

Full length article**STATISTICAL ANALYSIS OF COVID-19 VACCINATIONS: KARACHI AS A CASE STUDY**

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ABSTRACT

The entire world has started to vaccinate their respective countries' citizens to get rid of COVID-19 from their country. Likewise other countries, Pakistan has also started the vaccination process for its citizens and unlike the rest of the world, there have been different types of vaccines in Pakistan with different manufacturers and with different immunity booster levels. Through statistical analysis of vaccination in this research paper, we have tried to understand the diverse level of vaccines in Karachi and tried to get an understanding of the vaccination process happening in Karachi. For this kind of research, we have maintained the questionnaire and spread it through emails, WhatsApp, and Facebook. The questionnaire was sent to about 500 people from July to August 2021. The results obtained depict the satisfaction of the vaccination process with normal side effects. Unlike other countries, Pakistan is among the countries where the mass vaccination process has always been very difficult to conduct. Further using the data of seven stations for prediction purposes Multiple Linear Regression (MLR) models were constructed. A better future trend analysis of COVID-19 can be observed using these constructed models. The data for the time series modeling from, 1st January 2021 to 25 August 2021, was taken from National Command and Control (NCOCC) Pakistan.

KEYWORDS: COVID-19, Statistical Analysis, Vaccination

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1. INTRODUCTION**1.1 Paper Length**

Pakistan is a country which is situated in the South-Asian region, sharing borders with India, China, Iran, and Afghanistan. The population of this country stands 225,427,731 [1, 2]. To vaccinate such a huge population requires some good management skills [3]. The vaccination drive in Pakistan started in April 2021 [4]. Initially Pakistan got their first vaccine from China, donating half million doses of Sinopharm [5]. The vaccination process was

conducting in two ways, either to get vaccinated from any hospital, who have access to vaccines which is approved by the Pakistani government or get vaccinated through vaccination centers which was government's plan to do mass vaccination by setting up vaccination centers at different parts of city for people's convenience. The government also started electronic registration, so people and especially daily wagers do not have to skip a day only for registration process. The key thing which we wanted to observe was how efficiently and effectively the vaccination drive is really

going in Pakistan, for that purpose this survey form sort of paved our way through better understanding of vaccination process [6, 7, 8]. Multiple Linear Regression (MLR) is a technique to find the best relationship between the variables that socially affects. This technique is applied in any field where a particular data is possible to collect then for prediction and forecasting the MLR models are constructed [9, 10, 11]. In the MLR models shown below y indicates the confirmed cases, x_1 shows deaths and x_2 shows recovered patients.

$$\hat{y}_{AJK} = -5.681x_1 + 1.307x_2 - 39.957 \quad (1)$$

$$\hat{y}_{GB} = 25.960x_1 + 0.735x_2 - 1157.147 \quad (2)$$

$$\hat{y}_{ICT} = 251.057x_1 - 0.803x_2 - 46888.926 \quad (3)$$

$$\hat{y}_{KPK} = 6.758x_1 + 0.800x_2 + 6960.446 \quad (4)$$

$$\hat{y}_{Punjab} = 62.138x_1 - 0.981x_2 + 5753.399 \quad (5)$$

$$\hat{y}_{Sindh} = 72.683x_1 - 0.064x_2 - 36446.125 \quad (6)$$

$$\hat{y}_{Baluchistan} = 30.322x_1 + 0.693x_2 + 174.915 \quad (7)$$

Where equation 1 to 7 are the models of Azad Jammu and Kashmir (AJK), Gilgit Baltistan (GB), Islamabad Capital Territory (ICT), Khaybar Pakhtunkhwa (KPK), Punjab, Sindh and Baluchistan respectively.

1.1 Vaccination Centers

Government have announced different vaccination centers in different big cities to conduct mass vaccination, if we talk about only Karachi, there had been 29 allotted centers where people can get their vaccination done, amongst 29 of the allotted centers, two are the makeup vaccination centers setup by the government to conduct mass vaccination at Expo center and Khaliq

Dina Hall. The rest of the centers are already operational hospitals. To vaccinate such hugely populated city (Karachi) government tried different strategies and policies to drive people for vaccination, but none of the policy or strategy worked at the beginning of vaccination drive which started in April 2021. People showed reluctance over the vaccination process and had different mindset regards to vaccines and vaccination process, from April to July the vaccination process was sluggish and by the end of July 4th wave of COVID-19 had also emerged [12, 13, 14]. To tackle such situation government now has announced to block SIM (Subscriber Identity Module) and social media accounts of unvaccinated people by the end of July 2021 [15, 16]. After this announcement people have turned towards vaccination centers in huge numbers and finally the vaccination drive in Pakistan has taken some progress. Vaccination centers of every zone of Karachi are listed below [17, 18].

