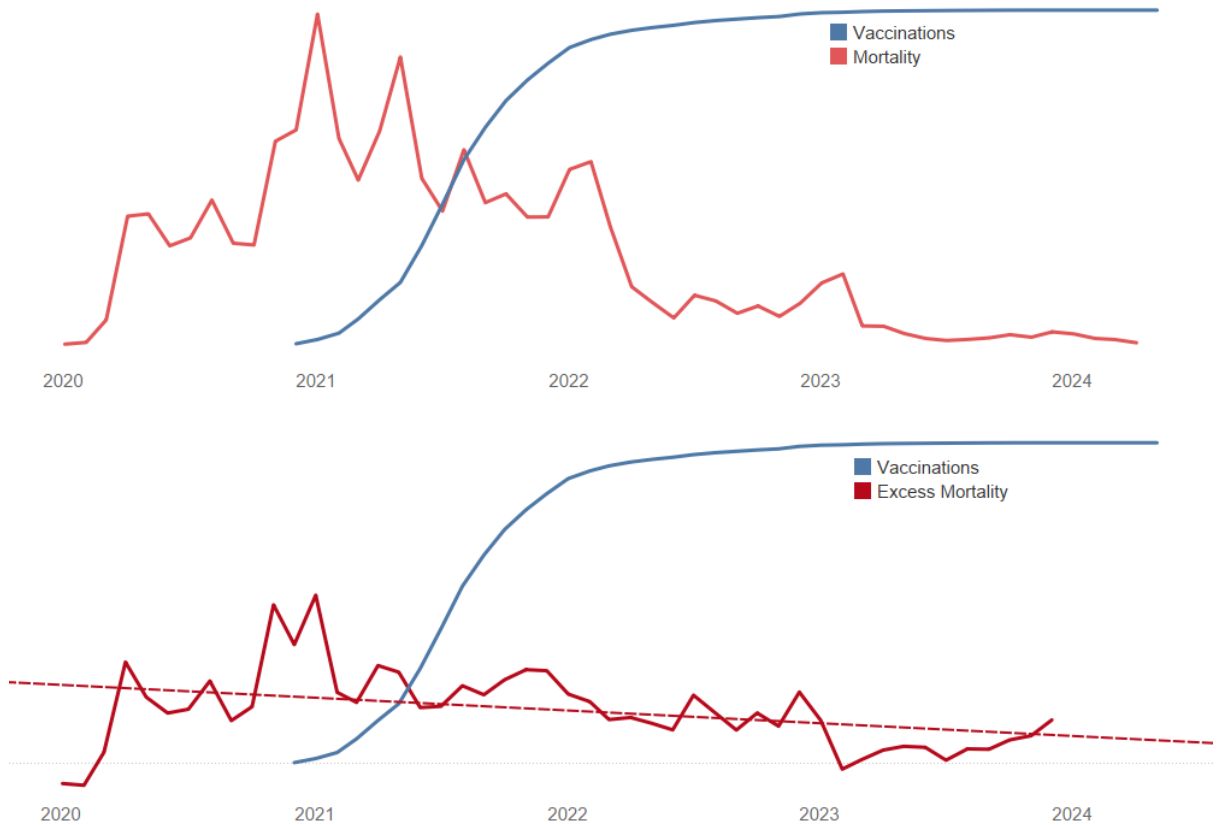
Fig 18. Vaccine Distribution vs. Average No. of Deaths (Top), and vs. Excess Mortality (Bottom)

