LIFESAVING

A rapid assessment of the effectiveness of Lebanon's Covid-19 lockdowns and vaccination campaign in the fight to control the virus

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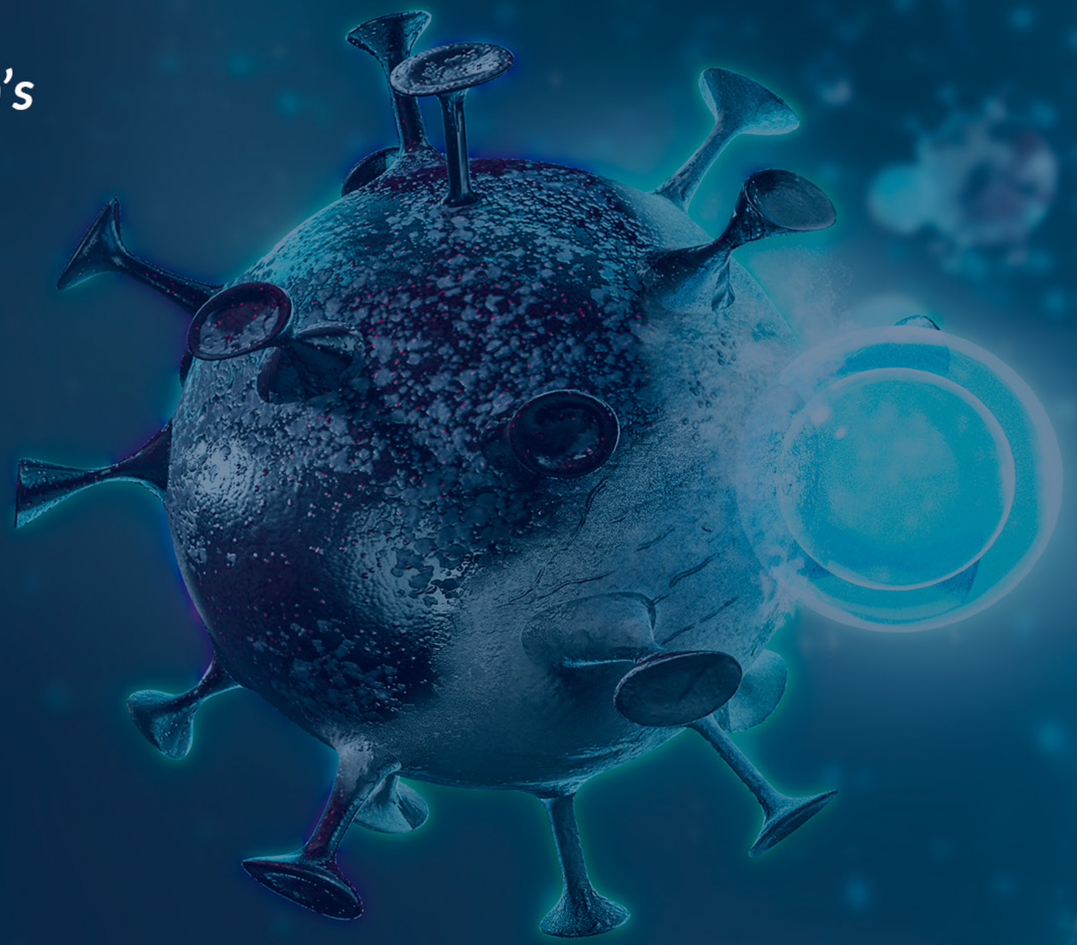

An analysis by the AI Unit at Siren Analytics

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This briefing identifies the effects of the lockdowns and the vaccination campaign implemented in Lebanon in the fight against Covid-19, examining their impact on the numbers of daily cases and deaths. Three data analysis approaches are adopted in order to determine the relation between the vaccination figures, the number of deaths, and the number of positive cases. A scenario is also considered where no preventive measures were taken in Lebanon to control virus.

Overall, the analysis found that the **preventive measures implemented through the Inter Ministerial and Municipal Platform for Assessment Coordination and Tracking (IMPACT) had a positive effect on reducing both the numbers of Covid-19 cases and related deaths across Lebanon. The data analysis suggests that the measures put in place helped avoid an additional 6,330 Covid-19 related deaths over a period of nine months.** Lockdowns prevented higher peaks in the numbers of cases and deaths, and the vaccination program reduced mortalities, even as the daily number of positive cases increased. Importantly, it is likely that Covid-19 related deaths would continue to fall if the number of vaccinated residents increased across Lebanon.

