COVID-19 VACCINATION PERFORMANCE ANALYSIS FOR THE UNITED STATES AND INDIA

Gulhan Bizel[1],[2],

Lalitha Sindhuja Putcha[3],

Sakshi Sharma[4]

Abstract:

The coronavirus disease 2019 (COVID-19) pandemic is an ongoing pandemic caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Amidst the pandemic pharmaceutical companies and health care centers have been trying relentlessly to combat the virus and vaccination is recently available. The COVID-19 vaccination campaign in the United States is an ongoing mass immunization campaign for the COVID-19 pandemic. Mass vaccinations began on December 14, 2020. The vaccines that are currently prevailing under the FDA's emergency use of authorization are Pfizer–BioNTech vaccine, Moderna vaccine, and Johnson & Johnson vaccine. Free vaccination against COVID-19 commenced in India on January 16, 2021, and the government is urging all its citizens to be immunized, in what is expected to be the largest vaccination program in the world. The Indian government has taken urgent measures to expand the country's vaccine manufacturing capacity and has also developed an efficient digital system to address and monitor all the aspects of vaccine administration. India's drug regulator has approved restricted emergency use of Covishield (the name employed in India for the Oxford-AstraZeneca vaccine) and Covaxin, the home-grown vaccine produced by Bharat Biotech. The timely and coordinated execution of these post-efficacy tasks will bring the pandemic to an effective and efficient ending. In this research, it has been studied COVID-19 vaccination trends of the United States and India with the aspects of region, states/union territory, age, and gender.

1. INTRODUCTION

The current COVID-19 pandemic has urged the scientific community internationally to find answers in terms of therapeutics and vaccines to control SARS-CoV-2 (Kaur, S.P., & Gupta, V. 2020). Vaccine development is usually measured in decades, so having access to approved vaccines available for large-scale distribution before the end of 2020 or even 2021 would be unprecedented (Graham, B. S. 2020). However, by late November 2020, several pharmaceutical companies announced the early results of their large vaccine trials claiming efficacy for the majority of the trial participants (Cohen, J. 2020). In this research, it has been studied COVID-19

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[1] Assistant Professor, Saint Peter's University, Jersey City, United States of America, https://orcid.org/0000-0002-0094-9107; gbizel@saintpeters.edu;

[2] Corresponding Author Details : Dr. Gulhan Bizel - gbizel@saintpeters.edu; Assistant Professor, Guarini School of Business, Saint Peter's University, Jersey City, United States of America

[3] MS (Business Analytics), Graduate Assistant, Saint Peter's University, Jersey City, United States of America, https://orcid.org/0000-0001-8861-8662; lputcha@saintpeters.edu;

[4] MS (Data Science), Graduate Assistant, Saint Peter's University, Jersey City, United States of America, https://orcid.org/0000-0003-4749-1559; ssharma2@saintpeters.edu;

vaccination trends of the United States and India. SARS-CoV-2 mRNA-based vaccines are about 95% effective in preventing COVID-19 (Turner, J.S., O'Halloran, J.A., Kalaidina, E. et al. 2021).The factors considered for research of this paper for both India and the United States are region, states/union territory, age, and gender. The United States has been considered as one of the best practices of the world while India was slow in the execution of the vaccination process.

United States Vaccination Execution

There have been and still are apprehensions regarding COVID-19 vaccination. Any vaccine development will be accelerated in the context of a grave public health emergency. The inherent probabilistic nature of the development of any biologic means that no vaccine could be said to be 100% safe. There will be risks and those risks are likely to be greater than with well-established vaccines. The priority setting for COVID-19 vaccination is given in the below table (Dooling, K. Dec 31, 2020).

Table 1: Priority setting for COVID-19 in the USA

Country	Stage/phase	Priority
United States/Centers for Disease Control and Prevention & Advisory Committee on Immunization Practices	Phase 1a	• Health care workers
		• Long-term care facility residents
	Phase 1b	• Frontline essential workers
		• Persons aged ≥ 75 yrs.
	Phase 1c	• Persons aged 65–74 yrs.
		• Persons aged 16–64 yrs. with high-risk medical conditions
		• Essential workers not recommended for vaccination in Phase 1b
	Phase 2	• All persons aged ≥ 16 yrs. who have not been vaccinated

India Vaccination Execution

A year has passed since the first case of novel coronavirus infections was detected in China's Wuhan province. At present, Covaxin and Covishield vaccines are being used for the vaccination drive in India as they are the only vaccines that have received approval (restricted use in emergency) from the Central Drugs and Standards Committee (Sharun, K., &Dhama, K.2021, April 16).Several factors complicate the use of COVID-19 vaccines: programmatic scale, in particular the need for vaccination of all age groups rather than simply children. India is regarded as the vaccine manufacturing hub of the world, contributing 60% to the global vaccine supply.(Sharma J, Varshney SK. 2021).Logistics - a global supply chain that will be complex and might result in bottlenecks and delays. The potential use of multiple different vaccines and a lack of evidence on substitution of one for the other, unique, and demanding cold-chain requirements (Kim, J.H., Marks, F. & Clemens, J.D. 2021, January 19). Despite all the challenges from making COVID-19 vaccination to supplying to all over the country, India has been striving hard to save its population.

India not only plans for domestic manufacture of COVID-19 vaccine but also for its distribution in countries that cannot afford to buy expensive vaccines from the Western world. In India, the data emanating from clinical trials of different vaccines support their eligibility for emergency authorization, even though some of the final details are not available yet. The emphasis now is on the quality control, quality production, and cost control of these vaccines to make them affordable to even the poorest nations in the world(Kumar, V.M., Pandi-Perumal, S.R., Trakht, I. et al.,2021). The phases in which vaccination was conducted in India are shown in the table below.

Table 2: COVID-19 vaccination phases in India

Country	Stage/phase	Priority
India	Phase 1	• Health care workers
		• Disaster management volunteers
		• Police and paramilitary forces
	Phase 2a	• Front line workers not vaccinated in Phase 1
		• Persons aged ≥ 60 yr
	Phase 2b	• Persons aged ≥ 45 yr

	Phase 3	• Persons aged ≥ 18 yr

In response to the global coronavirus disease 2019 emergency, clinical trial research assessing the efficacy and safety of vaccines emerged at an unprecedented rate. Older adults, persons with certain coexisting conditions, and front-line workers were at the highest risk for COVID-19 and its complications. Safe and effective prophylactic vaccines were urgently needed to contain the pandemic, which has had devastating medical, economic, and social consequences (Polack et al., 2020).

2. AIM OF STUDY

To study the vaccination performance of COVID-19 for The United States and India and thereby draw inferences from it.

3.MATERIAL AND METHODS

To accomplish this, it is critical to understand the acceptance of COVID-19 vaccination among its people. The purpose of this study is to describe the current vaccinated population percentage in all states of the USA, further break down the population into different age groups and describe the vaccinated population based on gender. This paper will also showcase the comparison of the vaccinated population in the USA and India. Hence the study will thereby analyze the administration of efficient COVID-19 vaccination in the two most affected countries, India and the USA.

For this study, datasets including the total population and total vaccinations completed for each state will be considered for both countries. From this data, further breakdown into different age groups and gender will be calculated to complete the purpose of this study. Finally, a comparative study for both countries on the same variables will be highlighted in this paper.