Furthermore, the vaccines may also have a positive effect to the progress of the countries in their attempts to return to their pre-COVID state.
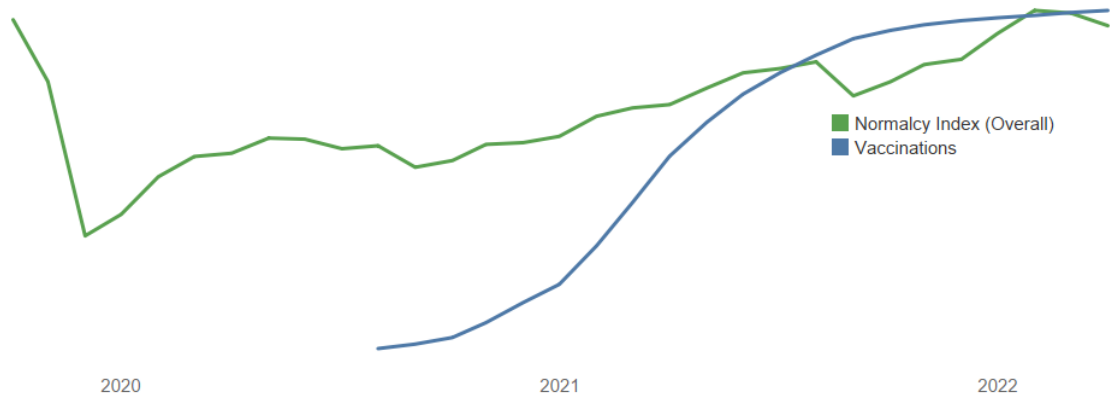

Fig 19. Vaccine Distribution vs. Return to Normalcy stated through Overall Normalcy Index

Looking at snapshots of vaccine distribution at the time of first vaccine distribution (late 2020), countries like Canada, United States (US), Argentina, Russia, and Germany have the earliest documented vaccine distributions.
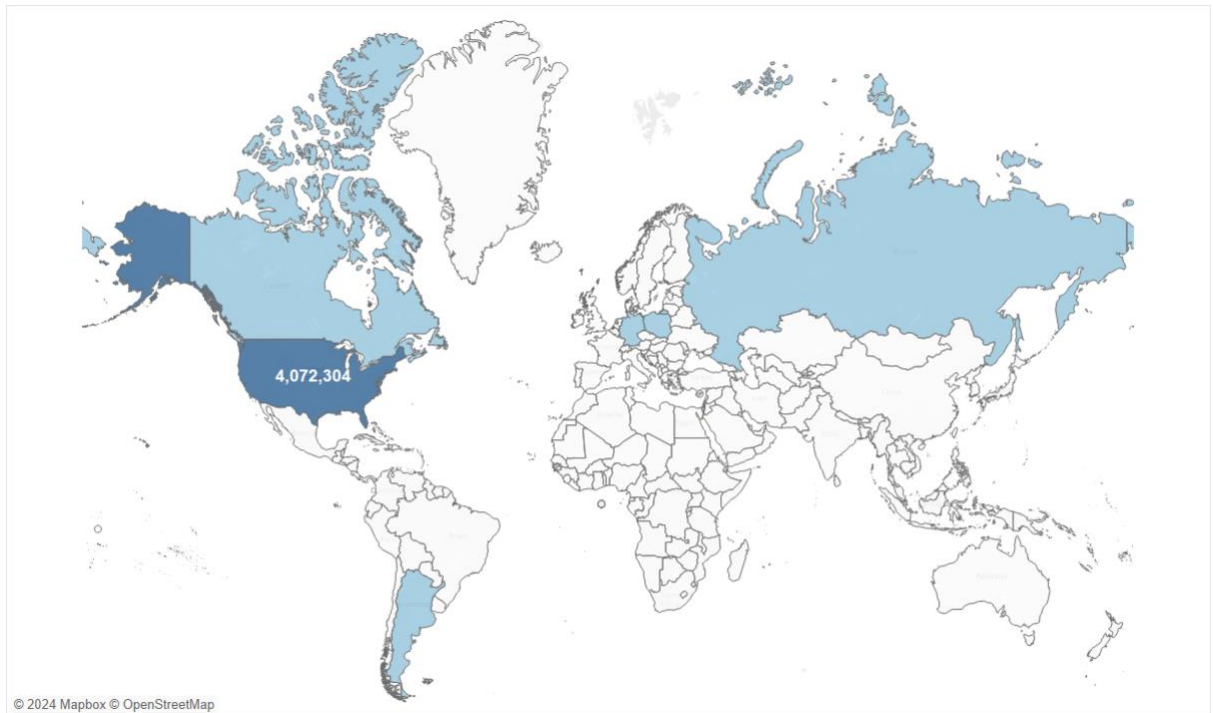
Fig 20. Vaccine Distribution – December 2020. United States has the highest number of vaccinated people based as of this period.