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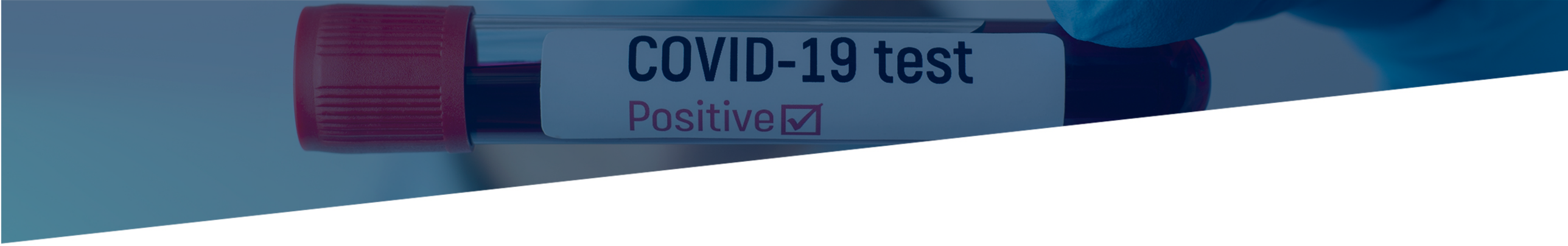


THE CONTEXT

Lebanon recorded its first Covid-19 case on 21 February 2020. Shortly after that, the number of cases started growing exponentially, forcing the government to adopt strict measures, such as a complete national lockdown that lasted around 70 days, until May 2020. A series of shorter lockdowns were implemented in November 2020 and between January and February 2021, in an attempt to manage the steep increase in the number of positive cases and reduce mounting pressure on hospitals across Lebanon.

On 14 February 2021, Lebanon received the first batch of vaccines and started inoculating its residents. A module to manage the vaccination campaign fairly and transparently was put in place on IMPACT, with workflows covering the whole vaccination process, from online registration through vaccine administration and e-certification. The government's National Deployment and Vaccination Plan prioritised elderly and vulnerable populations (such as people at increased risk of severe illness and death), whose inoculation was followed by younger cohorts. Today, 40% of the population in Lebanon is vaccinated, and any resident in Lebanon has access to a free vaccination.

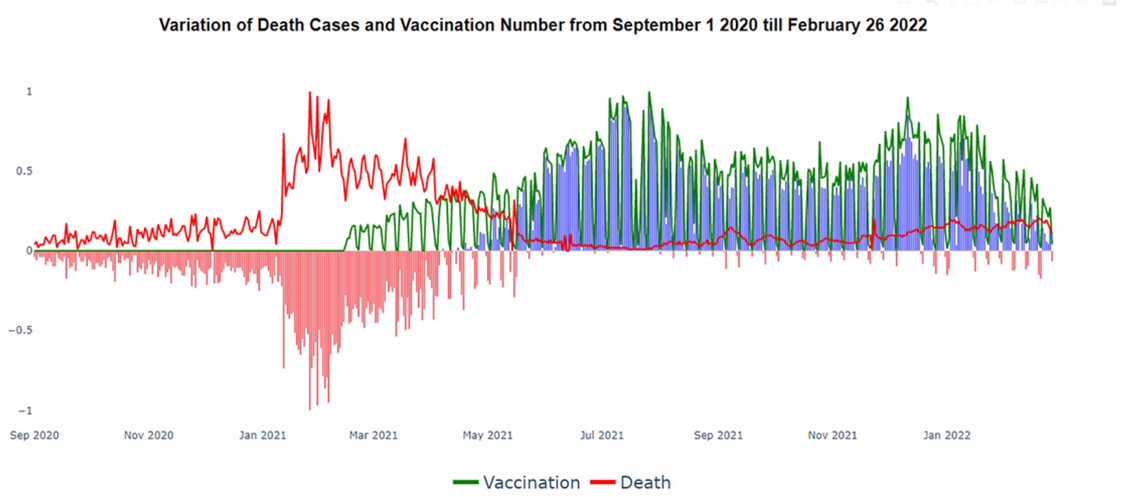
THE NUMBERS

The analysis was conducted on two datasets. The first one is provided by https://impact.gov.lb and records the daily number of positive Covid-19 cases and vaccinations. The second one is provided by https://ourworldindata.org/ and records the daily number of Covid-19 related deaths. The timeline of the data spans mid-2020 to end-2021 in order to reflect the variation of the Covid-19 cases and deaths in the period when the lockdowns were imposed and the vaccination began. An open source tool provided by the graphing company Plotly was used to plot the data, creating interactive graphs in a precise manner.

