Analysing the Success of the UK's COVID-19 Vaccination Strategy

Introduction

This document evaluates the success of the UK's vaccination strategy against COVID-19 by comparing it to other nations' approaches and outcomes. Additionally, the effectiveness of the vaccination strategy will be broken down by the countries of the UK to determine the performance by region.

To assess the vaccination strategy, the UK's plan must first be outlined. The nation's approach is described as 'top down' where the vaccinations were administered to groups of people in descending order of priority. The first of these groups were persons aged over 80 and health/social workers, followed by groups consisting of descending age bands and persons with medical conditions vulnerable to COVID-19 (Mounier-Jack et al, 2023).

Methodology

To facilitate comparisons between the UK, its regions, and other nations, various measures and graphs were created. This was necessary to account for variances in the data such as population differences between countries.

Population data for nations was obtained from The World Bank (2023). However, data for the UK countries, was procured separately from the Office for National Statistics (2021) and is limited to 2021. This was required as other population data sources treat the UK as a whole and do not provide population numbers by UK regions. Data relating to the hospitalisations and deaths in the UK from COVID-19 was sourced from the UK Health Security Agency (2023). For other countries, Our World in Data was used to obtain this same information in English (Mathieu et al, 2023).

After retrieval, the data was processed using Python with the Pandas library, such as creating date columns (Figure 1). SQL was also used for joining tables and creating calculated columns (Figure 2). Lastly, the Python libraries Seaborn and Matplotlib were employed for the generation of the charts. The colour palette used for the charts was defined with colour-blind friendliness in mind.

The countries chosen for comparing with the UK was Italy and Denmark. This choice was made since all are first world European nations that implemented a covid vaccination strategy (Gram et al, 2023; Mounier-Jack et al, 2023; Peruch et al, 2022), meaning comparisons can be made due to these similarities.

Vaccination Uptake

One of the key indicators to consider when measuring a vaccination strategy's success is the extent to which a nation's population accepts and is administered the vaccines. One of the UK's notable successes was that it was the first in the world to launch its COVID-19 vaccination strategy in December 2020 (Mounier-Jack et al, 2023). From this point, figure 3 shows that the percentage of the UK population receiving both the first and full vaccinations steadily increased with each month, peaked in September 2023,

and henceforth remained mostly constant with 78% having a first vaccination and 74% fully vaccinated. What can be drawn from this is that almost three quarters of the UK's population became fully vaccinated from COVID-19, falling just short of its aim of 75% (UK Parliament, 2020).

When comparing with Denmark and Italy, the UK maintained the highest the percentage of its population becoming fully vaccinated until September 2021 where both Denmark and Italy overtook the UK (figures 4 and 5). Additionally, Denmark's peak of first and full vaccinations reached 80% and 79% respectively (Figure 4), while Italy's were 86% having first vaccinations and 81% fully vaccinated (Figure 5). From this it can be surmised that both Denmark and Italy trumped the UK over time with uptake of vaccinations.

In terms of why the UK's overall vaccination rate compared lower, there are many factors that could have contributed to this. For starters there were challenges in planning for the demand of vaccines, coupled with misinformation in digital media resulting in vaccination hesitancy (UK Parliament, 2021). Furthermore, Italy's vaccination plan differed by making COVID-19 vaccinations mandatory for over 50s and healthcare workers (Peruch et al, 2022), while it was only prioritised for older age bands and healthcare workers in the UK and Denmark (Gram et al, 2023; Mounier-Jack et al, 2023). This could have contributed to Italy resulting in having the highest population vaccinated against COVID-19 out of the three nations.

Prevention of Hospitalisations and Deaths

Since a primary purpose of employing a vaccination strategy is to prevent hospitalisations and deaths, assessing the change in these before and after the strategy's launch can be used as a metric of its success. Figures 3 and 6 demonstrate that the UK started its vaccinations during the period of its peak in both hospitalisations and deaths from COVID-19 in 2020Q4 to 2021Q1. In 2021Q2 hospitalisations and deaths significantly dropped but gradually rose again until 2021Q4, though with less than half the impact compared to the previous year. Hospitalisations spiked in 2022Q1, reaching the second highest peak, and only reducing slightly until 2023Q2. Contrarily, deaths only rose slightly in 2021Q1 and continued to reduce thereafter.

What could be interpreted from this as that waves of COVID-19 still occurred as the vaccinations were administered over time. However, hospitalisations and deaths were reduced with each subsequent wave as more of the population became vaccinated, although it seemed to have more of an impact on reducing deaths than hospitalisations overall.

Italy experienced a similar trend of hospitalisations and deaths compared to the UK (figures 6 and 8). One of the differences that can be seen is that Italy had a longer peak period of hospitalisations and deaths, lasting from 2020Q4 thorough to 2021Q2. Additionally, the UK had a higher spike in deaths while Italy had higher peaks of

hospitalisations. Although both countries had similar reductions of hospitalisations and deaths from 2022, Italy achieved lower rates by 2023, perhaps attributed to its higher vaccination rate by that point in time.

Figure 7 illustrates that Denmark experienced a different outcome in hospitalisations and deaths related to COVID-19 compared to both the UK and Italy. While the peaks and troughs follow similar timings to the other two nations, Denmark's overall rates were significantly lower, with its peak of hospitalisations not reaching half of Italy's and its peak of deaths not reaching half of the UK's. Where Denmark's vaccination rates were lower than Italy's and only slightly higher than the UK's (figures 3, 4 and 5), this begs the question as to why the nation was much less affected by COVID-19. In Denmark's case, there were other factors that may have contributed, and potentially even had more of an impact than the vaccines. These factors include: sharing few borders with other countries, employing an immediate lockdown response, and the population having high trust in its government (Olagnier and Mogensen, 2020).

When accounting for all three nations' hospitalisations and deaths from COVID-19 (figures 6, 7 and 8) it could be surmised that a high vaccination rate does contribute to reducing the impact of subsequent waves of COVID-19. Although, as in Denmark's case, other factors can equally affect the rates as well. On the whole, it is challenging to pin down the major influence on the reduction of hospitalisations and deaths from COVID-19 since the numbers may have even been affected by natural causes over time, such as immunity to COVID-19 after having been infected previously or those particularly vulnerable to COVID-19 mostly dying in the earlier periods.

Breakdown by the Countries of the UK

When analysing the COVID-19 vaccinations uptake of the UK countries, though the UK started its programme in December 2020 (Mounier-Jack et al, 2023), England and Scotland's population were the earliest in accepting it (figures 9 and 10). However, this lead was short lived as by the following month Wales surpassed the other UK regions and maintained the highest percentage of its population being fully vaccinated throughout, peaking at 75% (figure 11) and achieving the UK target (UK Parliament, 2020). This is followed by Scotland at 71%, England at 68% and NI at 66% (figures 9, 10, and 12). Possibly, the primary reason for Wales achieving this is that their government administered its allocation of vaccines more quickly through the age bandings than the other regions (BBC, 2021).

Assessing the hospitalisations from COVID-19 for each UK country shows that Wales had the largest peak out of the regions, at 65 per 100k of its population, during January 2021 when the vaccines were just beginning to be distributed (figure 11). This is followed by England at 60, Scotland at 37, and NI at 31 per 100k of population at the same point in time (figures 9, 10 and 12). By scrutinising the hospitalisations after June 2021, when more of the population became vaccinated and the next wave of COVID-19 started, the performance of each UK regions' vaccinations can be evaluated.

With this in mind, it could be seen that England had the strongest recovery in hospitalisations between July and November 2021 where they more than halved; though in December 2021 England then experienced a spike in hospitalisations that exceeded the other regions. Wales could also be a contender for the strongest recovery in hospitalisations where a significant drop, compared to its peak, also occurred and did not spike again in December 2021, perhaps due to having the highest vaccination rate of the regions. Conversely, Scotland and NI may have underperformed by comparison since the hospitalisations of these regions did not decrease to under half of their respective peaks.