The vaccine access for United States and Germany is aligned with the noted cases during that period. However, other countries like Brazil and India who held the second and third most number of documented cases and were among the top 10 most populous countries were not among those with the earliest vaccine access.
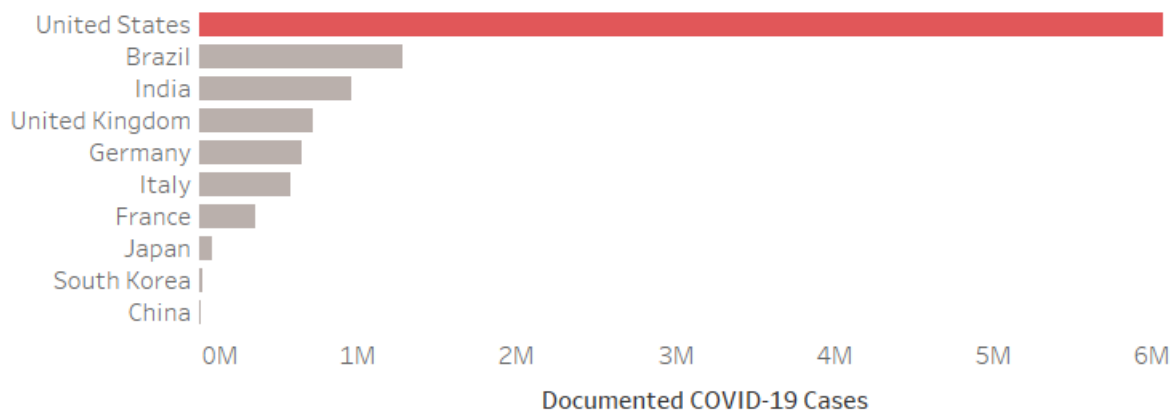

Fig 21. COVID-19 Cases – December 2020

A snapshot of the vaccine distribution during Q1 2022, the peak period of COVID-19 in terms of cases, shows some inequality with regard to access can still be identified with Italy and Spain, countries among those having the highest number of cases during that period not included in the top 10 countries distributing vaccines during or as of that period.
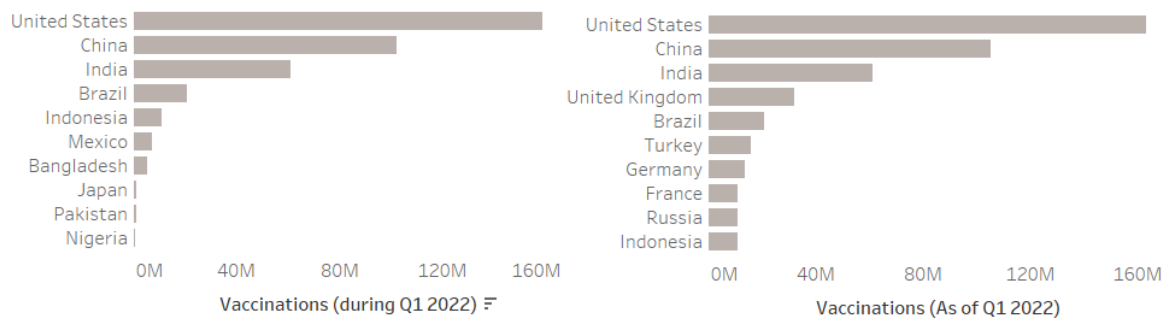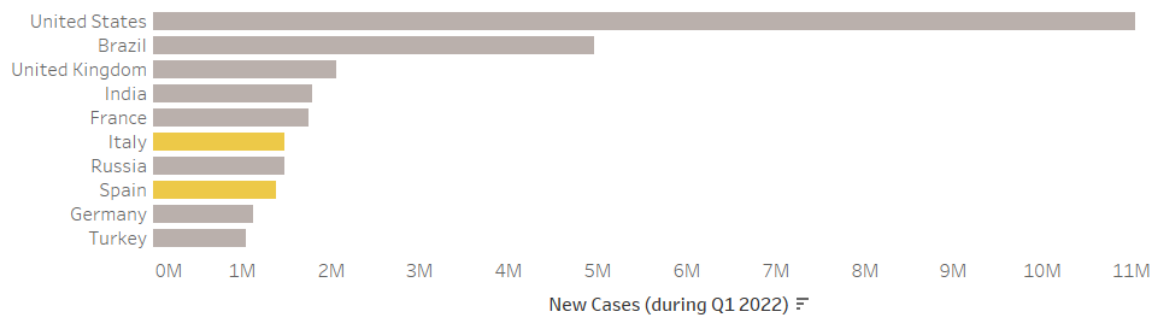
Fig 22. COVID-19 Cases and Vaccinations – Q1 2022