Different forecasting models and machine learning algorithms were used to forecast the number of Covid-19 cases and deaths that would have occurred had there been neither a series of lockdowns, nor a vaccination campaign. The training dataset for the models comprised data through to January 2021. The validation dataset comprised data from February 2021 onward, allowing for a comparison of what actually happened with what could have happened. Three approaches were adopted to analyse the effect of the vaccination campaign and lockdowns in Lebanon.

1- THE RELATIONSHIP BETWEEN DEATHS AND VACCINATION NUMBERS

The first approach involved studying the relationship between the number of daily vaccinations (shown by the green curve) and the daily number of deaths (represented by the red curve), from 1 September 2020 to 26 February 2022. The blue and pink bars represent, respectively, the positive and negative difference between the number of vaccinations and the number of deaths. These differences were used to estimate the area between the red and green lines.



The y-axis ranges between 0 and 1 in this scenario due to data normalisation. The team normalised the data of both categories (vaccinations, deaths), as the real numbers of daily vaccinations ranged from 0 to 31,000, while the real number of daily deaths ranged from 0 to 351. It is noticeable that before the vaccination campaign began, the daily number of deaths was increasing, achieving its peak values. After the vaccination campaign began, there was a rapid decrease in the daily number of deaths. One month on, daily deaths continued to fall until, during the third month, the green curve passed the red curve, indicating more normalised vaccinations than deaths. This trend continued until early July, with a growing gap between the daily numbers of vaccinations and deaths. **The graph thus shows the positive effect of the vaccination campaign on reducing Covid-19 related deaths in Lebanon.**

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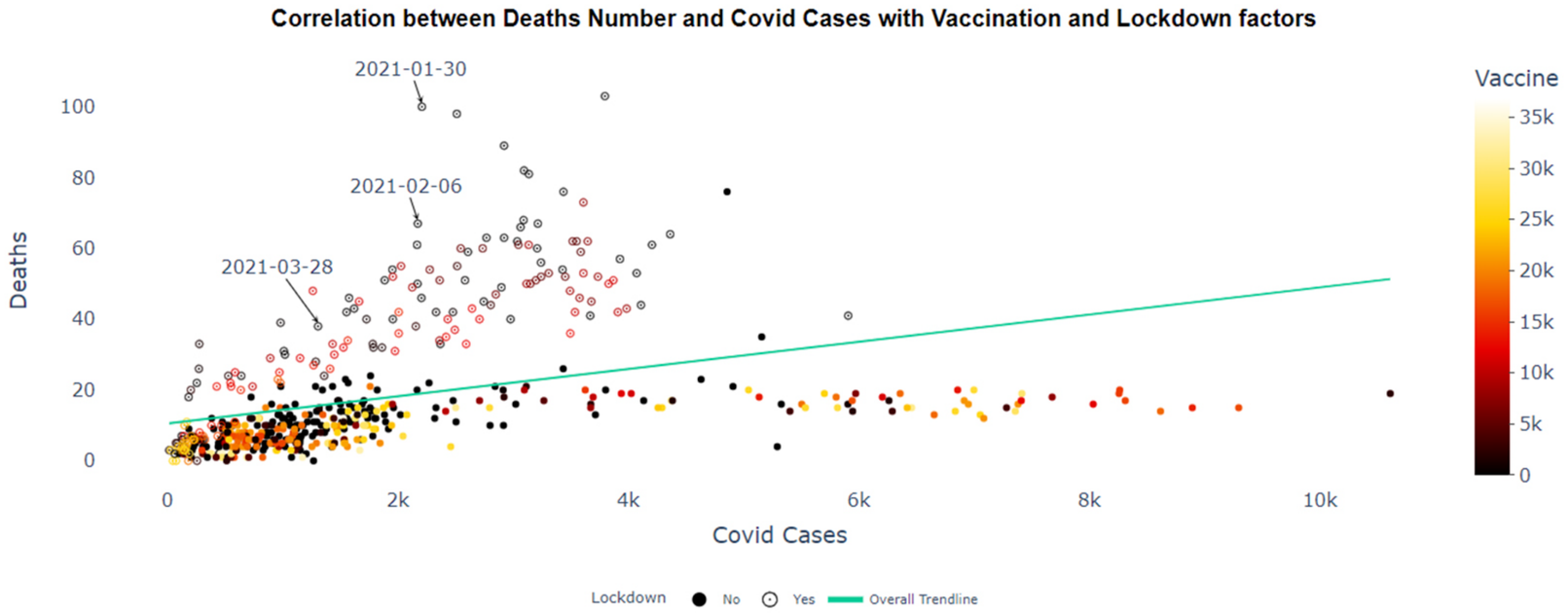
2- VARIATION IN DEATHS AND COVID-19 CASES, BASED ON VACCINATION NUMBERS AND LOCKDOWN PERIODS