The master dataset is obtained by merging two datasets. The first data set is for the population in each state of the USA in 2020 group by age (12-18, 19-64, 65+) and subgroup by gender. The second data set is vaccination data as of May 27th, 2021, for each state of the USA in 2020 group by age (12-18, 19-64, 65+) and subgroup by gender. The population data is collected from the United States Census Bureau, Statista Research Department, and Kids Count Data Center. The vaccination data is obtained from the Centre for Disease control for each state under different age groups. To estimate the gender distribution of the vaccinated population in each age group we have assumed that the proportion in different age groups is the same as the aggregate of the 50 states. As the datasets are formulated from different sources, it is required for the data to be maintained such that there would be no errors during the analysis. Hence, several data cleaning techniques have been employed as required for the acquired dataset.

The datasets relating to India have been retrieved from Kaggle with a wide range of data available, the vaccination data considered for the analysis range from January 1ˢᵗ of 2021 to May 18ᵗʰ of 2021 COVID-19 in India. The population data of 2011 was taken from the Indian Government Census Status for which an estimated population for 2021 was done at a growth rate of 16.4%.

Data preprocessing

With a wide range of data collected from various sites for analysis, data preprocessing is the initial necessary step. Data preprocessing is the preliminary processing of data to prepare it for primary research or further analysis. Having wrong or bad quality data can be detrimental to your processes and analysis. Data collected from various sites generally consist of lots of unclean and uninformative parts that are not required during the analysis. To prepare the data for statistical analysis, the below processing and cleaning steps were completed for population and vaccination data.

The United States Population Data Set

As the vaccination data is populated in the age group of 12-18, 19-64, and 65+, it is essential to prepare the population data in the same age group for a comparative study. 2019 population data were first processed for age range 0-18, 19-64, 65+ for each state. After that, the age group 12-18 is calculated by excluding children aged 0-11 from the child population data and lastly estimated all three age groups for 2020 based on the 2020 population data for each state data. Finally, data for gender ratio for each state separately was used to divide the groups into subgroups of male and female. Lastly, data cleaning techniques like Change Text to Lower/Upper/Proper Case, remove duplicate values and spell check for all states, converting numbers stored as text into numbers, getting rid of extra columns and extra spaces was implemented to get the data ready for analysis.

United States Vaccination Data Set

Two data sets: USA COVID-19 vaccinations CDC data as of May 27 and Gender ratio vaccination CDC data are used to create the vaccination master dataset. Extraction of required columns was followed by removing entities that are not part of the population data. The excluded data includes data from American Samoa, Bureau of Prisons, Dept. of Defense, Federated States of Micronesia, Guam, Indian Health Svc, Marshall Islands, Northern Mariana Islands, Puerto Rico, Republic of Palau, Veterans Health, Virgin Islands. The gender ratio for vaccination for the entire USA was used to calculate state-wise male and female vaccinated data. Lastly, the final data set is populated for age groups, Children 12-18_Male, Children 12-18_Female, Adults 19-65_Male, Adults 19-65_Female, Senior 65+_Male, Senior 65+_Female. All data cleaning techniques that were applied to the population data set were implemented to get the data ready for analysis.

India Population Data Set

As the population data set was based on the 2011 census, it initially consisted of 36 states comprising 28 states and 8 union territories. A reorganization act was passed by the Parliament of India which contained provisions to reconstitute Ladakh as a union territory, separate from the rest of Jammu and Kashmir on 31st October 2019. Based on the research question whether Article 370 has worked in the manner envisaged or has aggravated inequality and fueled the growth of conflict in Jammu and Kashmir. On 7th February 2014, the Union Cabinet unilaterally cleared the bill for the creation of Telangana being bifurcated from Andhra Pradesh and the state of Telangana was officially formed on 2nd June 2014. The formation of Telangana in June 2014 marked a continuity and change in the politics of State formation in India (Hausing, K. K. S. 2018). Thus, for the research paper, the population of Jammu and Kashmir, and Ladakh have been combined and

shown as Jammu and Kashmir. Likewise, the population of Andhra Pradesh and Telangana has been combined and shown as Andhra Pradesh. In total, the number of states for this study is now 34. The age bifurcation of the population is 18-30, 31-45, 46-60, and 60+ years for males and females respectively. Finally, a growth rate of 16.4% was applied for an estimated population as of 2021. Lastly, data cleaning techniques like Change Text to Lower/Upper/Proper Case, remove duplicate values and spell check for all states, converting numbers stored as text into numbers, getting rid of extra columns and extra spaces was implemented to get the data ready for analysis.

India Vaccination Data Set

Based on the population data, it is imperative to have the same number of states for comprehending the data in a meaningful manner. The vaccination data of Telangana and Ladhak was added to the data of Andhra Pradesh and Jammu and Kashmir respectively. Any discrepancies in the data were observed and corrected accordingly using data cleaning techniques. For this study, the vaccination data considered for all states are as of May 18th, 2021.

Data Cleaning Techniques

Data cleaning and preprocessing is the process of cleaning and preparing the text for further analysis. Online datasets, usually, may contain lots of noise and uninformative parts that could hinder the output during the analysis. To keep all the datasets in line for statistical analysis, the following data cleaning methods have been employed to get the multiple datasets merged wherever possible to improve the analysis. This would essentially decrease the noise in the datasets and would allow us to obtain more precise outcomes.

A brief description of all data cleaning techniques used in this paper is given below:
Change text: Sometimes all the text could be in lower/upper case, or it could be a mix of both. To make it consistent proper () function was used.

Remove duplicate values: Duplicated values are removed using the below steps:
Select the data and Go to Data –> Remove Duplicates.
If data has headers, ensure that the checkbox at the top right is checked. Select the Column(s) from which duplicates need to be removed and click OK.

Spell Check for all states: To check the spelling of all states in both the files to draw correct comparisons.

Converting numbers stored as text into numbers: Sometimes when data is extracted from external sources numbers get stored as text. This could create serious issues if that cell is being used in calculations.

The best way to convert these numbers stored as text back into numbers is by following the below steps:
Select the first cell in the column you need correction, and press Control + C
Select the cell/range that needs to be converted to numbers
Select Paste - Paste Special (Keyboard Shortcut – Alt + E + S)

In the Paste Special Dialogue box, select multiply (in operations category)
Click OK. This converts all the numbers in text format back to numbers.

Getting rid of extra columns and extra spaces: Extra columns with duplicated data values or columns with data values not used in this paper are removed to make the data neat. To get rid of any extra spaces which are generally difficult to spot, a TRIM function was used to clean the dataset (Bansal, S. 2021, May 10).

4.RESULTS

This paper analyzes COVID-19 vaccinated data for the USA. Itfurther drills down the data into different states and subgroups it into different age groups and gender. Comparative study for highest and least vaccinated states is performed based on Gender distinction and finally, analysis of data for the senior population is conducted. The same approach and analysis are then performed for India. Lastly, a comparative study is completed to evaluate the difference in vaccinated population for both the countries and arrive at concluding the results.

4.1 Analysis of the USA population and vaccination data

On Jan 4th, 2021 the first COVID-19 vaccination in the United States took place, as the country gears up for its largest-ever immunization campaign. As of May 27th, 2021, 58 % of the total USA population is vaccinated from COVID-19. The highest vaccinated state with an 80 % vaccinated population is Vermont and the lowest vaccinated state with a 40% vaccinated population in Mississippi. The detailed analysis for all states, gender, and age groups is given below.