Applying the same logic to assess the deaths per 100k of population by UK regions reveals that Wales also had the highest peak at 2.7 in January 2021 (figure 15). This is followed by England at 2.3 at the same point, Scotland at 1.9 in April 2020, and NI at 1.8 in January 2021 (figures 13, 14 and 16). By comparing after June 2021 again, England experienced the strongest recovery with deaths per 100k lowering to 0.3 by December 2021. Scotland recovered most effectively after England at 0.38, then Wales at 0.4, and NI at 0.5 for COVID-19 deaths per 100k of population in December 2021. It's worth noting that NI's inferior reduction in deaths could be linked to the fact that it also had the lowest vaccination rates at the time. Furthermore, Scotland's worst period of deaths occurred earlier than the other UK regions which in turn may mean those most susceptible to COVID-19 perished from it earlier than the other UK countries.

Where Wales performed strongly in preventing subsequent hospitalisations and deaths, the rapid distribution of their vaccines could have been a strong factor in this. Therefore, rapidity in a vaccination strategy could be considered an important element. At the same time, it must be acknowledged that other factors such as age differences of the populations could also have influenced the rates.

Concluding Thoughts

In evaluating the effectiveness of the UK's vaccination strategy, the UK initially lead the way compared to other nations by being the first with its 'top down' approach but was quickly surpassed by other countries such as Denmark and Italy in vaccination rates. The UK vaccination strategy can be seen as successful in mitigating subsequent waves of COVID-19 due to reduced rates of hospitalisations and deaths, as also shown with Italy and Denmark. However, it is important to remember that other factors likely affected this as well, including immunity from previously being infected by COVID-19.

When comparing the UK regions, England can be seen as the most successful in preventing deaths, while Wales as the most effective in reducing hospitalisations. Both regions also achieved high vaccination rates of their respective populations. The COVID-19 pandemic evidently proved to be a learning curve for many nations; one of the key takeaways being that rapid deployment of vaccinations and trustfulness in them by the population are crucial to the success of a vaccination strategy.

Appendix

Figure 1 – Python function for extracting the year, month, and quarter from a data frame column.

```python
def get_date_values(df, col):
    """Converts a column to datetime then adds columns for year, year_and_month, and quarter"""
    df[col] = df[col].astype(str)
    df[col] = pd.to_datetime(df[col])
    df["year"] = df[col].dt.year
    df["year_and_month"] = df[col].dt.strftime("%Y-%m")
    df["quarter"] = pd.PeriodIndex(df[col], freq="Q").astype(str)
```

Figure 2 – SQL code for joining UK vaccinations table to world population data and creating calculated columns.

```
uk_vaccinations_vs_pop = pd.read_sql(
    """
SELECT
    UV.location,
    UV.year_and_month,
    MAX(UV.cumPeopleVaccinatedFirstDoseByVaccinationDate) AS first_vaccs,
    CAST((MAX(UV.cumPeopleVaccinatedFirstDoseByVaccinationDate)
        * 1.0 / WP.population) * 100 AS FLOAT) AS first_vaccs_percent_of_pop,
    MAX(UV.cumPeopleVaccinatedSecondDoseByVaccinationDate) AS fully_vaccd,
    CAST((MAX(UV.cumPeopleVaccinatedSecondDoseByVaccinationDate)
        * 1.0 / WP.population) * 100 AS FLOAT) AS fully_vaccd_percent_of_pop,
    WP.population
FROM UkVaccinations AS UV
JOIN WorldPopulation AS WP
    ON WP.year = UV.year
    AND WP.[Country Name] = UV.location
GROUP BY UV.year_and_month;
""",
    conn,
)
```

Figure 3 – United Kingdom COVID-19 Vaccinations Uptake as a Percentage of the Population (UK Health Security Agency, 2023; The World Bank, 2023)

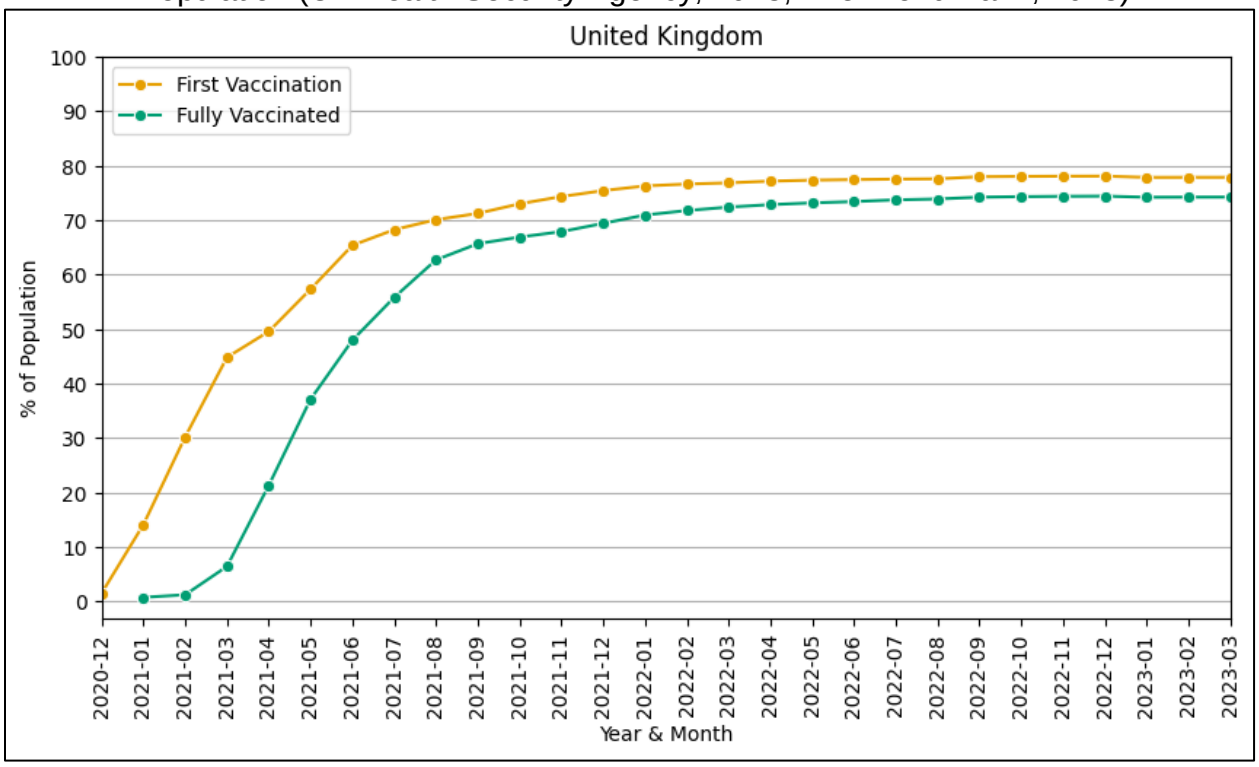


Figure 4 – Denmark COVID-19 Vaccinations Uptake as a Percentage of the Population (Mathieu, E. et al, 2023; The World Bank, 2023).