Lifestyles Shifts due to COVID-19

Evaluating the normalcy index of all 51 countries in the third dataset might have an offsetting effect due to the difference in each country's recovery strategy to their pre-pandemic state. Thus, to extract a more meaningful assessment, the team focused on analysing one country as its scope and opted to select the country with the most comprehensive data available and the most similar trend of normalcy to the global average. Filtering through these conditions, the USA has been chosen for analysis.

Fig 23: World vs. USA (Overall Normalcy Index)

As of August 2022, the USA is 6th in terms of normalcy index among the top 10 countries most affected by the first wave of COVID-19 cases (Fig 21) with index value of 79 which is below the world's average of 90.15 as of this period.
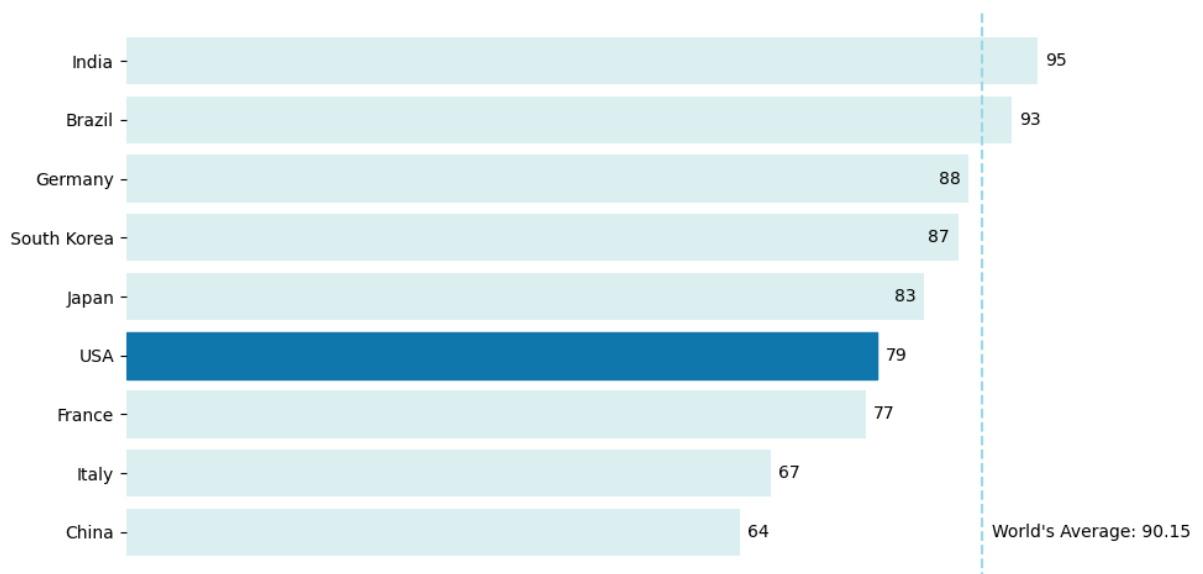
Fig 24: Normalcy Index among the top 10 most affected countries

