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An Analytical Study of the Efficacy, Reliability, and Acceptability of the Covid –19 Vaccine in the State of Kerala, India

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Abstract: We study the problem of people testing positive for COVID-19 even after vaccination. In a practical scenario, vaccination is a crucial step to tackle the pandemic along with other non-pharmaceutical measures. However, people are testing COVID-19 positive even after taking one or both the vaccine doses. This paper examines whether vaccination is effective for the pandemic, how reliable and acceptable the vaccines are by focusing on the case of Kerala, India. Kerala is a state with a population of 3.46 crores and almost 2.8 crore people are administered with the first or second dose of vaccine. According to a report published on August 11th, Kerala had over 40,000 vaccinated people testing positive for COVID-19. Here we analyse the data collected from across the state in the month of September 2021. In addition, we examine vaccine acceptability in the state by comparing the data collected in September 2021 and March 2022.

Keyword: COVID-19, vaccination, efficacy, reliability of vaccine, acceptability, vaccination drive.

1.Introduction

Virginia E. Pitzer et al. [1] modelled the change in transmission of typhoid, which helped in calculating the effects of vaccination. They found out that the model's guess is based on persistent transmission bearers. Michael T. White et al. [2] reviewed the methods used to estimate the efficacy of the pre-erythrocytic and transmission-blocking vaccine with the help of clinical trial data. Ahmed et al. [3] develops a non-linear model for the faster rate of increase in COVID-19 and implemented joint variability in the classes to determine the effectiveness of vaccines. They proved that the pandemic can be reduced by increasing voluntary vaccination among susceptible and exposed communities. In the paper, by Monia Makhaoul et al. [4] they try to inform about the development/licensing/decision-making/implementation of the COVID-19 vaccine with the help of mathematical modelling by finding the preferred characteristics of the vaccine products and impacts on the population for a longer period. And they concluded that a partially effective full vaccine greater than or equal to 70% efficacy in reducing susceptibility and greater than or equal to 80% of coverage is good enough to handle the pandemic economically. The review prepared by Almut Scherer and Angela McLean [5], puts forth some simple ordinary differential equation models of mass vaccination that can solve issues like vaccine coverage, and vaccine-induced immunity decreasing over time. Rebecca C. Harris et al. [6] used mathematical modelling to know the impact of future vaccines could be altered by characteristics of vaccine, age targeting, and epidemiological setting. Erik J. Dasbach et al. [7] assessed the three types of mathematical models of Human Papillomavirus (cohort, population dynamic, and hybrid) for evaluating HPV vaccination policies. They concluded that, cohort models are the best. In the research study done by Arun Velu et al. [8],

the influence of covid vaccine on the world is analysed using machine learning, and the tendencies discovered to be highly fascinating are reported. Zhi - Peng Yan et al. [9] examine the latest data on twelve vaccinations to assess the effectiveness, safety, and use among the distinct groups. All of their clinical trials have shown encouraging immunogenicity, various degrees of protective efficacy, and a tolerable safety profile. Roy L Soiza et al. [10] examine the key potential vaccinations that may become accessible, focusing on evidence of safety and effectiveness in older persons. It stated that more collaboration between vaccination trial teams and individuals with expertise in running trials in frail older persons is required to assist create a tighter comparison between experimental and key real-world populations. The goal of Tyagi et al. [11] is to compile the data and reflect the epidemiological statistics required, as well as apply a mathematical prototype method to the new outbreak that encompasses all perspectives of the data as of August 8, 2020, and so predict the direction of the future epidemic scenario in India for all policymakers. Jyothi Bhola et al. [12] describe a predictive mathematical model in a work that can provide us with a notion of the virus's fate, indicative data, and future forecasts to understand the pandemic's future path. Article by Daniel R. Feikin et al. [13] prioritized reviewing the various evidence about the time span for which vaccines provide protection. They also check the rate Since the vaccine program began, the number of those infected with the delta strain has risen. And they showed that efficacy of various decreases with time.