4.11 Overall analysis of the USA population and vaccination data.

Standing among the countries with the highest vaccinated population, the USA has already vaccinated around 58% of its population. The below map represents the USA total population vs. Vaccination in all states.

Figure 1
Map of the USA representing total population vs. vaccination in all states
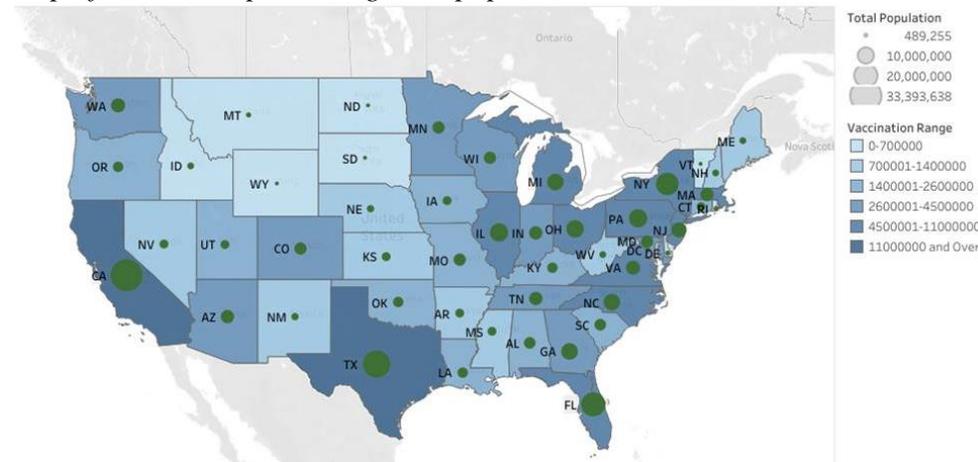
As the count of vaccinated population correlates positively with the total population in the USA, it is a good indicator of higher vaccinations in the country. The population of the USA accounts for 279.92 million out of which 162.48 million are already vaccinated to achieve a 58% vaccination for the country. Figure 2 represents the data in a bar chart to compare population and vaccination metric values.
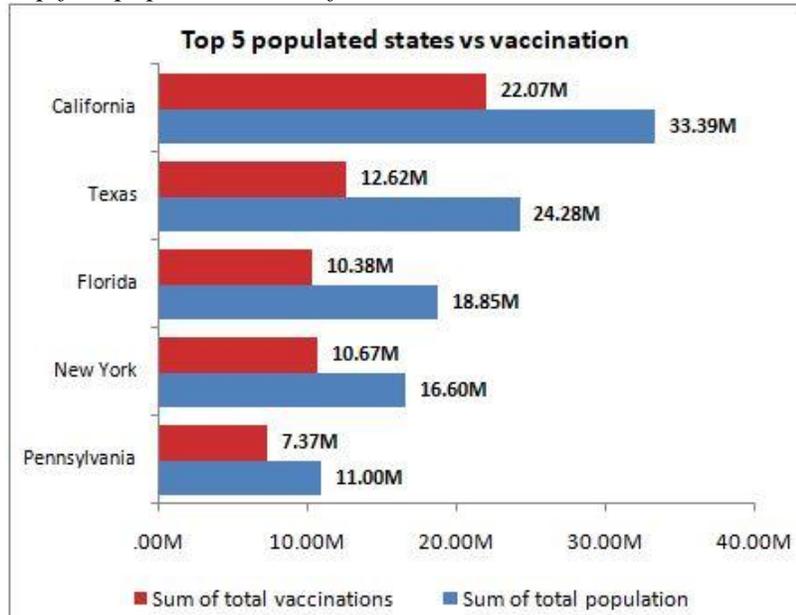
Figure 2
Bar chart for the USA
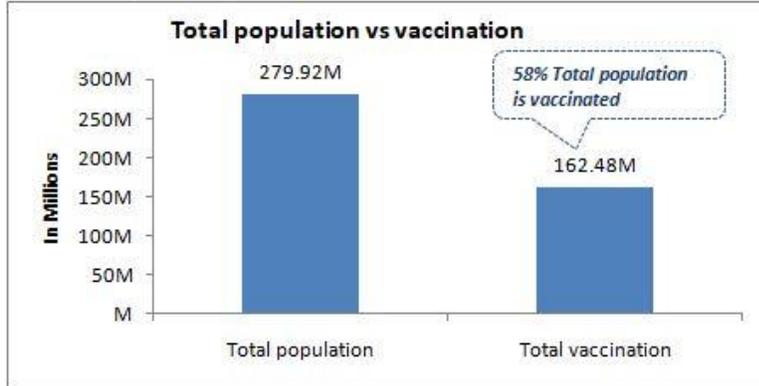
4.12 State-wise analysis of the USA population and vaccination data.

The analysis is continued further by inspecting the data for each state of the USA. The average percentage of vaccination for the top five most populated states is 61% whereas it is 59% for the least five populated states. Figure 3 compares the five most populated states in the USA with the vaccinated population in absolute numbers.

Figure 3
Top five populated states for the USA

Vermont which is one of the least populated states has the highest percentage of vaccination compared to all the states in the USA and contributes the most in 59% of total vaccination of least five populated states. Figure 4 represents the least five populated states in the USA with the vaccinated population in absolute numbers.

Figure 4
Least five populated states for the USA
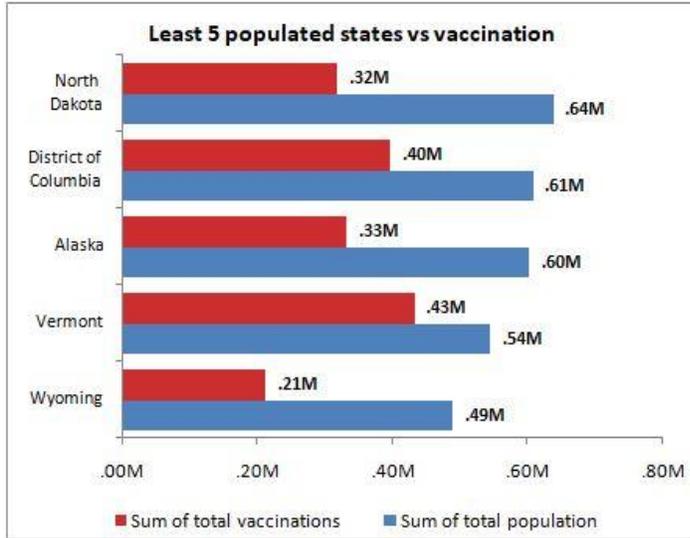
4.13 Gender analysis of the USA population and vaccination data.

With 58% of the total vaccinated population, it is observed that 61% of the female population is vaccinated which is 6% more compared to males although the female population is just 1.5% higher than males. The data analysis represents that in each state females vaccinated percentage is more than males. This percentage difference lies between 1 - 11 percent. Figures 5 and 6 represent the data in a bar chart to compare population and vaccination metric values for females and males respectively.