20

This value already improved by 29 points, coming from a normalcy index of 50 during 2021. It can also be noted that as the country with the top number of early COVID-19 cases, the USA's normalcy index sharply declined from 98 during 2020.
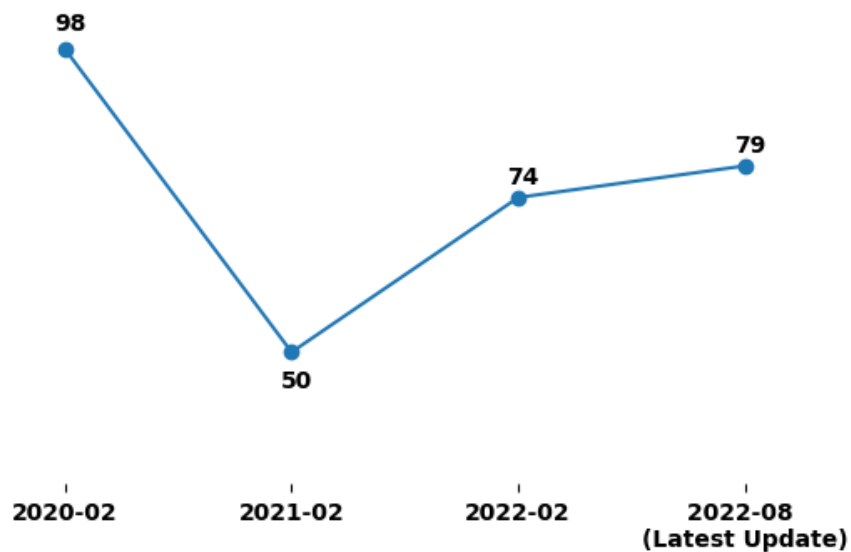

