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COVID-19 Vaccination Progress in India and its Neighbors

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ABSTRACT

The novel coronavirus COVID-19 has affected the entire world in an unprecedented manner. Countries around the world are trying to control the rate of infection primarily through vaccination drives. Now that the vaccine has been developed and introduced in various countries, the deployment of vaccines to the masses seems to be a challenging task.

The present paper is an attempt to explore the progress of the vaccination drive around the world. The focus has been particularly on India and its neighbours in South Asia. Current COVID-19 data set on vaccination status has been analysed and referred to get insight into the dataset on various aspects on vaccination progress including daily vaccination progress, which vaccination scheme is used the most, the number of people vaccinated etc.

This study can be a useful report for experts and the concerned officials in India to have a comparative understanding of vaccination progress. Python and associated graphic libraries have been used to explore the dataset.

Key Words: COVID-19, Vaccination progress, Vaccination scheme, Time Series, India, South Asia

INTRODUCTION

The present COVID-19 epidemic has prompted scientists all across the world to look for answers in the form of medicines and vaccines to combat SARS-CoV-2. Published research on SARS-CoV and, to a lesser extent, MERS has provided insight into vaccine options for this unique coronavirus. Large-scale vaccination campaigns will begin in most nations in the first half of 2021. Demand will outstrip supply, forcing countries to select who should be vaccinated first, depending on risk and epidemiological concerns. Many of these efforts will be carried out in "waves," with different population groups being targeted in a staggered manner based on priority and as more vaccines become available. According to current global standards, health workers, the elderly, and persons with pre-existing diseases that enhance their risk of severe disease should be prioritized. In most countries, reaching these people will necessitate unique vaccination tactics that leverage the experience and capacity of existing children and maternal immunization programs, as well as influenza vaccines. Vaccination tactics beyond 2021 will be determined by the vaccines' efficiency and duration of protection, vaccine demand, and the success of vaccination programs. Also, no definite statistics on the period of protection provided by the various vaccination products, their ability to protect against new or future viral variations, or their effectiveness are conclusively known.[1]

Concerning vaccination strategies in India, Serum Institute of India, ZydusCadila, Biological E, Indian Immunologicals, Bharat Biotech, and Mynvax are six biotech enterprises in India alone that are collaborating with multinational vaccine producers.[4] DNA vaccines live attenuated recombinant measles vaccines, inactivated viral vaccines, subunit vaccinations, and vaccines created by codon optimization are among the projects that are being worked on. Moreover, academic institutions such as the National Institute of Immunology (NII), the Indian Institute of Science (IISc), the International Center for Genetic Engineering and Biotechnology (ICGEB) in New Delhi, the Translational Health Science and Technology Institute (THSTI), and others are working to develop vaccines, therapies, and SARS-CoV-2 animal models to contain the pandemic as quickly as possible. [2]

Thus, considering the present times, as COVID-19 vaccines are introduced, national and subnational governments, the

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general public, civil society organizations, the media, and regional and global immunization partners will place a high demand on data from national and sub-national public health agencies.

The present paper is an attempt to provide scientific data that would be particularly useful to national authorities in charge of managing, implementing, and monitoring COVID-19 vaccine introduction and distribution in their countries. It may also be beneficial to any partners who give the necessary support in countries, as well as organizations that build and install information systems to support vaccination programs in their respective countries. The present research paper aims to create a database to better understand vaccine deployment in various countries, with emphasis on India and its neighbours. It aims to research the various vaccinations available in various global locations, with a focus on vaccine distribution to the last mile.

Scope of the research

The primary aim of this work is to analyze the progress of vaccination around the world. More specifically analysis on the progress of vaccination in India in comparison of its neighbours including Nepal, China, Pakistan, Sri Lanka, Maldives etc. has been performed. This work attempts to find answers to the following questions about vaccination progress in the world. More specifically our point of interest is to understand how India vs its neighbours have progressed in terms of vaccination.

