COVID-19 Data Insights: A Visualization of Cases, Deaths, Vaccinations, and Testing Trends

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***Abstract*— This paper presents a data-driven visual analysis of global COVID-19 trends, emphasizing the pandemic's impact across regions and demographic groups. It aims to assist healthcare researchers and policymakers in identifying long-term patterns and extracting actionable insights to improve future outbreak preparedness. The core objective is to design an interactive Power BI dashboard that visualizes key metrics such as confirmed cases, deaths, vaccinations, and testing over time and across geographic areas. The completed dashboard delivers comprehensive insights into COVID-19 data, enables global and country-level comparisons, and employs data-driven storytelling to illustrate the impact of various public health interventions.**

Keywords— COVID-19, data visualization, Power BI, pandemic analysis, public health, interactive dashboard, outbreak preparedness

Introduction

The COVID-19 pandemic, which began in early 2020, has had a profound global impact, prompting widespread vaccination campaigns to mitigate its effects. Understanding the relationship between vaccination rates, death rates, and socioeconomic factors is crucial for informing public health policies. This report leverages a comprehensive dataset containing daily COVID-19 metrics (cases, deaths, vaccinations, stringency index) and country-level data (GDP per capita, population, continent) to analyze these relationships. We use SQL Server Management Studio (SSMS) to write subqueries for data extraction and Power BI for visualization and analysisEase of Use

Key Insights

This report presents an analysis of COVID-19 data visualization techniques to track the spread of the virus, vaccination rates, and other related data. The study highlights the significance of data visualization tools such as Power BI, Excel to raw data into meaningful insights. Key trends in infection rates, mortality, and vaccine distribution are examined using real-world datasets from authoritative sources such as the World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC). The findings offer recommendations for improving pandemic response strategies through enhanced data visualization.

Data Sources

- For this project, we obtained the dataset from Our World in Data (OWID), an open-source platform for datasets that are licensed under CC BY Source
- Dataset Name: Compact COVID-19 Dataset
- Published By: Our World in Data (OWID)
- Website: https://ourworldindata.org
- Data Coverage: Global, with country-wise breakdowns from Year 2020 to 2025
- Reliable & Up to Date – Aggregates data from sources like WHO, CDC, and government health agencies
- Comprehensive – Covers COVID-19 cases, deaths, vaccinations, and testing, providing essential data for our project to visually analyze trends across different regions and time periods

Background

The dataset includes daily records from January 2020 to December 2024 for multiple countries, covering metrics like cases, deaths, vaccinations, and stringency index, alongside country-level data such as GDP per capita and population. The stringency index measures the strictness of government responses (e.g., lockdowns), while vaccination metrics include total vaccinations, people vaccinated per hundred and fully vaccinated per hundred.

Existing System

Traditional analysis of COVID-19 data often involves static reports or Excel-based dashboards, which lack interactivity and scalability. Power BI, a business intelligence tool, allows for dynamic visualizations, making it ideal for this analysis. data aggregation, such as calculating total vaccinations and deaths per country or continent, directly from the database.

Findings

1)Regional & Demographic Impact

The USA, Brazil, and India have the highest number of confirmed COVID-19 cases and deaths, reflecting the significant impact of the pandemic, influenced by factors like large populations and varying healthcare systems. China, India, and the USA lead in vaccinations, while the USA, India, and the UK have conducted the most tests, indicating large testing infrastructure that aims to manage the virus's spread. These trends highlight both the scale of the pandemic and the differing public health responses across these countries.

When comparing total new cases with total new deaths over time, we can see in the graph there is a noticeable increase of deaths in 2022 although there wasn't a significant increase in new case. This should be studied by the researchers to understand what the reason could be here. Fortunately, by year 2024 the number of new cases and deaths have decreased greatly in comparison to the previous years.

To normalize the data and compare it between the continents we looked at the statistics per 100 thousand. Asia leads by most vaccinations, and in the graph, it shows how it impacts other Covid related factors. We can see that Asia has less deaths and cases, because of that we can conclude that higher vaccination rate can improve the situation. Of course, vaccination is not the only factor here, we must also investigate government restrictions.

2)Mortality and Healthcare Analysis

In 2021, Africa had the highest case fatality rate (CFR), followed by Asia and Europe, which suggests their healthcare systems were under a lot of pressure. However, CFRs dropped in 2022 and 2023, likely due to better treatments and more people getting vaccinated. Testing also increased in some regions like Europe and Asia which had a huge spike in tests per case in 2021, showing how aggressively they tried to decrease the cases. On the other hand, places like Africa and South America had lower testing rates, which might've made it harder to catch cases early. The positive rate was high in Asia, Europe, and North America during the early years, meaning lots of people who got tested were infected. Overall, things seemed to improve over time, with more testing, lower death rates, and better control of the virus.