Fig 25: USA Normalcy Index

The Overall Normalcy Index is computed from 7 variables: Cinema, Flights, Traffic, Office Occupancy, Public Transport, Retail Footfall, Time Outside. Traffic was the only variable that increased after the pandemic, whereas the others, especially Cinema, Office Occupancy and Public Transport, witnessed a significant drop, highlighting the shift in lifestyle by Americans during the pandemic period. Cinema attendance saw the largest drop at 44.62%, followed by Office Occupancy (31.63%) and Public Transport usage (29.24%). Retail footfall and time spent outside also decreased, by 12.00% and 5.43%, respectively. Air travel dropped by 2.70%, while traffic was the only metric to see a positive change, with a slight increase of 6.53%.
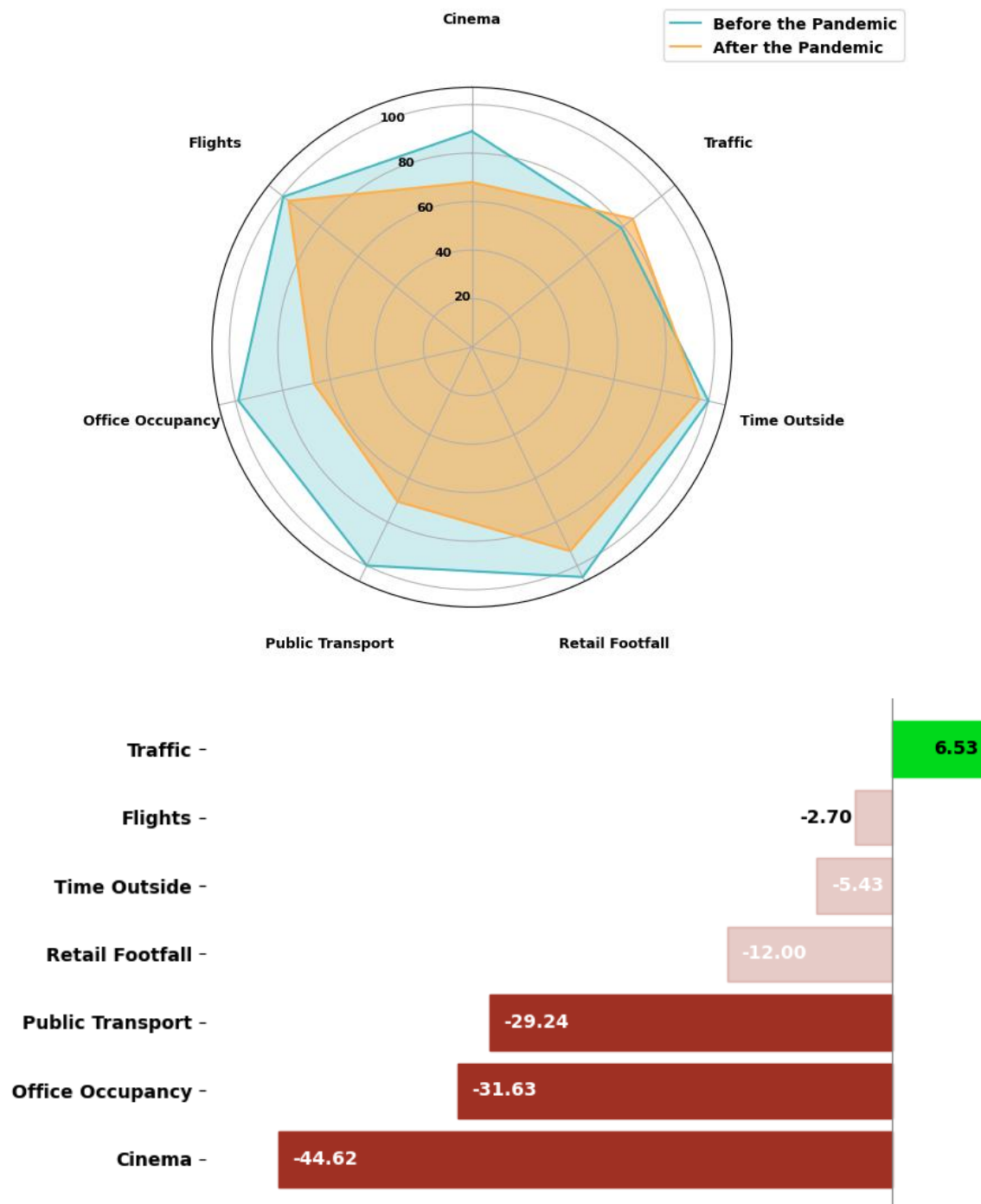
Fig 26: Lifestyle Shifts in the USA due to COVID-19

Discussion

How serious was COVID-19 and what are the main factors leading to its spread?

Each year saw rising COVID-19 cases and deaths, with 2021 having the highest increase in deaths and 2022 the highest increase in cases. Vaccinations surged in 2021, peaking in 2022, contributing to a decline in death rates despite higher case numbers. The US recorded the most fatalities, followed by Brazil, India, and Russia. Europe emerged with the highest overall death toll, while Oceania had the lowest. In early 2023, China experienced a significant surge in deaths, impacting Asia's mortality figures.

The relationship between population size and COVID-19 cases showed that as population increased, the number of cases likely increased as well. However, the percentage of the population affected by COVID-19 did not follow a linear trend. Countries like Bulgaria, Bosnia Herzegovina, and Hungary had high death rates relative to their populations.

Normalized graphs showed that while cases surged, deaths decreased over time, likely due to vaccinations and policy changes. The pandemic's impact varied widely, influenced by public health responses, vaccination rates, and healthcare infrastructure.

What was the role of Vaccinations in putting the pandemic to an end?

Both the correlation and trend analysis have shown that vaccination has a negative relationship with the number of deaths, projected mortality levels, and number of critical and moderate cases of COVID-19.

A separate trend analysis between the vaccination levels and the overall normalcy index signals that the vaccine might also have some effect on the return of the countries to its pre-pandemic state.