Figure 5
Bar chart for females for the USA
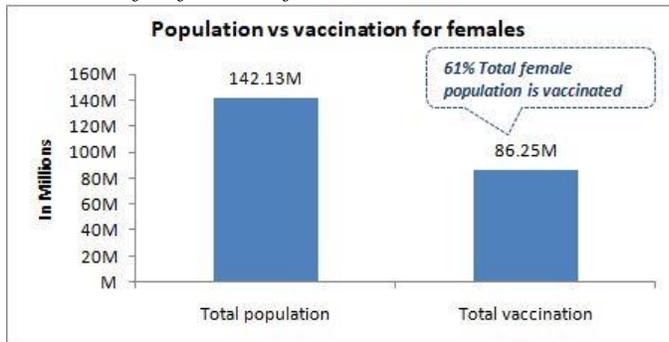
Figure 6
Bar chart for males for the USA
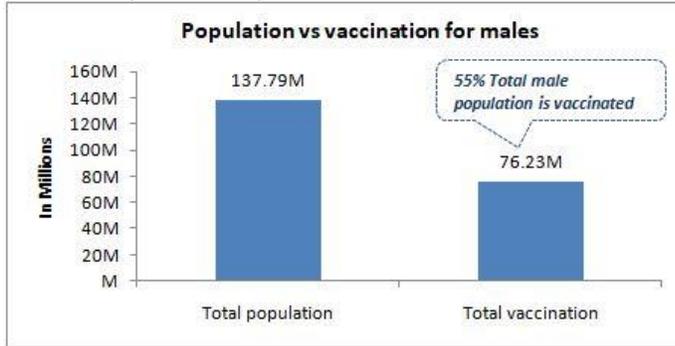
Vermont, Hawaii, and Massachusetts are states with maximum female vaccinated population percentage whereas Mississippi, Alabama, and Louisiana have the least female vaccinated population percentage. There are 10 states where the population of Females is lesser than Males, even then all the states have a higher percentage of vaccinated females. Figure 7 and Figure 8 represent the gender distinction of the vaccinated population in the USA for the highest and lowest vaccinated states respectively.

Figure 7
Tornado chart for highest female vaccinated states vs male for the USA
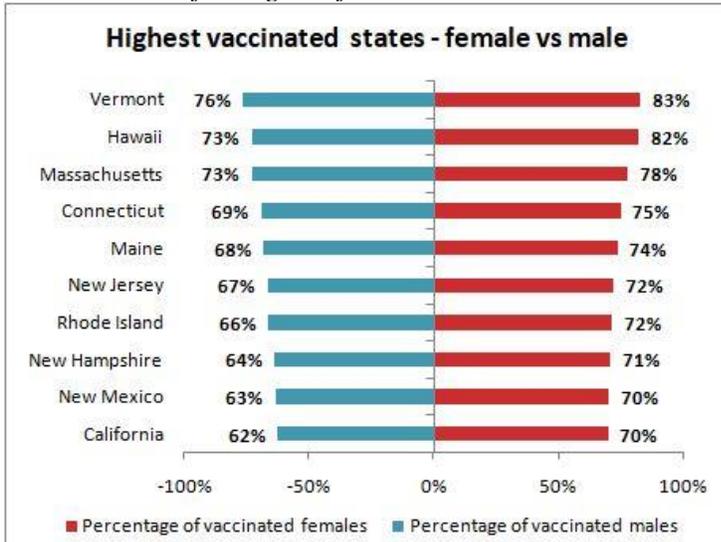
Figure 8
Tornado chart for least female vaccinated states vs male for the USA
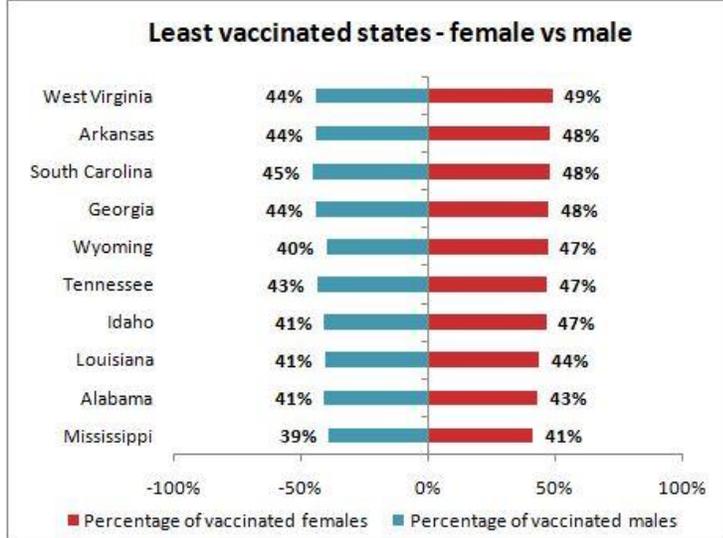
4.14 Age-wise analysis of the USA population and vaccination data.

It started by first securing the elder population followed by adults who have health risks and in the meantime trials were running for children. As of May 27th, 2021, this analysis represents that 85% of the elderly population is vaccinated across the USA. More than half of the adult US population is also vaccinated and the number is growing every day. Children being the last ones to receive vaccination are currently at 20%. Figures 9, 10, and 11 represent the data in a bar chart to compare population and vaccination metric values for children (12-18), adults (19-65), and seniors (65+) respectively.

Figure 9
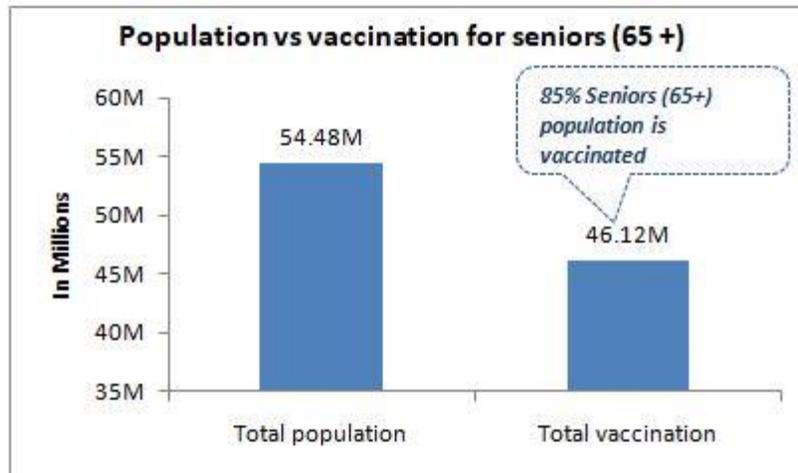*Bar chart for children (12-18) for the USA*
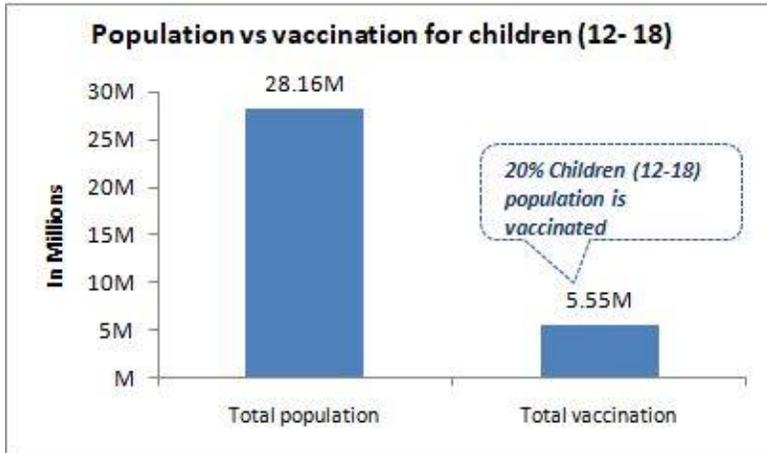
**Figure 10**
Bar chart for adults (19-65) for the USA
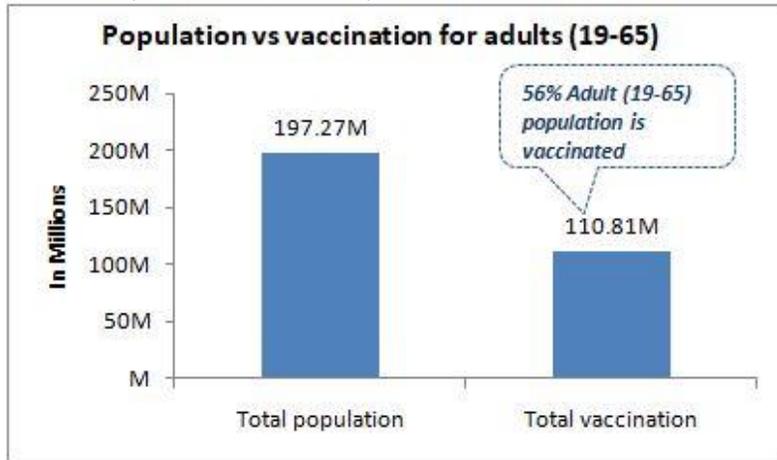
Figure11
Bar chart for seniors (65+) for the USA