The second approach involved examining the effects of the lockdowns and the total vaccination numbers on deaths and infections, respectively. An Ordinary Least Squares trendline was used to estimate the unknown parameters of the model by minimising the errors. The dots on the graph below are coloured according to the daily number of vaccinations, and the open circles represent the days when a lockdown was in place. The green trendline shows the correlation between the daily numbers of Covid-19 cases and deaths.



To measure the effect of the January 2021 lockdown, three dots on the graph were marked with dates. From this, it is clear that the daily numbers of COVID-19 cases and deaths decreased as the lockdown went on. The three dots are coloured in black since no vaccines were available in Lebanon during January and February, and in March, vaccination rates were very low. **Therefore, the reduction in cases and deaths can be attributed to the lockdown.**

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The domain between 0 and 2,000 on the x-axis is divided into two parts: the first below the trendline, and the second is above the trendline. It is clear that the dots above the trendline correspond to the period of lockdown, with the daily number of deaths varying between 20 and 60, and the daily number of vaccinations varying between 0 and 12,000. Below the trendline, the majority of the dots represent days where there was no lockdown. Daily vaccination numbers ranged between 0 and 30,000, but most of the dots are of a lighter colour, indicating a high number of vaccinations. Daily deaths ranged from 0 to 16 in this domain.

In the domain between 2,000 and 4,000 daily cases, the graph shows that the number of deaths peaked, even though there was a lockdown. The dark colour of the dots above the trendline, shows that daily vaccinations were low (less than 10,000). Meanwhile, below the trendline, the light colour of the dots indicates that a large number of vaccinations were being administered each day, peaking at 31,000, while there were no more than 20 daily deaths.