1. What vaccines are used in each country?
2. Which vaccination scheme is used most?
3. Determine vaccination scheme distribution per country. Scheme for India & its neighbours
4. Total vaccinations per country, grouped by vaccine scheme. Who is doing well?
5. People vaccinated per country, grouped by vaccine scheme. Who has done well?
6. Daily vaccinations per country. Compare India's progress with its neighbours.
7. Total vaccination per cent evolution of all countries/ selected countries (India VS its neighbours)
8. Inspecting time series and rolling mean. Determine Month wise seasonality.
9. Predict the number of cases in India VS Neighbors.

Apart from finding the answers to the above questions, Time Series Analysis has been applied to the data to determine the Month wise seasonality and the number of cases in India and its neighbours has also been predicted.

Methodology

A. Selecting the Dataset

The data on current vaccination status has been obtained from the information portal GitHub- https://github.com/owid/covid-19-data and datasets from Kaggle.[1]

This dataset is a collection of the COVID-19 data maintained at the website with the address https://ourworldindata.org/coronavirus

The data contains the following information:

Relevant details should be given including experimental design and the technique (s) used along with appropriate statistical methods used clearly along with the year of experimentation (field and laboratory).

Table 1: Dataset Description

Data column	Details
Country	this is the country for which the vaccination information is provided
Country ISO Code	ISO code for the country
Date	date for the data entry
Total number of vaccinations	number of total immunizations in the country
The total number of people vaccinated	number of people that received the entire set of immunization according to the immunization scheme (typically 2);
Daily vaccinations	the number of vaccination for that date/ country
Total vaccinations per hundred	ratio (in percent) between vaccination number and total population up to the date in the country;
Total number of people vaccinated per hundred	Ratio (in per cent) between population immunized and total population up to the date in the country
Number of vaccinations per day	number of daily vaccination for that day and country
Number of vaccinations per day	number of daily vaccination for that day and country;
Daily vaccinations per million	ratio (in ppm) between vaccination number and total population for the current date in the country
Vaccines used in the country	total number of vaccines used in the country (up to date);
Source name	Source of the information (national authority, international organization, local organization etc.);
Source website	website of the source of information

B. Tools and Techniques used

Python packages have been used for data ingestion, preparation and visualization. Plotly is used for visualization. Folium library has been used to plot map objects.

In the vaccination progress analysis, the following points have been focussed upon:

- What vaccination schemes are used in various countries?
- Total number of vaccinations and per cent of vaccinations;

- Daily vaccinations and daily vaccinations per million;
- Total people vaccinated and per cent of people vaccinated;

The data has been visualized and an analysis report has been presented here based on the latest values as well as for the variation in time of the above-mentioned values.

RESULTS

The objective was to find which vaccination schemes are used in different countries, specifically Indian & its neighbours. Following is a snapshot of the information retrieved. This information can be useful in analyzing which vaccine has wider acceptability and efficacy. More than one vaccine scheme is being used in some countries.

Table 2: Vaccine Scheme

Vaccines	Countries
CanSino, Sinopharm/Beijing, Sinopharm/Wuhan, Sinovac	China
Covaxin, Oxford/AstraZeneca	'Central African Republic', 'India'
Oxford/AstraZeneca, Sinovac	'Benin', 'Indonesia', 'Thailand'
Oxford/AstraZeneca, Sinopharm/Beijing	Nepal
CanSino, Oxford/AstraZeneca, Sinopharm/Beijing, Sinovac, Sputnik V	Pakistan
Oxford/AstraZeneca, Sinopharm/Beijing, Sputnik V	'Sri Lanka'
Moderna, Pfizer/BioNTech	Singapore

Based on the above-obtained information, we were interested in finding vaccines that are used most.

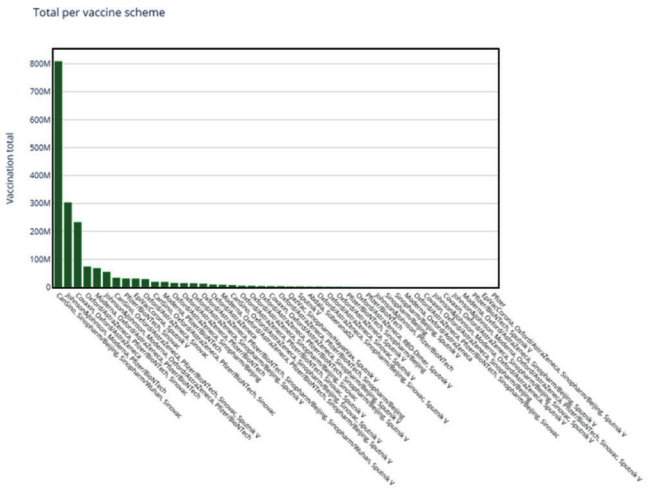

Figure 1: Total Vaccination per Vaccine Scheme.