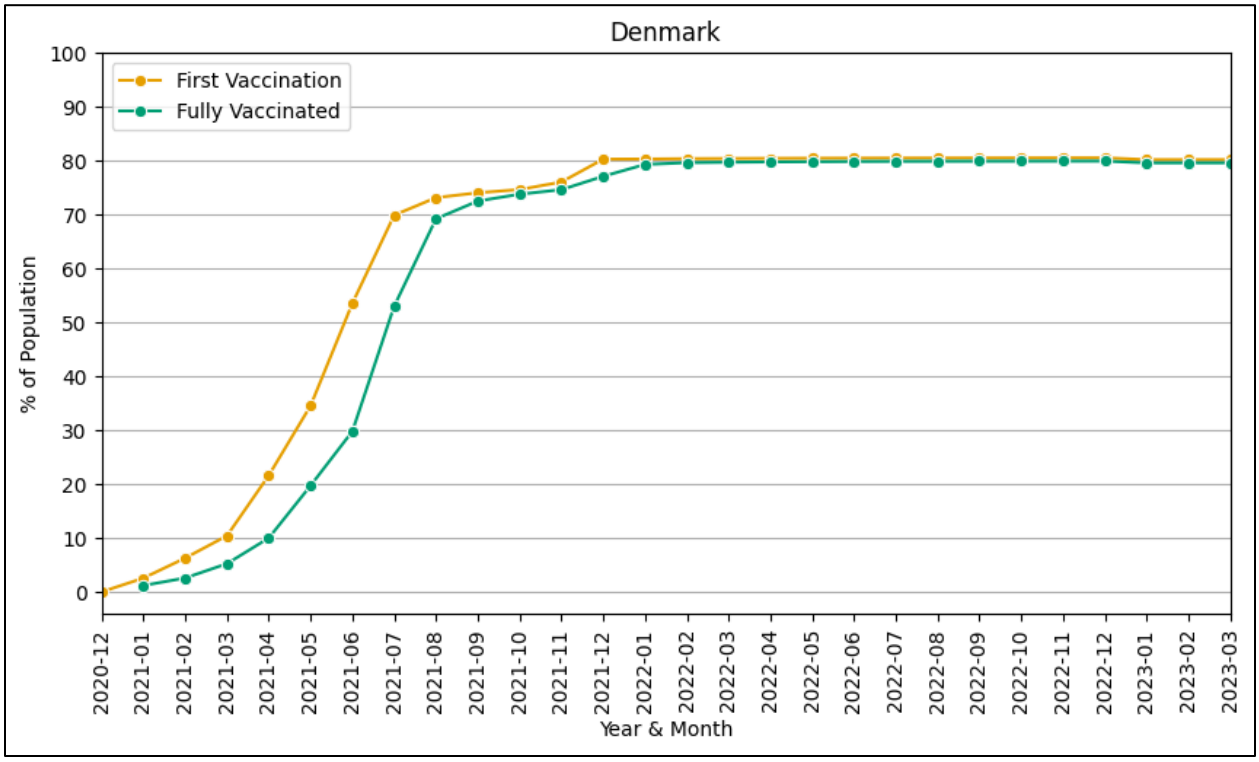


Figure 5 – Italy COVID-19 Vaccinations Uptake as a Percentage of the Population (Mathieu, E. et al, 2023; The World Bank, 2023).

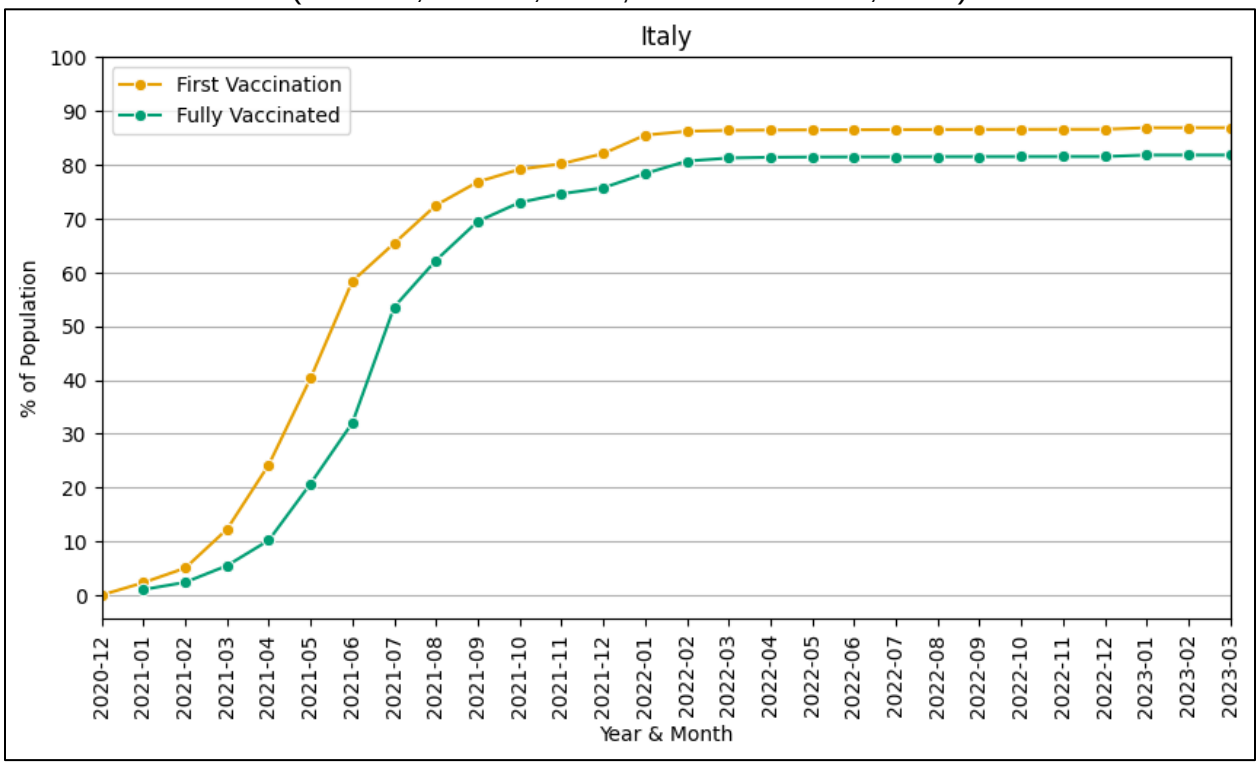


Figure 6 – COVID-19 Hospitalisations and Deaths per 100k of Population in the United Kingdom (UK Health Security Agency, 2023; The World Bank, 2023)

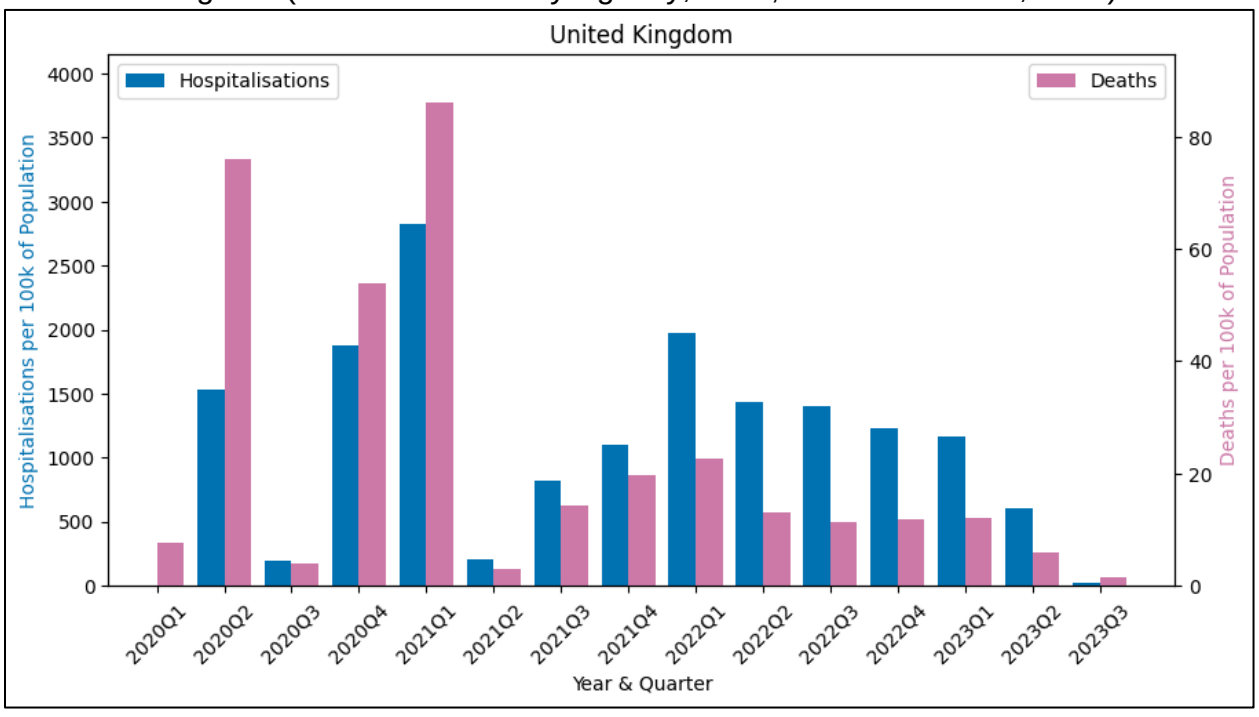


Figure 7 – COVID-19 Hospitalisations and Deaths per 100k of Population in Denmark (Mathieu, E. et al, 2023; The World Bank, 2023).