This paper inspects the efficiency of COVID-19 vaccines used in Kerala, the southernmost state of India. We also investigate the reliability of the vaccines and their acceptability using various statistical techniques.

2.Vaccination Drive

On January 16, 2021, India began a COVID-19 vaccine campaign. India's national COVID-19 immunization effort was the world's largest. And the drive started in Kerala on the same date. The Drug Control General of India (DGCA) had approved two vaccines for emergency use: Covaxin and Covishield. India's vaccination drive was driven by these two vaccines. The first group to get the vaccines were the health and frontline workers. The second stage was an age-appropriate category. Vaccination for people of age 60 and above and for people in the age group 45-59 with the serious disease started from March 1st 2021. For people of age 45 and above the vaccination started from April 1st 2021.18-44 group vaccination started from May 1st,2021. Vaccination for children of age group 15-18 started on 3rd January 2022. The government of India implemented the centralized vaccination policy on 21st June 2021, by which the government would provide free vaccines to the citizens of age 18 and above.

The state vaccination drive was carried on by both the public and private sectors. Mass vaccination was provided by the government in various places for free across the state and paid vaccination was set up in private hospitals. The state would procure vaccines and distribute them to private hospitals. There are also private hospitals that buy vaccines directly. Even though more people preferred to take their jabs at the government set up mass vaccination camps, there were a lot of challenges faced by the officials which includes vaccine shortage, hesitancy of people to get vaccinated, and so on. Despite all that the state was able to vaccinate a good part of the population.

To date, 90% of the Indian adults are administered the first dose of vaccine and 59.5% of the population is fully vaccinated. In Kerala, 100% of the adult population is vaccinated with first dose and 90.96% has taken the second dose. 79.53% in 15-17 age category and 17.19% in 12-14 age category has taken their first dose. Administration of the precautionary dose is also going on and 26% of the adult population has taken their third dose.

3. Objective

We investigate the efficacy or effectiveness, reliability, and acceptability of the COVID-19 vaccine during the pandemic.

4. Research design, Data and Methodology

To find the efficiency of the COVID-19 vaccines. To find the reliability of vaccines. To find the acceptability of the vaccine.

- H1: Vaccination is not effective in preventing COVID-19.
- H2: Vaccines are not performing consistently well.

Primary data for the study were collected in September 2021. Questionnaires were circulated among the people of various districts across the state and more than 600 responses were received. Informal discussion supplemented the data collected. The collected data were sorted district-wise and examined for results. For the study, we have also considered the data of family members of people who responded. For the acceptability part of the paper another survey was also conducted in March 2022 (after the third wave).

A chi-square test was used to find the relationship between vaccination and people getting affected with SARS-Cov-2. A proportion test was performed to check how reliable the vaccines are. Comparison of percentages of data is used to understand people's change in attitude towards taking the jabs.

5. Results

From the data, we obtained the following results:

95.6% of those who attended the survey belonged to the age category 18-40 and the rest in 41-60. Out of the people who responded 60.5% of them were administered with the first dose vaccine, 33.8% with the second dose, and the rest were unvaccinated. Only 19.1% of them were infected with COVID-19 and 80.9% were not affected. Among the people affected 64% were not vaccinated at the time of infection and 36% were vaccinated. In the vaccinated affected group, 24.6% has done their first dose of vaccination, and the rest was fully vaccinated (that is, they had their second dose). 79.1% of the affected people had either chronic or other lifestyle diseases, 51.4% had lifestyle issues and the rest 48.6% were chronic disease patients. Only 3.8% of the people infected died.

Hypothesis 1:

Null hypothesis: Vaccination is not effective in preventing COVID-19.

(Chi-square test of independence for checking the effectiveness or efficacy of the vaccines.)

	Affected	Not-affected	Total
Vaccinated	35	485	520
Not vaccinated	83	15	98
Total	118	500	618

Table 1: Two-way table for individual responses

	Affected	Not-affected	Total
Vaccinated	127	2085	2212
Not vaccinated	210	192	402
Total	337	2277	2614

Table 2: Two-way table of data including family members

At 1% significance (α =0.01) with degrees of freedom df =1, so the rejection region for the test is $R = \{\chi^2 : \chi^2 > 6.635\}$.