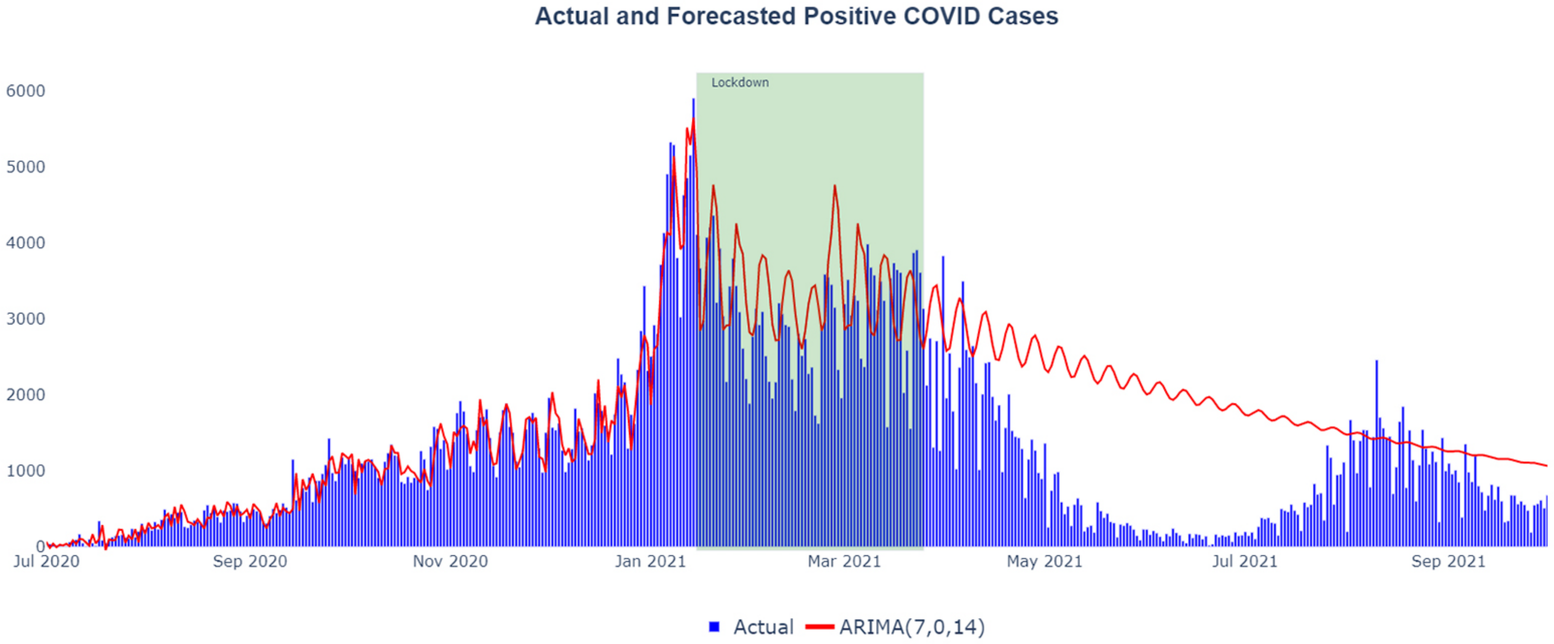
In the last domain between 4,000 and 10,000 daily cases, a limited number of dots sit above the trendline, and all of those dots are coloured in black, indicating low vaccination on those days. A peak of 76 daily deaths was recorded for those dots sitting above the trendline in this domain. The dots below the trendline are generally lighter in colour, indicating a high number of vaccinations that, almost reached 30,000 per day. When the number of daily cases reached 10,000, the number of deaths peaked at only 19.

Overall, it is evident that daily mortalities were at their highest when lockdowns were in place, even though daily case numbers were not at their highest. When the vaccination campaign picked up (red dots above the trendline), the number of deaths started to decrease. The low daily number of deaths at the bottom left of the graph can be due to two possible factors: the low number of positive cases, or the high vaccination numbers. However, as the number of cases increases, the days with the greatest number of deaths are shown by black dots, indicating low vaccination rates; whereas, the days with the lowest number of deaths are shown by lighter dots, indicating high vaccination rates. It is therefore possible to conclude that the low daily number of deaths at the bottom left of the graph is likely due to increased vaccination.

In sum, when daily vaccination numbers were low, the number of deaths increased in a linear fashion; however, once daily vaccinations increased, the number of deaths decreased - even in the absence of a lockdown, and despite daily cases reaching their highest levels since the beginning of the pandemic.

3- THE EFFECTS OF LOCKDOWNS AND THE VACCINATION CAMPAIGN ON CASES AND DEATH RATES

In the third and last approach, the effect of both lockdowns and the vaccination campaign on cases and deaths was examined by forecasting these values, while training the model only on the period before the lockdown and before the start of the vaccination. In the below graph, the actual number of daily cases is shown in blue, with the red line representing the forecasted number of cases had no lockdown been imposed. The red line was generated using a time series forecasting model named ARIMA.