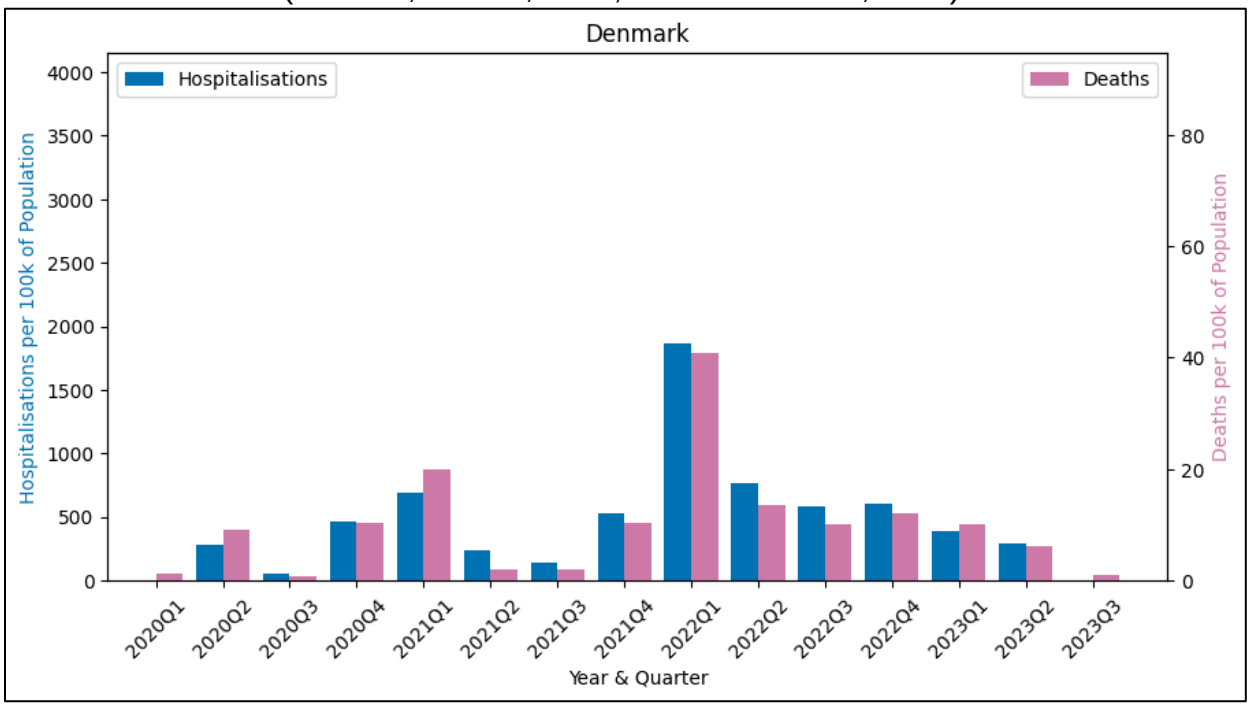


Figure 8 – COVID-19 Hospitalisations and Deaths per 100k of Population in Italy (Mathieu, E. et al, 2023; The World Bank, 2023).

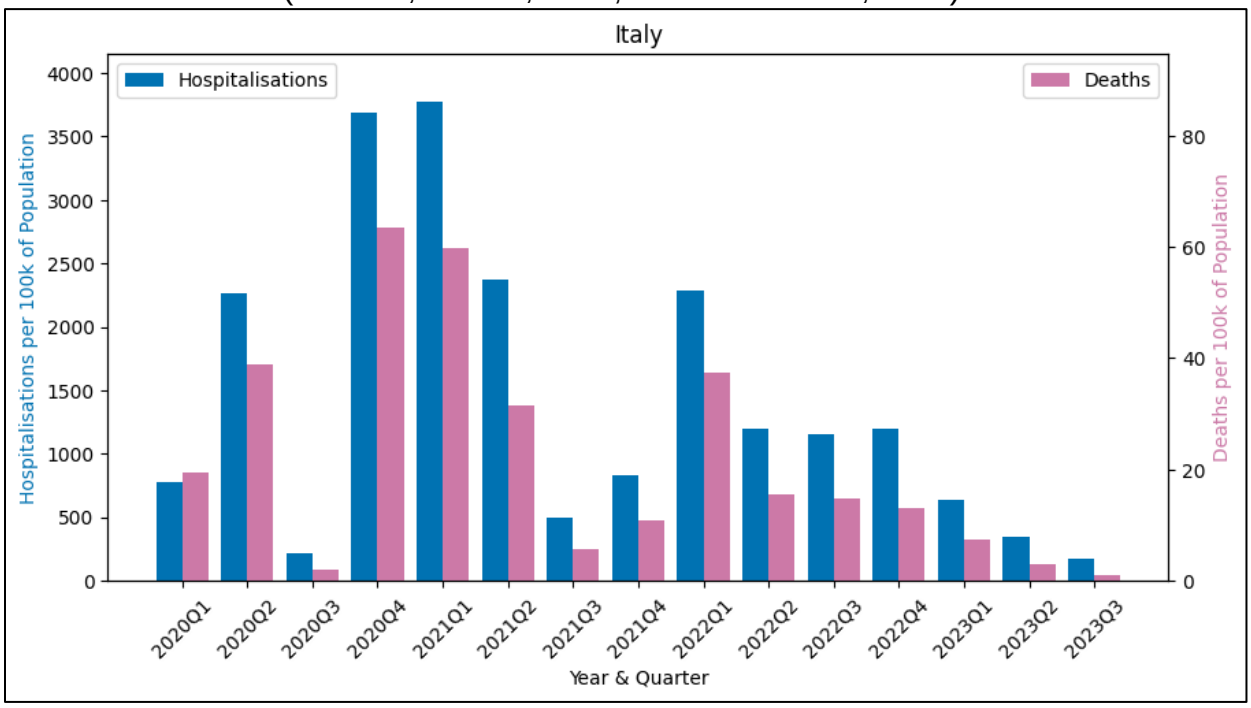


Figure 9 – England COVID-19 Hospitalisations per 100k of Population and Vaccinations Uptake Percentage (UK Health Security Agency, 2023; Office for National Statistics, 2021)