In general, vaccination priority should be given to the elderly to minimize the number of deaths. Overall the USA has already vaccinated 85% of its Senior 65+ population as of May 27th which is around one-fifth of the total US population. Mississippi and West Virginia have the lowest percentage of Senior 65+ vaccinated population (74%) followed by Alabama and Wyoming at 75%. Vermont has the highest percentage of Seniors 65+ vaccinated population (99%) followed by Pennsylvania at 98%. Montana and West Virginia have almost one-fourth of their population above the Senior 65+ bucket however, their vaccinated population is among the least vaccinated states in the USA. Hawaii, Maine, and Vermont on the other hand are among the highest vaccinated states for seniors 65+ with almost the same percentage of the Senior 65+ population in their states. Figure 12 represents the data in a bar chart to compare population and vaccination metric values for Seniors 65+.

Figure 12
*Highest vaccinated states in the USA*
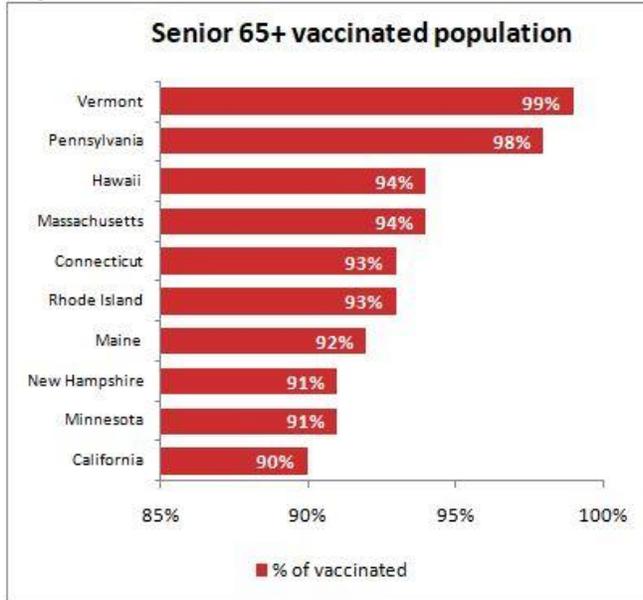
4.2 Analysis of India population and vaccination data.

India began inoculating health workers from Jan 16, 2021, in what is likely the world's largest COVID-19 vaccination campaign, joining the wealthier nations where the effort was already underway. Indian authorities hope to give shots to 300 million people, roughly the population of the United States (The Associated Press. 2021, January 16).

4.21 Overall analysis of India population and vaccination data.

Despite a promising start in January, India has administered jabs to just around 10% of its total population. The drive has lagged in recent months because of low supply and delays in approving new vaccines. The below map represents India's total population vs. Vaccination in all states.

Figure 13

Map of India representing total population vs. vaccination in all states
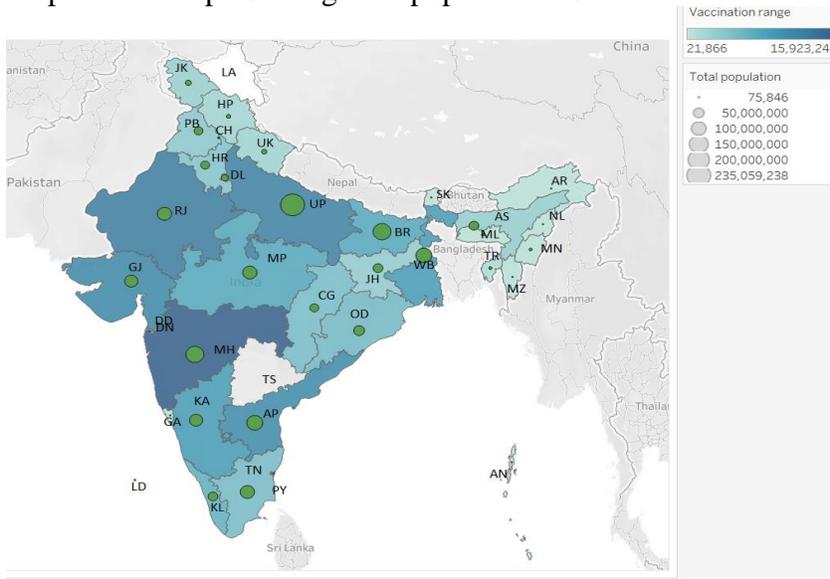
Note: The vaccination data of Telangana and Ladhak was added to the data of Andhra Pradesh and Jammu and Kashmir respectively. The population of India accounts for 1425.51 million out of which 145.37 million are already vaccinated to achieve a 10% vaccination for the country. Figure 14 represents the data in a bar chart to compare population and vaccination metric values.
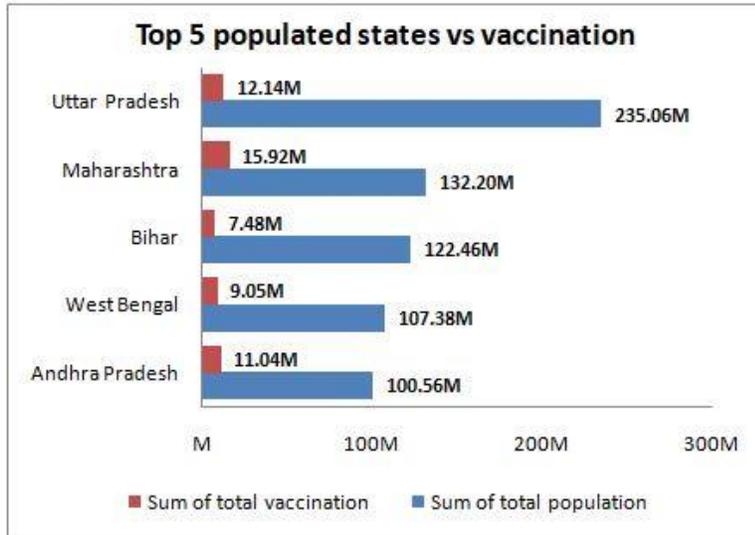
Figure 14