Lockdowns are put in place to control the spread of Covid-19. However, they take time to take effect. In Lebanon's case, as shown in the graph, the peak of positive cases happened in January 2021, prompting the government to implement a nationwide lockdown. During the lockdown, the number of cases slowly started decreasing. However, the lagging effect of the lockdown appeared in April onward, with daily Covid-19 cases continuing to fall. The number of vaccinated people was low in April and May, as the vaccine had only just been introduced in Lebanon. **Therefore, the drastic decrease in positive cases can be attributed to the lagging effect of the lockdown.**

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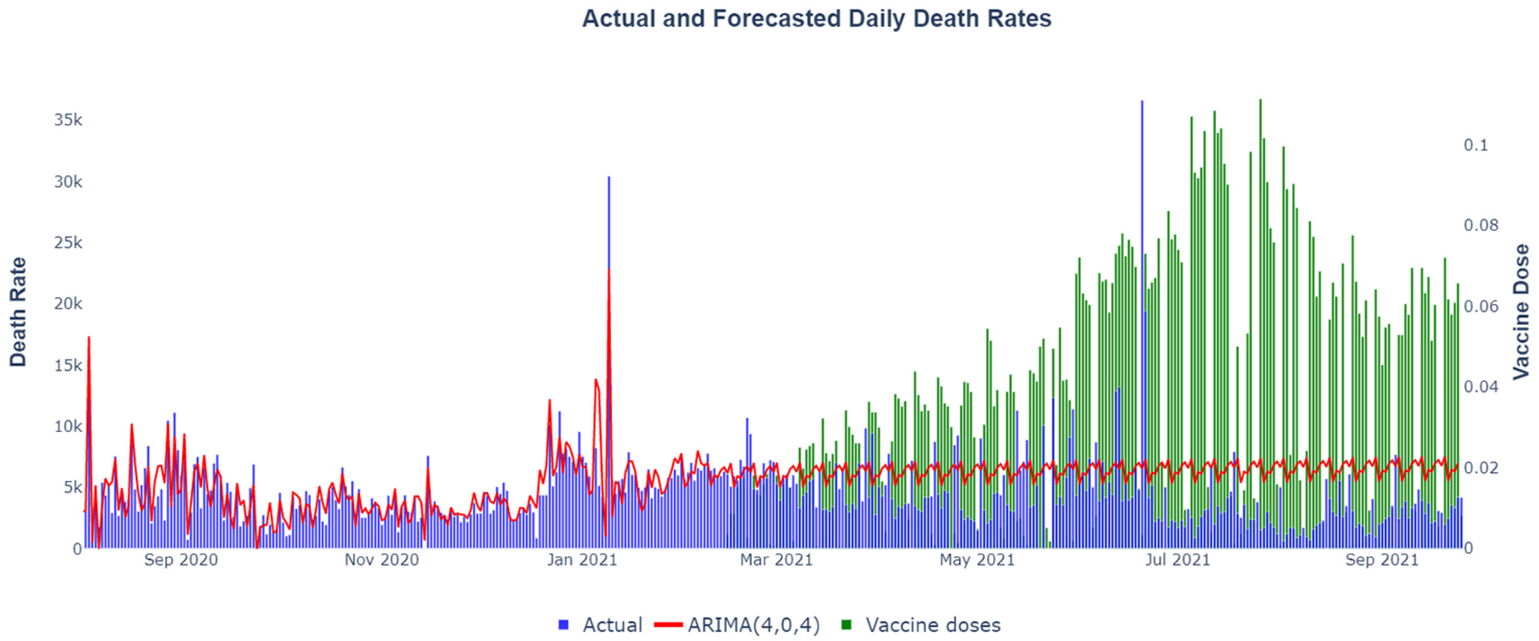
Based on the ARIMA (7,0,14) model that fitted best the training data of the positive Covid-19 cases, and by calculating the difference between the forecasted and actual values, the analysis shows that, by the end of September 2021, there could have been 240,650 more cases than were actually registered, or an additional 870 cases daily. .

The effect of the vaccination campaign and the lockdown can be examined by comparing the actual versus forecasted daily death figures. In the graph below, we can see the actual daily death figures in dark blue, the daily vaccination numbers in green, and the forecasted daily deaths that could have taken place had no lockdown or vaccination program been implemented, represented by the red line.



Based on the ARIMA (4,0,4) model that fitted best the training data of the daily death rate, the analysis shows that, had no lockdown nor vaccination program been implemented, by the end of September 2021 the daily death rate would have been greater than the actual one by a daily average of 0.5%.

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Combining the results obtained from these forecasting models, it is possible to conclude that, if the daily numbers of cases and death were to follow the trend of the timeline before the 2021 lockdown and the deployment of the vaccination program, there could have been an additional 24.44 daily deaths, or an overall additional 6,330 “avoided deaths,” between January and September 2021.

For questions and inquiries please contact
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