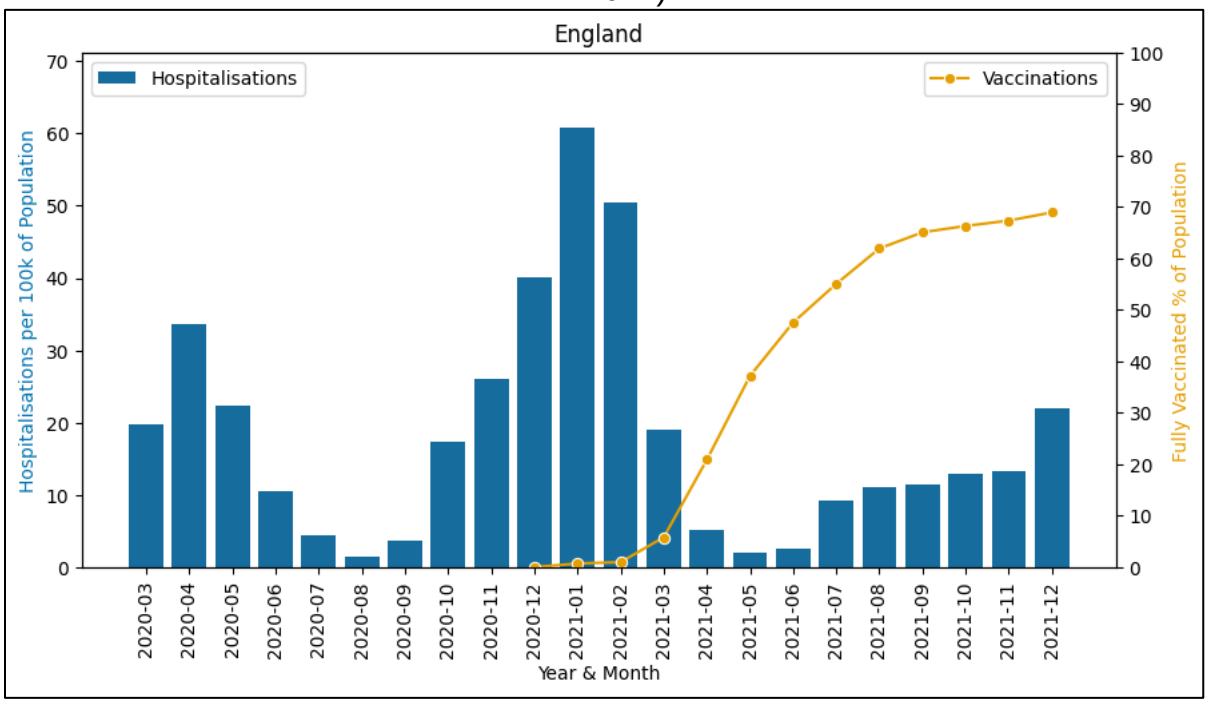


Figure 10 – Scotland COVID-19 Hospitalisations per 100k of Population and Vaccinations Uptake Percentage (UK Health Security Agency, 2023; Office for National Statistics, 2021)

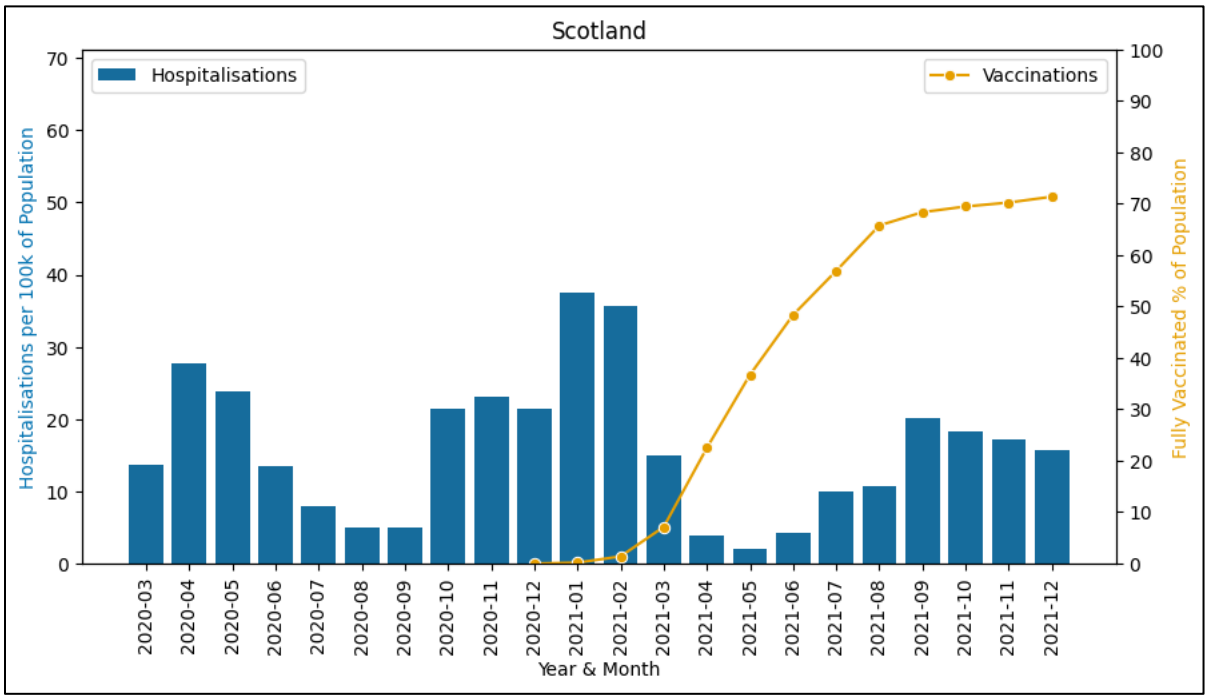


Figure 11 – Wales COVID-19 Hospitalisations per 100k of Population and Vaccinations Uptake Percentage (UK Health Security Agency, 2023; Office for National Statistics, 2021)

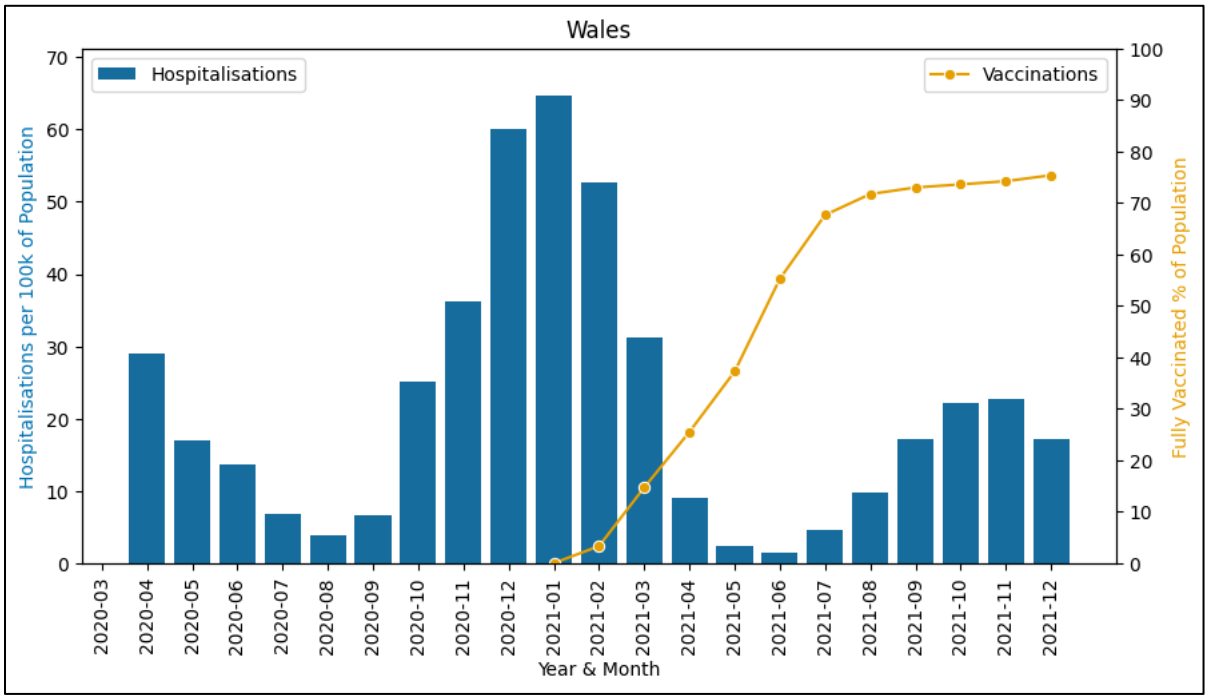


Figure 12 – Northern Ireland COVID-19 Hospitalisations per 100k of Population and Vaccinations Uptake Percentage (UK Health Security Agency, 2023; Office for National Statistics, 2021)