This clearly shows that the "*CanSino, Sinopharm/Beijing, Sinopharm/Wuhan, Sinovac*" vaccine scheme is most used.

Treemap representations have been used to observe the vaccination scheme distribution per country.

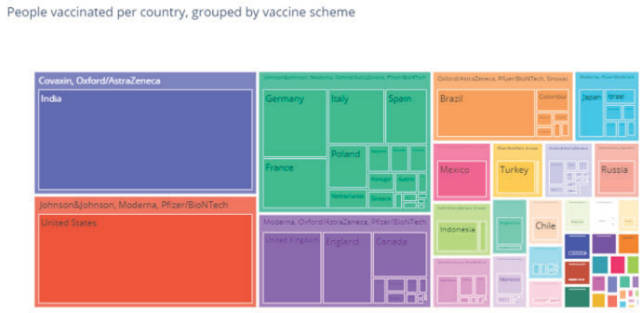

Figure 2: TreeMap Representation For Vaccination Scheme.

Then the countries statistics were evaluated, irrespective of the vaccine scheme to find the answers to following

- Total number of vaccinations per country;
- Per cent of vaccinations from the entire population;
- Daily number of vaccinations;
- People vaccinated per country
- Daily number of vaccination per million population;
- Daily number of vaccination per hundred population;

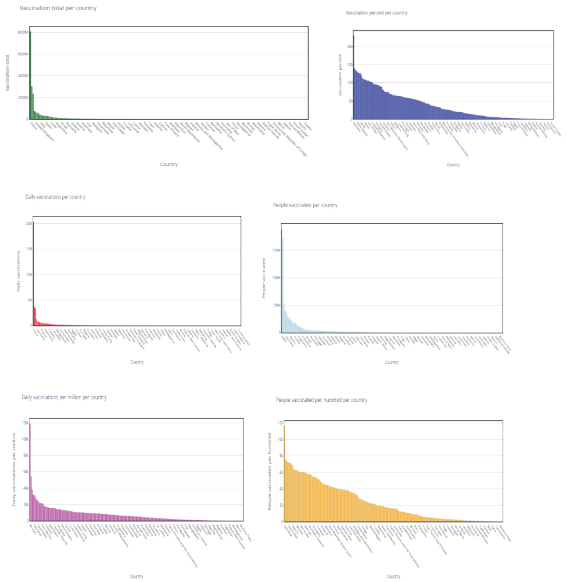

Figure 3 (I-VI): Countries Statistics, Irrespective to the Vaccine Scheme.

DISCUSSIONS

The following conclusions were drawn from the above graphs:

- In terms of total vaccinations per country, China is doing far better in comparison to others. Countries like Great Britain, Turkey, Poland are also doing well.
- In terms of Vaccination percentage, Gibraltar has quite well. Understandably the smaller countries with less population were found to do well in this case. Countries like Great Britain, Uraguay, Spain, Qatar, Singapore are doing well.

Vaccination progress (India vs its Neighbors)

The vaccination progress in terms of total vaccination percent evalution in India[3] w.r.t its neighbors was analysed. The data has been observed till 1st week of June 2021.

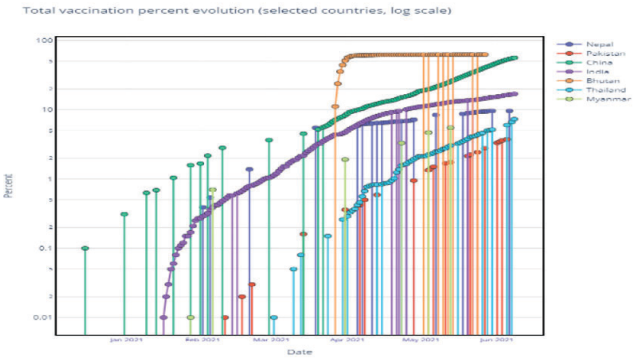

Figure 4: Total Vaccination Percent Evaluation in India w.r.t its Neighbors.