Bar chart for India
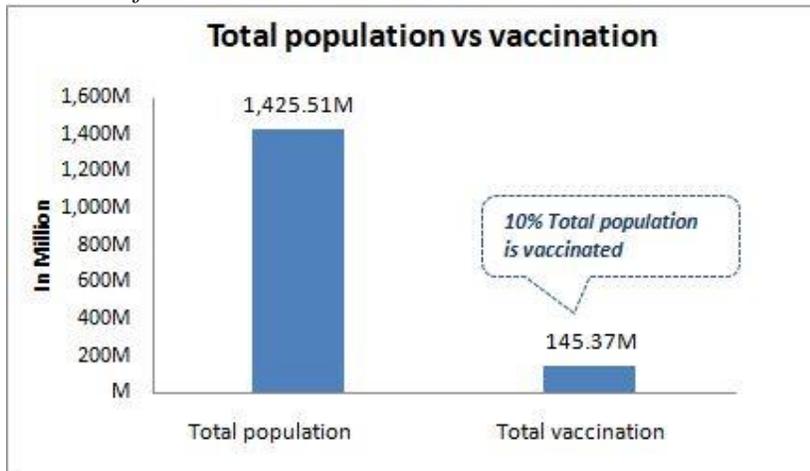
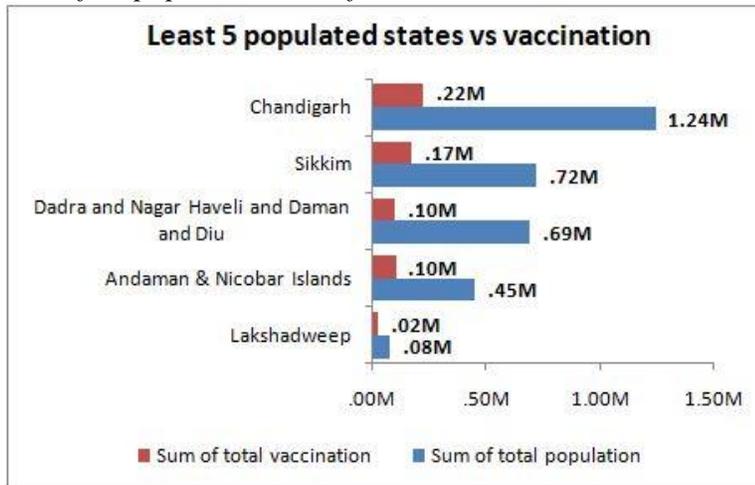**3.22 State-wise analysis of India population and vaccination data.**

The analysis is continued further by inspecting the data for each state of India. The average percentage of vaccination for the top five most populated states is only 9% whereas it is 21% for the least five populated states. Figure 15 compares the five most populated states in India with the vaccinated population in absolute numbers.

Figure 15
Top five populated states for India

Indian states like Lakshadweep, Andaman & Nicobar Islands, Dadra, and Nagar Haveli, and Daman and Diu and Sikkim with less than one million populations have vaccinated on an average 22% of their population. Figure 16 represents the least five populated states in India with the vaccinated population in absolute numbers.
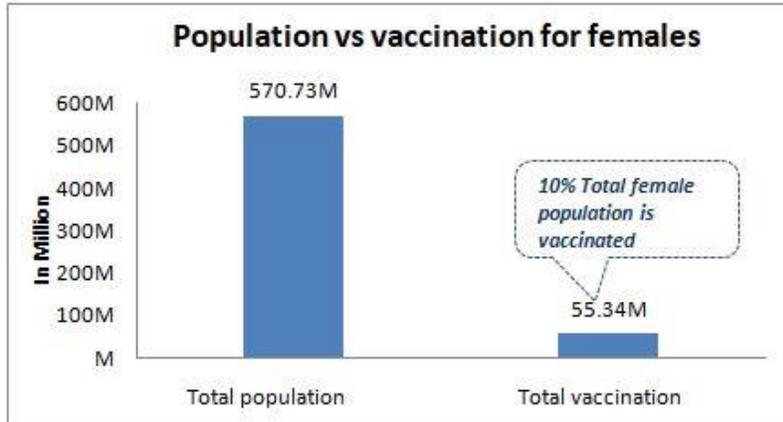
**Figure 16**
Least five populated states for India

4.23 Gender analysis of India population and vaccination data.

With only 10% of total vaccinations in India, there is not much difference in the percentage of female and male vaccinated population. Though India has 60% of its population as males, the vaccinated population for males is 11% that is just one percent higher than females. Figures 17 and 18 represent the data in a bar chart to compare population and vaccination metric values for females and males respectively.