For the individual responses, the Chi-squared statistic is $\chi^2 = 324.447$. It is concluded that the null hypothesis is rejected. For the data including families, the Chi-squared statistic is $\chi^2 = 654.909$. Hence, the null hypothesis is rejected. Thus, we reach the conclusion that vaccination is effective in preventing COVID-19.

Hypothesis 2:

Null hypothesis: Vaccination is not the best protection against severe illness

(P = 0.5).

(One- tail proportion test for checking reliability of the vaccine).

	Serious	Not- serious	Total
Vaccinated affected	46	81	127

Table 3: Data (including family members) of people who had disease serious and not serious.

At 5% significance $(\alpha = 0.05)$, rejection region for this left-tailed test $R = \{z : z_c < -1.645\}$. The z-statistic computed is -3.1127 .

Therefore, null hypothesis is rejected.

We can conclude that vaccination is the best practice against severe diseases.

- Which according to people is the best practice against Covid-19.

	September 2021	March 2022
Percentage of people who think vaccination is the best prevention practice.	49.52%	70.18%
Percentage of people who think other non-pharmaceutical methods are the best prevention practices.	50.48%	29.82%

Table 4: People's voting on prevention practices against COVID-19 disease.

Data collected in September 2021 indicate that almost 50% of the respondents believe vaccination is the most effective method of prevention among the compared four practices. According to data collected in March 2022, this belief had increased by almost 21%. Consequently, we can conclude that vaccines are now widely accepted as people understand their overall effectiveness.

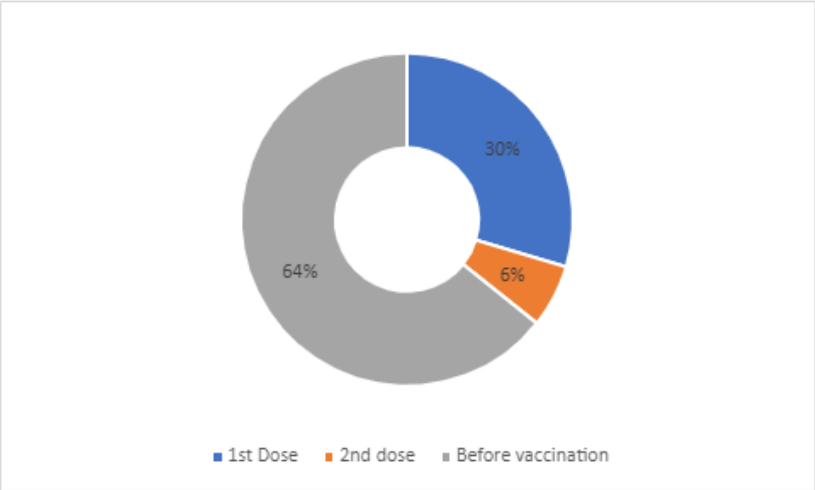

Figure 1: Pre-vaccination and post-vaccination rates of patients who tested positive for COVID-19 (after the 1st and 2nd dose).

6. Conclusion

The pandemic is not yet over and it is the primary responsibility of every individual to make sure that they follow all the guidelines issued by both the state and central governments. The

preventive measures include non-pharmaceutical interventions like social distancing, wearing a mask, sanitizing, and the pharmaceutical measure which is vaccination. As Kerala is a state with a high population, it is particularly important to get vaccinated on time to combat this outbreak. In this study, we have concluded that the vaccines are very efficient to resist the Coronavirus. Vaccines are the best protection, as a very fewer percentage of people who test positive after vaccination are having the disease serious. Also, people now have less hesitancy to take the vaccine than before. Furthermore, people are less hesitant to get the vaccine now than they were previously. These are good indicators that the state can have a 100% vaccinated population soon and the pandemic can be controlled efficiently.

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