1.2 Vaccine Supply to Pakistan

Since Pakistan is a third world country which hugely relies over foreign funds sometimes, to move the economic cycle. With COVID-19 outbreak, same as rest of the world, Pakistan was looking up to the developed countries and W.H.O (World Health Organization) to facilitate Pakistan with COVID-19 vaccines. Initially Pakistan got their first COVID-19 vaccination consignment through China, who donated half million doses of Sinopharm to Pakistan [5].

Pakistan, then received the first consignment of UK's AstraZeneca through COVAX facility, where the donation of doses was 1,238,400 followed by another donation of 1,236,000 doses of AstraZeneca [19].

Pakistan got vaccine donation from USA (United States of America) as well, the USA government donated 2.5 million doses of Moderna vaccine in the first batch which followed the second batch of three million doses of Moderna [20].

China further donated 1.55 million doses of Sinovac vaccine to Pakistan as well [21]. China also donated 60,000 doses of CanSino vaccine to Pakistan as well [22]. Moreover, Pakistan also received 100,000 doses of Pfizer vaccines as well through COVAX facility [23]. Among all above vaccines, Pakistan was also able to import first private vaccine consignment as well from Russia, Pakistan imported 50,000 doses of Sputnik vaccine which solely would be provided to big private hospitals [24].

So, to break down the above-mentioned vaccines received to Pakistan, here what the overall vaccines donation stands.

2. Material and Method

2.1 Questionnaire

Just as mentioned above, we just wanted to sort of get the understanding of how well the vaccination process is happening in Pakistan and how many different types of vaccines are being used and which vaccine is standing alone as compared to all different types of vaccines. In the questionnaire/survey form [25]. We asked only eight basic questions which were enough to get the desire understanding and these are as under.

- Did you get vaccinated?
- From where did you get vaccinated?
- Which vaccine did you take?
- How did the staff treat you?
- When you get vaccinated, how often did the management look after your health progress?

- In the vaccination center/hospital, was everybody following the SOPs?
- After vaccination, did you feel any type of side effects of the vaccine?
- Are you satisfied by the procedure/process of vaccination?
- Using MLR method for few stations the trend analysis models were constructed.

2.1.1 Did you get vaccinated?

The reason to ask this particular question at the very beginning of the questionnaire was to help others indirectly, if somebody who have not vaccinated, he/she would leave the questionnaire from the beginning which sort of help us to get the understanding of the ratio of people who got vaccinated or not. Especially at times when the vaccination drive has really got overwhelmed by people at the vaccination centers, are there still some people who are still reluctant to get vaccinated?

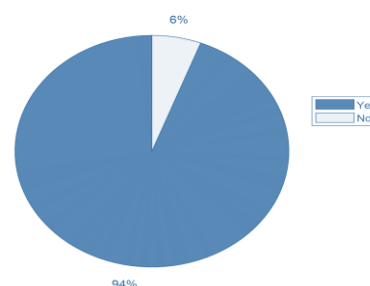


Figure 1. pie graph of the response, showing the 94% agreed.

As the result was pretty satisfying as only 6% people did not get vaccinated, which shows that the ratio to unvaccinated to vaccinate people is low.

2.1.2 From where did you get vaccinated?

The reason to ask this question was to get understanding of how many people are getting vaccination from hospitals rather than

vaccination centers, since vaccination centers have mass vaccination process going but it has proper and organize way of conducting vaccination.

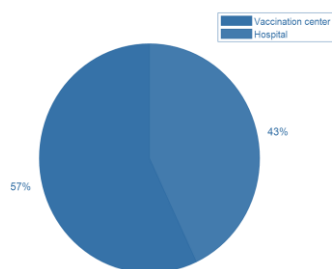


Figure 2. Pie graph showing that most of the people were vaccinated in vaccination center.

We can see that most of the people get vaccinated from vaccination center, since numbers of hospitals are not according to the population of the Karachi city.

2.1.3 Which vaccine did you take?

This question has very much significance than any other question; in fact, this question was the pillar of this questionnaire.

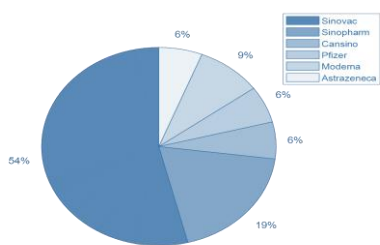


Figure 3. Pie graph of vaccine, showing that most of the people vaccinated by Sinovac.