Figure 17
*Bar chart for females for India*

Figure 18
Bar chart for males for India
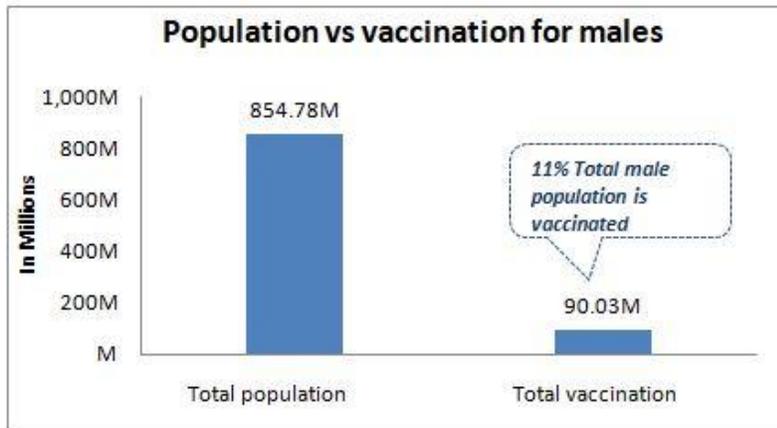
Himachal Pradesh, Tripura, and Lakshadweep are states with the highest vaccinated female population whereas West Bengal, Uttar Pradesh, and Tamil Nadu are among the states with the lowest vaccinated female population although these three are highly populated states of India amounting to almost 30% of total India population. Figure 19 and Figure 20 represent the gender distinction of the vaccinated population in India for the highest and lowest vaccinated states respectively.
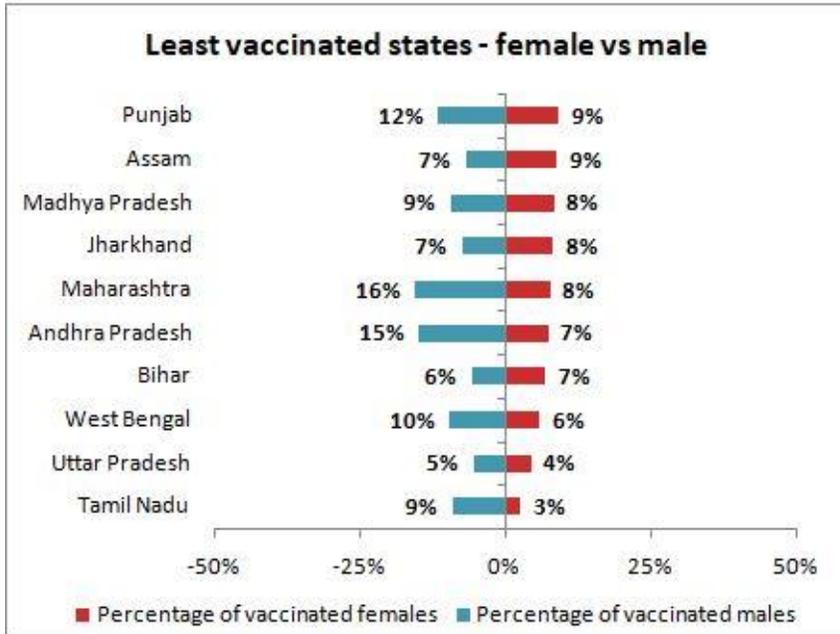
Figure 19
Tornado chart for highest female vaccinated states vs male for India
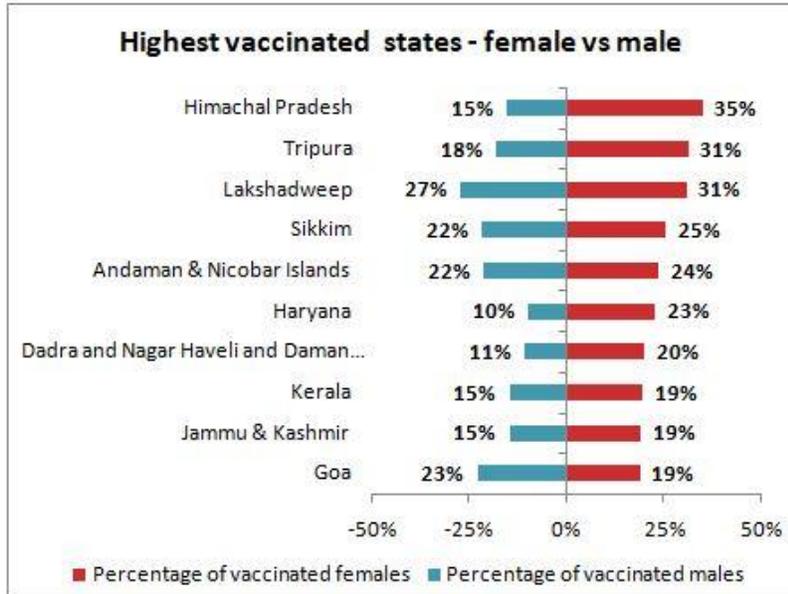
Figure 20
Tornado chart for lowest female vaccinated states vs male for India


**4.24 Age-wise analysis of India population and vaccination data.**

Just like the USA, India also started by first securing the elder population followed by adults who have health risks, and in the meantime trials were runnings for children. As of May 18th, 2021 this analysis represents that 36% of the elderly population is vaccinated across India. Around 28% of the population in the age group of 45-60 are vaccinated. However, age groups 31-45 and 18-30 are only at 5% and 2% respectively. Figures 21, 22, 23, and 24 represent the

data in a bar chart to compare population and vaccination metric values for 18-30, 31-45, 46-60, and 60+ respectively.
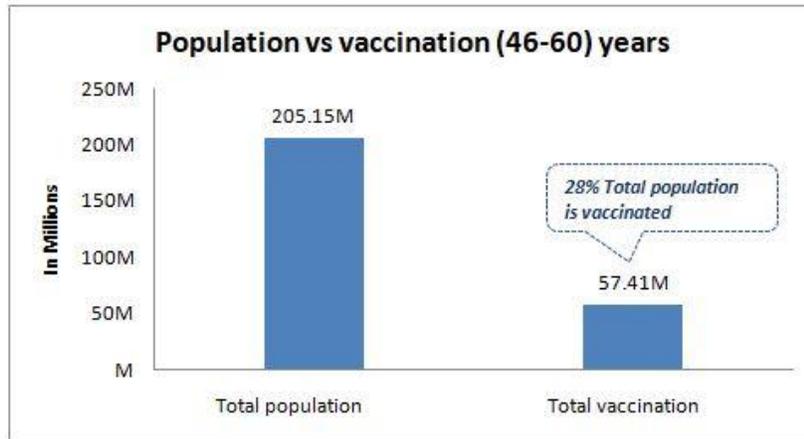
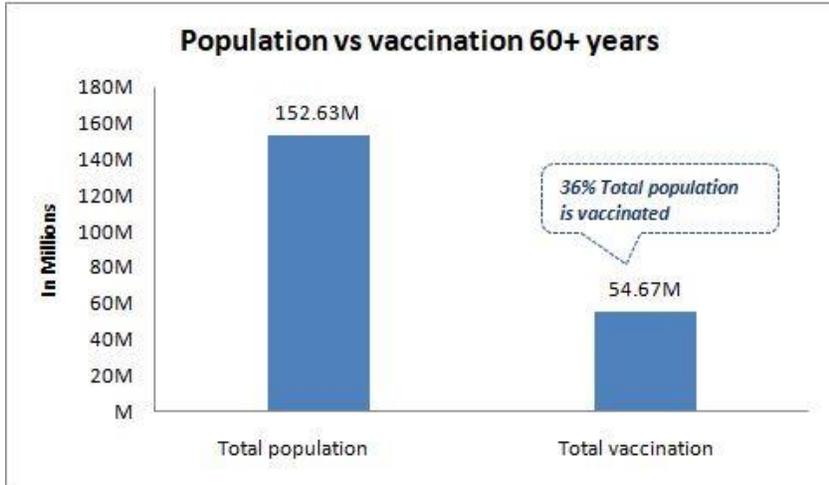**Figure 21**
Bar chart for 18-30 years for India
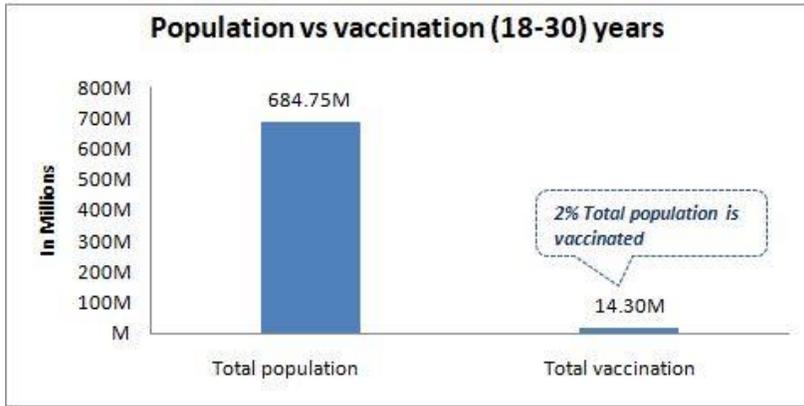
Figure 22
Bar chart for 31-45 years for India
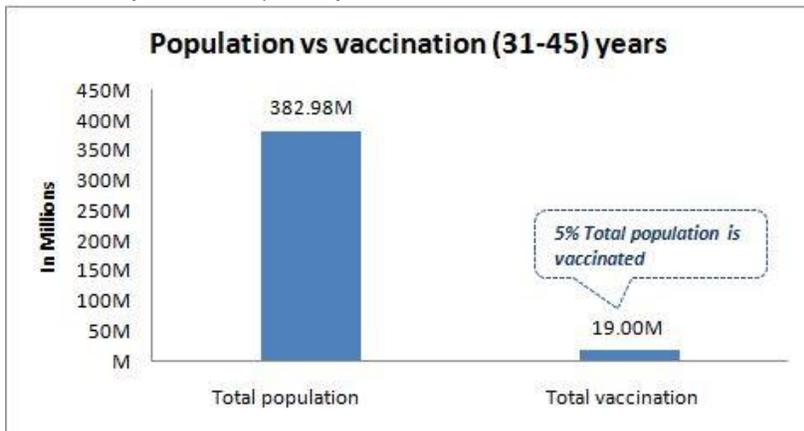
Figure 23
Bar chart for 46-60 years for India