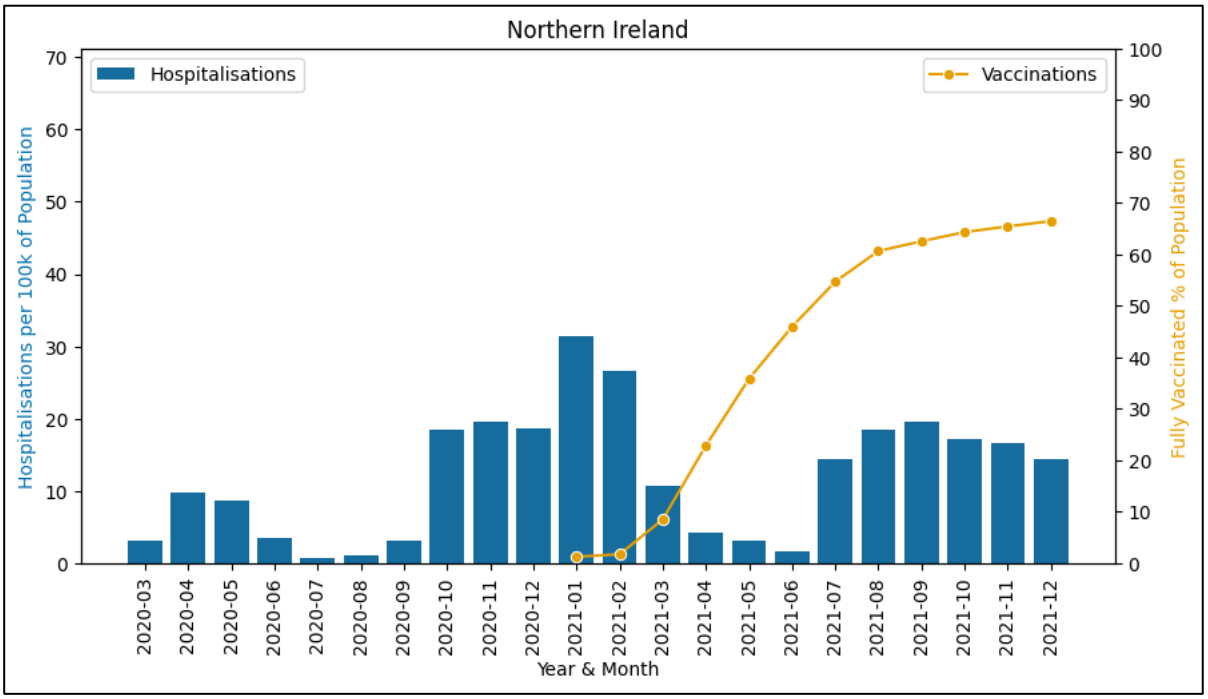


Figure 13 – England COVID-19 Deaths per 100k of Population and Vaccinations Uptake Percentage (UK Health Security Agency, 2023; Office for National Statistics, 2021)

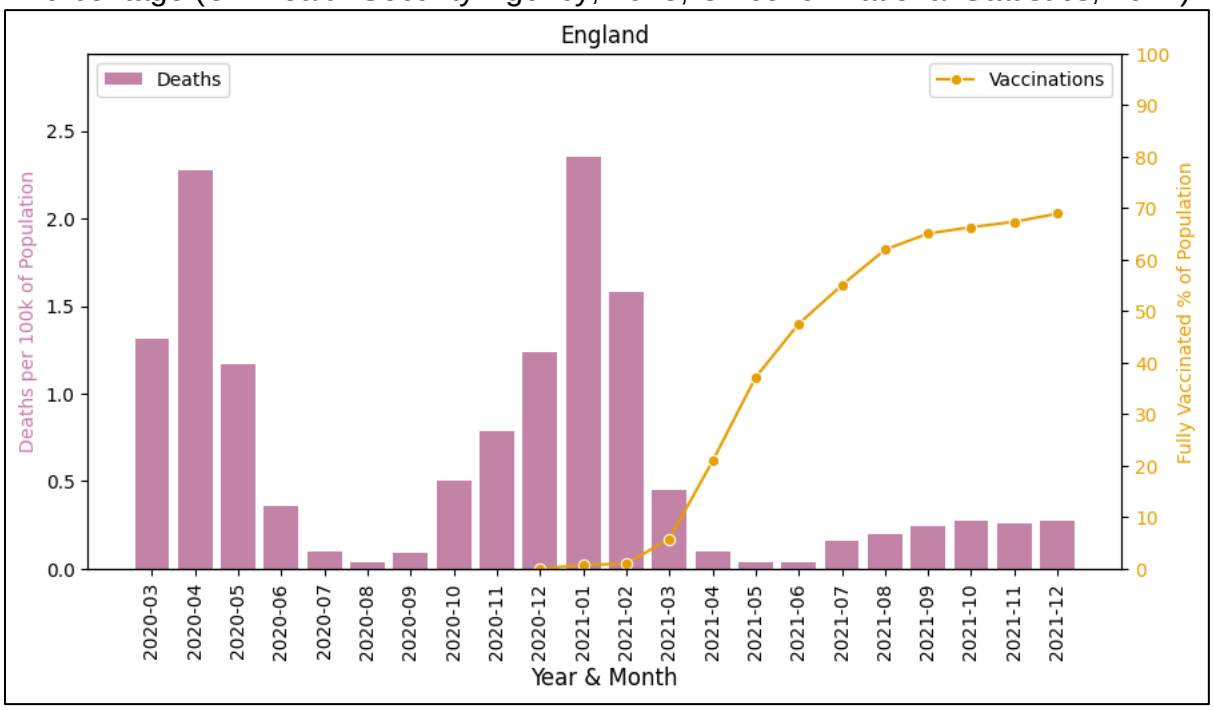


Figure 14 – Scotland COVID-19 Deaths per 100k of Population and Vaccinations Uptake Percentage (UK Health Security Agency, 2023; Office for National Statistics, 2021)

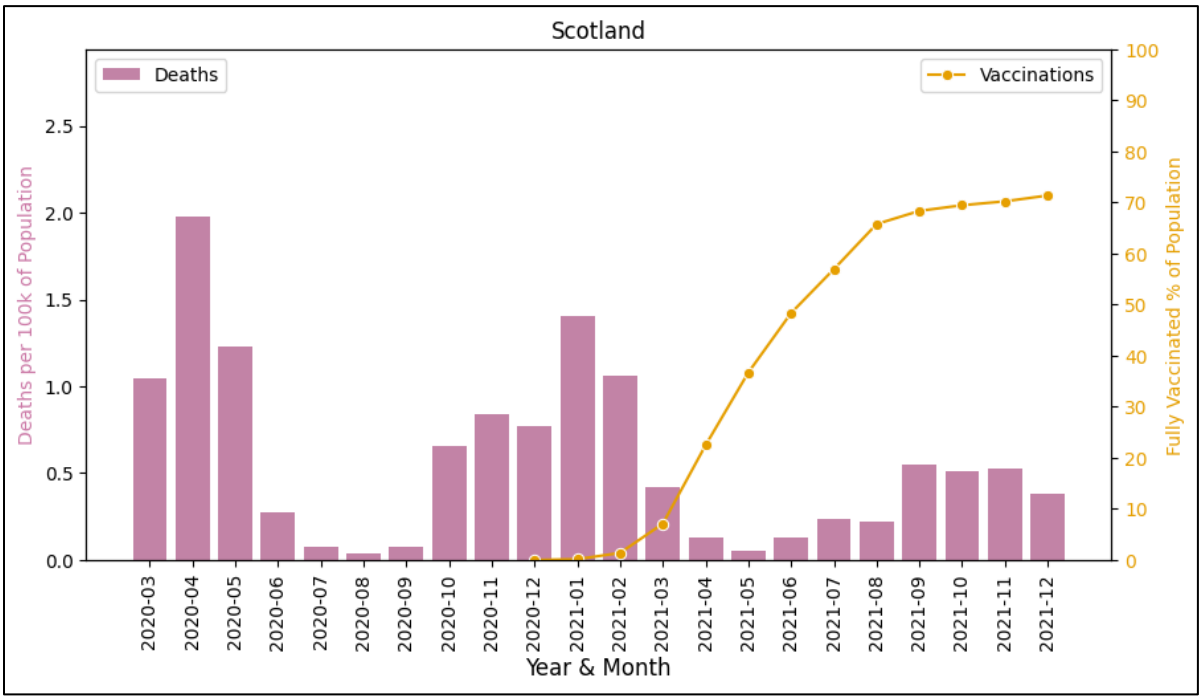


Figure 15 – Wales COVID-19 Deaths per 100k of Population and Vaccinations Uptake Percentage (UK Health Security Agency, 2023; Office for National Statistics, 2021)