The above plot depicts that both Bhutan & China are comparatively doing much better. Rests are also improving with their vaccination program.

The comparison was also performed on the progress on daily vaccination evolution in India VS its neighbours. The plot depicts that China & India are comparatively doing better.

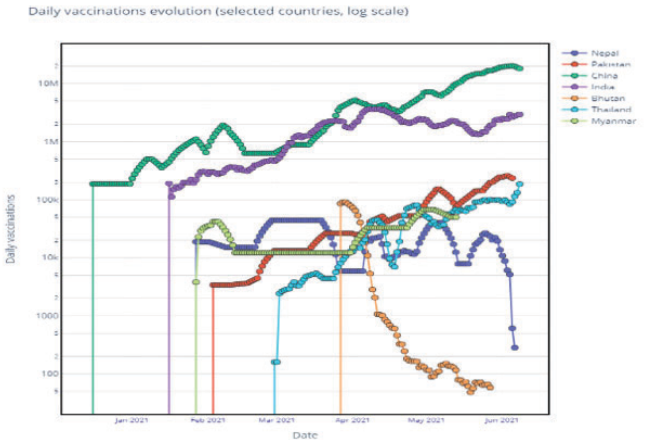

Figure 5: Daily Vaccination Evolution in India VS Its Neighbors.

The time series was also inspected and the rolling mean of 12 months was also computed. This depicts a steeply rising trend from April 21 onwards. This is primarily due to the availability of vaccines around the world and also due to rising cases in many countries like India.

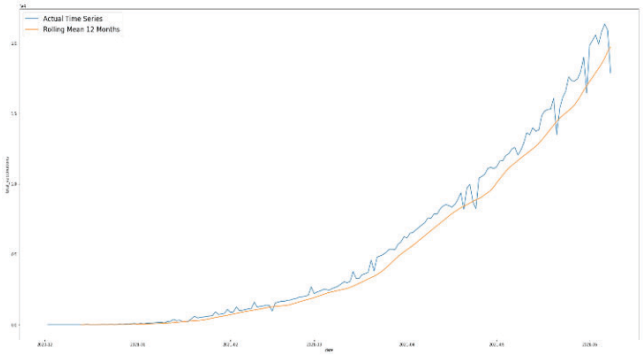

Figure 6: Time Series Plot.

The plot below depicts the report of the daily vaccination status of Indian neighbours

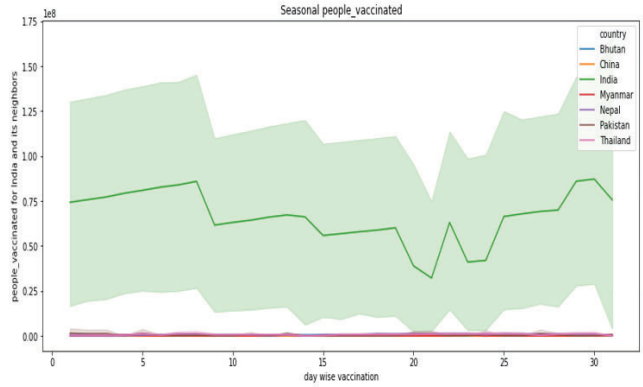

Figure 7: Day-wise Vaccination Progress of Indian Neighbors.

CONCLUSION AND FUTURE SCOPE

As vaccination is still in its early stages of production, many countries are still facing a shortage of doses. The presented analysis can be useful to concerned authorities in charge of managing, implementing, and monitoring COVID-19 vaccine introduction and distribution in their countries. Furthermore, suitable time series prediction models could be created in the next work to predict some important predictors of COVID-19.

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Authors' Contribution: Neda Fatima is currently pursuing Ph. D. in electronics and communication engineering with special emphasis on the Internet of Things, Data Security, Cloud Computing and Machine learning. A Gold Medalist and an author of nine reputed research papers, she has three Best Paper Awards to her credit.

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