3)Vaccination Coverage and Global Health Analysis

Global vaccination coverage varies significantly across regions, with North America, Europe, and parts of Asia exhibiting high vaccination rates, while Africa and South America lag due to economic and logistical challenges. The analysis confirms a strong correlation between GDP and vaccination coverage, as wealthier nations tend to have better access to vaccines. Additionally, mortality rates have declined post-vaccination, with South America and Oceania experiencing the most significant reductions. However, disparities persist, highlighting the need for equitable vaccine distribution and enhanced healthcare systems in lower-income regions.

Outliers in the dataset reveal unexpected trends, such as high-GDP regions with lower-than-expected vaccination rates (e.g., Oceania) and low-GDP countries achieving effective vaccination programs (e.g., Cuba). Eastern Europe presents another anomaly, were high vaccine availability contrasts with high mortality rates due to vaccine hesitancy. To address these disparities, global efforts should focus on strengthening healthcare infrastructure, combating misinformation, and ensuring fair vaccine distribution. This report emphasizes the critical role of vaccinations in public health and the necessity for international cooperation to bridge healthcare inequalities worldwide. your conference for the name of your paper. In this newly created file, highlight all of the contents and import your prepared text file. You are now ready to style your paper; use the scroll down window on the left of the MS Word Formatting toolbar.

4)Hospital Strain

Approximately 148 million people were admitted to hospitals and 25 million were admitted to ICUs for COVID during the past five years, according to reports [5]. Most of these admissions occurred from 2020 to 2022, during the early years of the pandemic. Total Hospitalization and ICU admission peaked in Q1 2021 and almost reached the same values again in Q1 2022 [5].

Many countries have zero values for hospitalization and ICU admission, suggesting that those values were not reported for those countries.

The months of December and January saw the highest totals for hospitalization and ICU admissions. In temperate climates, seasonal flu spreads during these months as well, according to the WHO [6]. The CDC considers COVID-19 as a seasonal respiratory virus [7]. It spreads through coughing, sneezing, and exchange of particles, just like the flu.

Outliers exist in the data, however. Europe experienced a high point of both admissions in April, and North America experienced high values in August. Some sources, such as Science News, do not consider COVID-19 to be seasonal, and note that human behaviour has had an impact on its spread [8]. These include social distancing and mask wearing.

5)Government Stringency Impact Analysis (2020–2022)

This analysis investigates how government policies, measured through the Stringency Index, influenced the spread and severity of COVID-19 across countries and continents from 2020 to 2022.

Governments maintained high policy stringency, especially in Asia, Europe, and South America, resulting in relatively lower cases and deaths.

2022: Despite a surge in cases, many regions significantly reduced stringency, relying more on vaccinations, natural immunity, and health system capacity.

Population Density: Higher-density continents generally enforced stricter measures, but the relationship was not linear some low-density regions had high restrictions due to localized risks.

Europe had high case counts even under moderate restrictions, possibly indicating early reopening, vaccine rollout, or reporting accuracy differences.

Challenges

a)Missing or Incomplete Data

Some countries lacked consistent data

b)Aggregated vs. Country-Level Data

Continent-level entries had to be removed to prevent double-counting or skewed analysis

c)Blank vs. Zero Values

Needed to differentiate between missing values and actual zero values to avoid misinterpretation

d)Calculated Metrics Complexity

Custom metrics like CFR, Tests per Case, and Positivity Rate required careful definitions and consistent formulas

e)Visual Comparison Challenges

Countries with vastly different population sizes and testing policies made comparisons tricky; needed normalized metrics

f)Balancing Detail and Clarity

Too many visuals risked overwhelming the audience; had to choose visuals that best conveyed insights

g)Audience Understanding

Needed to simplify complex data findings for non-technical stakeholders without losing meaning.

Conclusion

The findings highlight the significant role of vaccinations in reducing mortality rates globally. However, economic disparities and regional healthcare challenges create gaps in vaccine accessibility. While wealthier nations have achieved high vaccination rates, low-income regions still struggle due to logistical barriers and misinformation. The analysis reveals a clear shift in global COVID-19 management strategies — from prevention through strict lockdowns in 2020 to adaptive response with relaxed policies by 2022. While early restrictions were effective at containing spread, governments began balancing health outcomes with economic and social considerations as the pandemic evolved. Policy effectiveness varied by region, population structure, and pandemic phase, but overall, stricter lockdowns did align with reduced case and death rates in earlier stages

Recommendations:

1. Improve Global Vaccine Distribution: Increase efforts to ensure vaccines reach underprivileged regions.

2. Enhance Healthcare Infrastructure: Invest in medical facilities and distribution networks in low-GDP countries.

3. Address Vaccine Hesitancy: Implement awareness campaigns to combat misinformation and improve public trust.

4. Strengthen International Collaboration: Encourage partnerships between governments and health organizations to bridge vaccination gaps.

5. Early Action Matters: Rapid and strict measures were effective in the early phase — future outbreaks should follow this model before system overwhelm.

6. Improve Data Transparency: Standardized global reporting is critical for meaningful comparisons and public trust.

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