Figure 24
Bar chart for 60+ years for India


As vaccination for the elderly started from the beginning of the campaign, almost 36% of the 60+ Indian population was vaccinated at the time of this analysis. States like Goa, Sikkim, Tripura, and Himachal Pradesh have the highest vaccinated population of elderly. Figure 25 represents the data in a bar chart to compare population and vaccination metric values for 60+ populations.

Figure 25
Highest vaccinated states in India
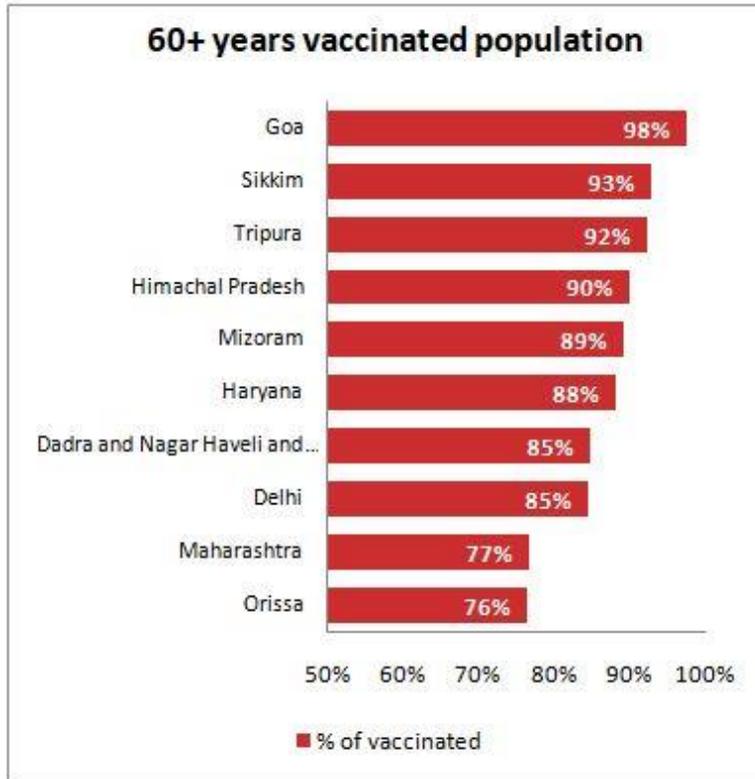
4.3 Comparative Analysis of the USA and India vaccination numbers.

Though both the countries are trying their best to achieve maximum vaccinated population, this paper highlights a vast difference in terms of vaccinated population in the USA and India. The USA has a 58% vaccinated population (refer to figure 2) compared to only 10% in India (refer to figure 14). The percentage of the vaccinated population in the highest populates state in the USA is 66% (refer to figure 3) whereas for India this percentage for the most populates state is only 5% (refer to figure 15). In addition, as this paper analyzed the female vs. male vaccinated population for both the countries, it is observed that in the USA female's percentage of vaccination is more than males whereas it is the opposite in the case of India (refer to figure 5 and figure 17). With a long road ahead for both the countries to fully vaccinate their population, India needs to strategize a better and effective mechanism to vaccinate the Indian population to achieve success against COVID-19.

5. DISCUSSION

The development of a vaccine is a complex and time-consuming process, which differs from the development of conventional medicines. Many efforts have been directed towards the development of vaccines against COVID-19, to avert the pandemic. The U.S. pursued vaccine procurement through Operation Warp Speed, a massive new public-private partnership wherein funding of USD $18 billion was provided for the development of vaccines that were intended for

US populations. Whereas on the other hand India's National COVID-19 Vaccination Strategy is based on scientific and epidemiological evidence which focuses on systematic end-to-end planning. The division of vaccine supply 50% to Govt. of India & 50% to other than Govt. of India channel would be applicable uniformly across for all vaccines manufactured in the country.

Religious beliefs:

The number of vaccination refusals based on the religious exemption is increasing. The question is whether religious freedom is a threat to public health, in this case to the vaccination system. (Hodge, J. G.2015). In the United States, preliminary analyses by (Perry et al.,2020) showed that Christian nationalism predicted that Americans would be less likely to take precautionary steps to protect others from infection. The society of the 21st century, just as many societies and cultures in the history of human civilization use religion as an excuse for wars, discrimination, and now for vaccination refusal. On the other hand, the rural population in India has a perception that by getting vaccinated they would be more prone to the COVID-19 and are avoiding it despite the government's efforts to get everyone vaccinated. It is therefore important to proactively investigate the likely predictors of COVID-19 hesitancy among religious groups and start to mobilize key actors within existing religious, scientific, and political structures toward a common goal of vaccination (Olagoke, A. A., Olagoke, O. O., & Hughes, A. M. 2021).

Vaccination strategies:

To encourage its people to get vaccinated despite various religious beliefs, companies across the USA are offering rewards to their vaccinated customers and employees. It includes perks like a free ride to the vaccine appointment center by Uber and Lyft, Free childcare for parents and caregivers during vaccination appointments by YMCA, Kinder care, learning care group, and Bright Horizon. The highest stakes are in New York, which is offering a lottery with a $5 million grand prize, and Ohio, where five lotteries will each award $1 million to a vaccinated adult and a full-ride college scholarship to a vaccinated child (Volpp, K. G., & Cannuscio, C. C.2021). The idea of the program is creative ways to convince people to get vaccinated to achieve herd immunity. It can be an incentive to those who are not actively against vaccination but may have delayed it.

Vaccine hesitancy, rumors, and myths surrounding the COVID-19 jabs have thrown people in rural India into an abyss of fear. As a result, political leaders are announcing a reward of lakhs of rupees to maximize the inoculation drive. Many Indian firms are also offering discounts on items ranging from fast food to flights to lure people to get vaccinated against COVID-19. While the Indian arm of fast-food giant McDonald's is offering a 20 percent discount on meals, Grofers is giving one month's subscription to its loyalty program, and home appliances maker Godrej extended product warranties (Reuters.2021, June 23). Vaccine prioritization is not solely a question of science but a question of ethics as well.

6. CONCLUSIONS

The purpose of this research is to highlight the crux of vaccine development, implementation, and strategies of the United States and India and thereby draw comparisons between both countries. This paper concludes that there is a big difference in the vaccinated population percentage in both countries. However, there are certain limitations since COVID-19 cases are still ongoing so the

conclusions would differ based on data that is more recent. In addition, the vaccination is not yet tested on the new variants of the Delta virus that have not been considered in this paper.

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Conflict of interests
The authors declare that there is no conflict of interest.

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