Although a detailed reason for how the vaccine reduces the negative effects of COVID-19 cannot be isolated in the data, the above findings still build a positive case for vaccine distribution. Thus, there is an increased amount of importance placed to early vaccine access in reducing the irreversible impact of the pandemic.

During the early stage and peak of pandemic, some levels of inequality are noted regarding vaccine distribution with the US having the highest and earliest vaccine access. This inequality has largely been addressed to date with the top 10 most populous countries having the top 10 number of people vaccinated.

Several explanations in the noted early inequality can be provided, the US has a relatively high investment in developing the vaccines, with four vaccines originating

from the country including Pfizer, the top brand distributed globally. Moreover, since majority of the countries have been on lockdown, distribution issues may have added to the incongruence in early access. In addition, these vaccines might have requirements regarding their storage. As such, infrastructures to support vaccine distribution might have to be in place before a country can be provided with a continuous supply of certain vaccines.

The above conjectures notwithstanding, global health policymakers need to identify the blockers in vaccine access and develop possible countermeasures. A steady flow in the supply chain of vaccines might be one of the keys in lowering the impact of the next global pandemic.

Has the world returned to normal after COVID-19?

The discussion around whether the world has returned to normal after COVID-19 or if we are experiencing a new normal is nuanced, based on the varied recovery rates and lasting lifestyle change observed globally. Taking the USA as an example several changes shifts can be named.

One of the most notable shifts is the drop in office occupancy as remote work becomes more prevalent. Many companies, forced to adapt during the pandemic, have now adopted hybrid or fully remote work models.

Another significant change is the decrease in public transport use coupled with an increase in traffic, suggesting a shift toward private transportation. Concerns about virus transmission in crowded public spaces have driven many people to opt for private vehicles, resulting in higher traffic volumes and increased congestion.

Additionally, reduced retail footfall and cinema attendance reflect a move towards online shopping and streaming services. The pandemic accelerated the digital transformation, with consumers increasingly turning to e-commerce for their shopping needs and streaming platforms for entertainment.

In summary, the pandemic has triggered profound changes in how we work, travel, and consume, leading to a "new normal" that integrates these shifts into everyday life. As remote work, private transportation, and digital consumption continue to shape our routines, society must adapt to these evolving trends and their long-term impacts.

Conclusion

The report has provided a comprehensive analysis of the COVID-19 pandemic through three critical research questions: the severity and spread of the virus, the role of vaccination in mitigating the pandemic, and the return to normalcy post-pandemic.

COVID-19 had a profound impact globally, characterized by significant morbidity and mortality. Larger populations saw more cases, but high death rates were not directly proportional to population size, as seen in countries like Bulgaria and Hungary. Countries like China, South Korea, and Singapore initially managed to control the virus through stringent public health measures. However, new variants and differing responses lead to challenges in subsequent waves, highlighting the complexity of managing the pandemic in densely populated regions.

Vaccinations were crucial in controlling the pandemic, significantly reducing severe cases and deaths. Governments relied on vaccines to mitigate the virus's spread, with vaccination certificates accelerating uptake and improving public health and economic conditions. However, vaccine distribution was unequal, with high-income countries having better access, delaying recovering in developing economies. Effective national vaccination plans were essential, and addressing global vaccine inequality remains a critical goal for future preparedness.

The world has not entirely returned to pre-pandemic normalcy; instead, a "new normal" has emerged. Remote and hybrid work models have redefined traditional workplaces, reducing the need for physical offices. There has been a shift from public transport to private vehicles due to health concerns, leading to increased traffic congestion. The pandemic accelerated the shift to online shopping and streaming services, reflecting significant digital transformation. These changes indicate lasting impacts on daily life, necessitating societal adaptation.

In conclusion, the COVID-19 pandemic has led to significant changes in global health, economic stability, and daily life. Understanding the virus's spread, the critical role of vaccination, and the new normal provides valuable insights for policy makers. Their insights can help build more resilient healthcare systems and prepare for future health crises, ensuring that the lessons learned from this pandemic are integrated into future strategies for better global health and economic resilience.

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