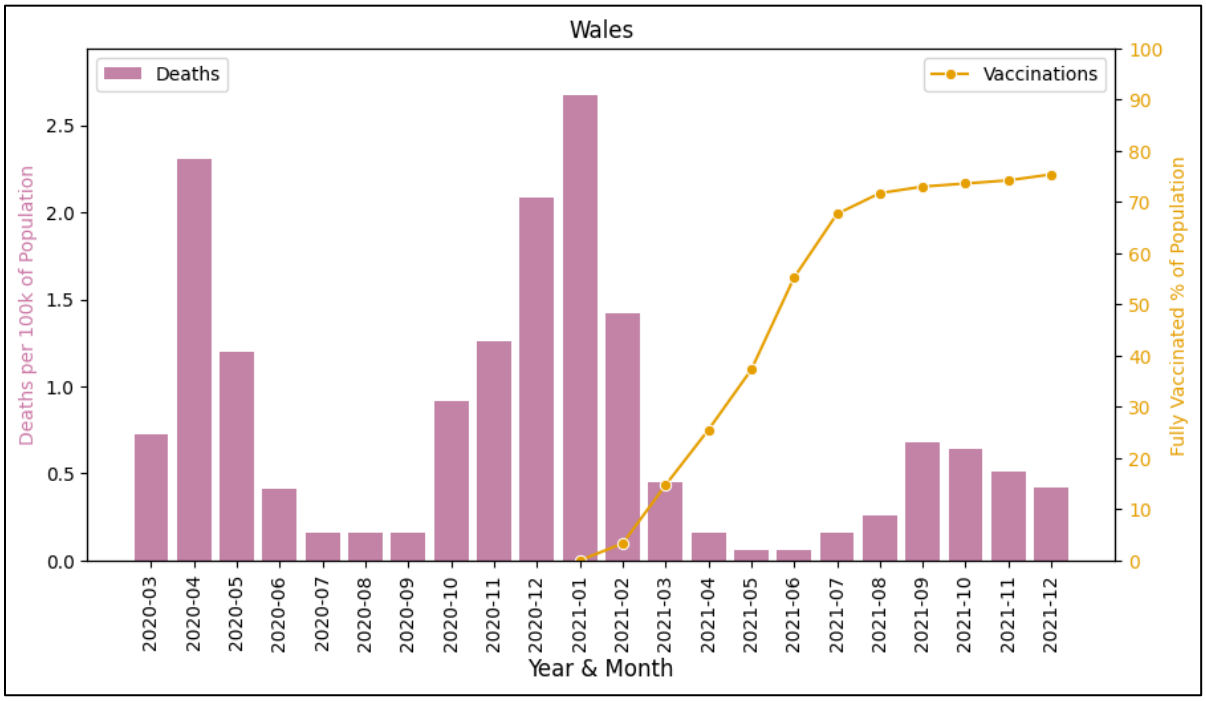
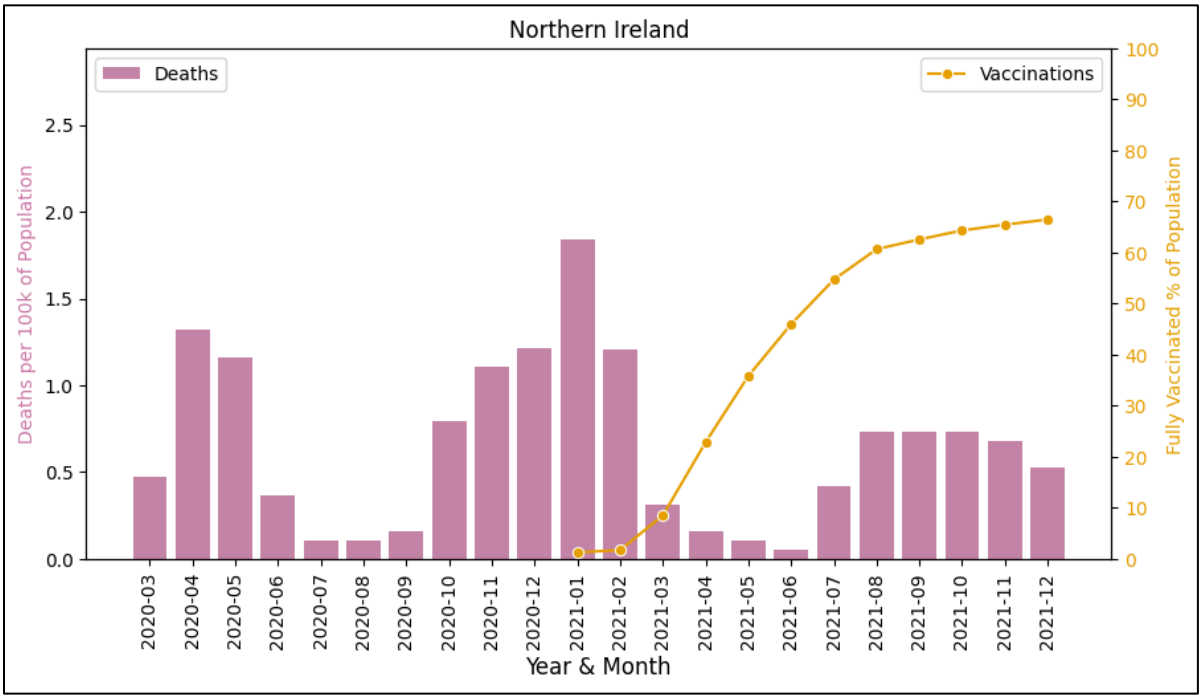


Figure 16 – Northern Ireland COVID-19 Deaths per 100k of Population and Vaccinations Uptake Percentage (UK Health Security Agency, 2023; Office for National Statistics, 2021)



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BBC (2021) *Covid vaccination rollout: How is Wales leading the UK and the world?* [Online]. Available at: https://www.bbc.com/news/uk-wales-57189986 (Accessed 28 May 2023)

Gram, M.A et al (2023) 'Sociodemographic differences in Covid-19 vaccine uptake in Denmark: a nationwide register-based cohort study', *BMC Public Health*, 23(1) [online]. Available at: https://doi.org/10.1186/s12889-023-15301-x (Accessed 29th September 2023)

Mounier-Jack, S. et al (2023) 'Covid-19 vaccine roll-out in England: A qualitative evaluation', *Plos one*, 18(6) [online]. Available at: https://doi.org/10.1371%2Fjournal.pone.0286529 (Accessed 28th September 2023)

Mathieu, E. et al (2023) *Coronavirus Pandemic (COVID-19)* [Online]. Available at: https://ourworldindata.org/coronavirus (Accessed 28th September 2023)

Office for National Statistics (2021) *Population estimates - local authority based by single year of age* [Online]. Available at: https://www.nomisweb.co.uk/datasets/pestsyoala (Accessed 30th September 2023)

Olagnier, D. and Mogensen, T.H. (2020) 'The Covid-19 pandemic in Denmark: Big lessons from a small country' *Cytokine & growth factor reviews*, 53 [online]. Available at: https://doi.org/10.1016%2Fj.cytogfr.2020.05.005 (Accessed 30th September 2023)

Peruch, M. et al (2022) 'Did Italy really need compulsory vaccination against COVID-19 for healthcare workers? Results of a survey in a centre for maternal and child health', *Vaccines*, 10(8) [online]. Available at: https://doi.org/10.3390%2Fvaccines10081293 (Accessed 29th September 2023)

UK Health Security Agency (2023) *Coronavirus (COVID-19) in the UK* [Online]. Available at: https://coronavirus.data.gov.uk/details/download (Accessed 28th September 2023)

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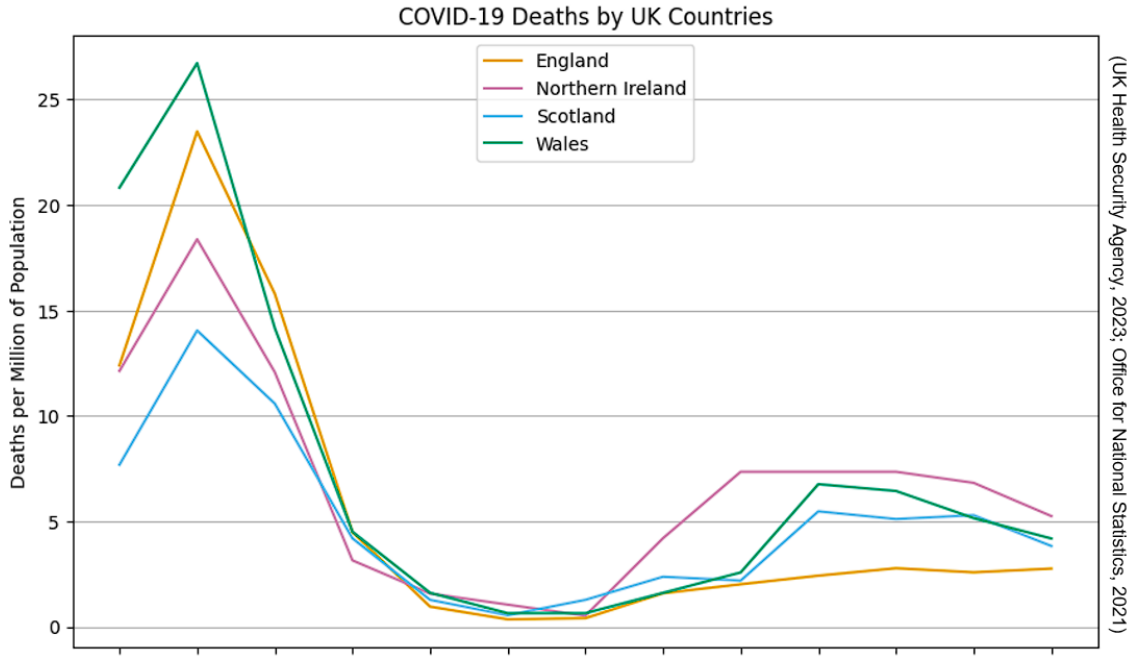
UK Parliament (2021) *Supply and planning issues threaten UK's "world beating" vaccine achievements* [Online]. Available at: https://committees.parliament.uk/work/904/covid19-planning-for-the-vaccine-part-1/news/139179/supply-and-planning-issues-threaten-uks-world-beating-vaccine-achievements/ (Accessed 29th September 2023)

The World Bank (2023) *Population Estimates and Projections* [Online]. Available at: https://datacatalog.worldbank.org/search/dataset/0037655/Population-Estimates-and-Projections (Accessed 28th September 2023)

Task 2 Visual Unannotated

COVID-19 Vaccinations Save Lives



December 2020
Start of COVID-19 vaccinations

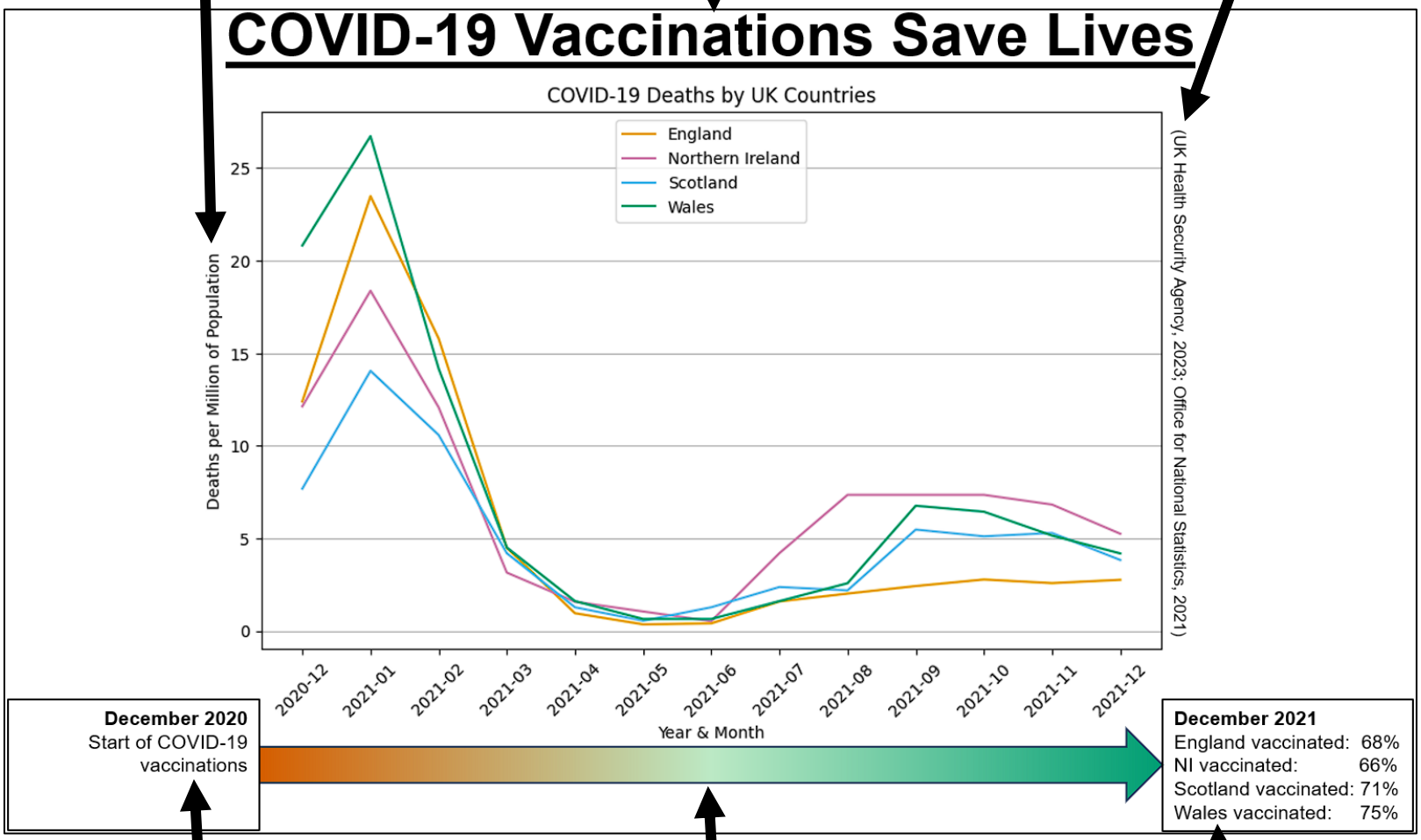
December 2021
England vaccinated: 68%
NI vaccinated: 66%
Scotland vaccinated: 71%
Wales vaccinated: 75%

Task 2 Visual Annotated

Deaths metric is per million of population so that the numbers are smaller and easier to read

Bold title with strong message to draw the reader's attention.

Citation of data sources



December 2020 used to show the peak in COVID-19 deaths when the vaccinations just started.

Arrow used to emphasise progression of high to lower death rates over time when vaccines started. Colours for this and the line chart were selected with colour-blind friendliness in mind.

December 2021 shown alongside vaccination rates to demonstrate to the reader that vaccines can reduce deaths.

References

Office for National Statistics (2021) *Population estimates - local authority based by single year of age* [Online]. Available at: https://www.nomisweb.co.uk/datasets/pestsyoala (Accessed 30th September 2023)

UK Health Security Agency (2023) *Coronavirus (COVID-19) in the UK* [Online]. Available at: https://coronavirus.data.gov.uk/details/download (Accessed 28th September 2023)