As we discussed earlier that Pakistan received different types of COVID-19 vaccines, so it was necessary to find out which vaccine has highest intake in Karachi. The result showed that more than 50% people have taken Sinovac vaccine.

2.1.4 How the staff did treat you?

This is a very important question in regard to the management level of hospital and vaccination center, because when there has been mass vaccination, then it becomes very important and noticeable thing in order to understand the professionalism of the staff.

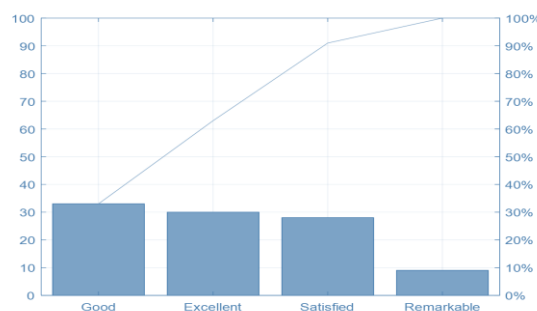


Figure 4. Bar graph of people satisfaction.

The result showed that the treatment of staff to patient was quite mixed, but still, it gives an insight that the vaccination process is going in a well-organized manner.

2.1.5 When you get vaccinated, how often did the management look after your health progress?

This question had a lot to do with the basic practice of medical school, where the candidates are advised to check the health progress of their patient till the time of their discharge. Since COVID-19 vaccines have two doses and the time interval between first and second dose is 2-3 weeks, this question was for getting the understanding of the management of hospital and vaccination centers to check whether they check the health progress of their patient or not.

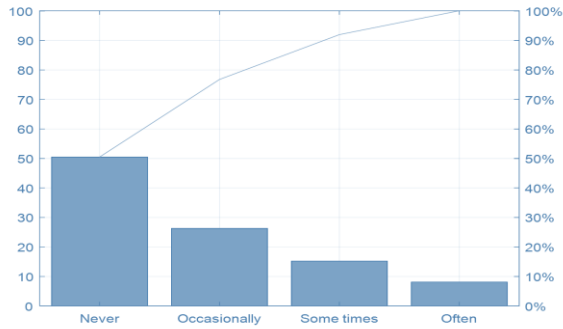


Figure 5. Bar graph of staff attitude.

2.1.6 In the Vaccination center/hospital, was everybody following the SOPs?

The purpose of this question is to understand whether the staff of the hospital or vaccination centers were following the SOPs (Standard Operating Procedure) or not, because they are on the receiving end and they are the ones with high chance of getting infection directly. So, the result showed some satisfying and good result.

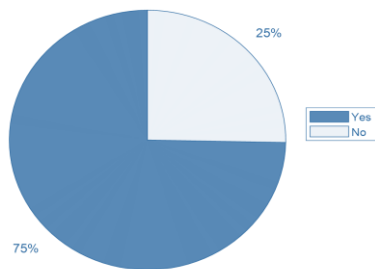


Figure 6. Pie graph showing that 75% were compliance the covid SOPs.

2.1.7 After Vaccination, did you feel any type of side effects of the vaccine?

It was important to get an idea whether the vaccines have any unknown side effects or no, because there have been rumors of unknown side effects of vaccines which played keen role towards reluctant behavior of people with vaccination.

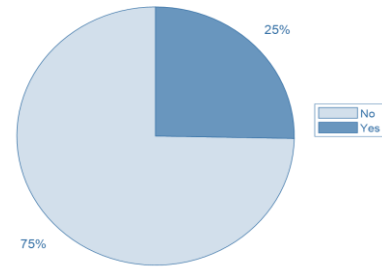


Figure 7. Pie graph indicating the side effects of vaccine.

2.1.8 Are you satisfied by the procedure/process of vaccination?

This question sort of conclude the whole experience of people who got vaccinated, it may include the level of facilities provided, level of transparency, level of professionalism, and level of all round experience of the patients.

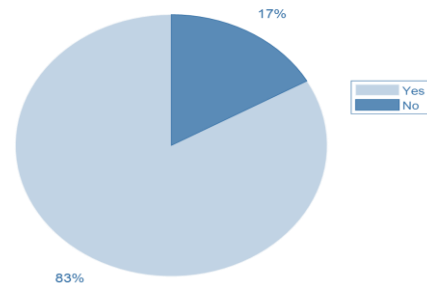


Figure 8. Public satisfaction percentage indicating that 83% were satisfied.

The 83% of the people are satisfied with the vaccination process by the Government.

3. RESULTS AND DISCUSSIONS

By the short survey conducted in Karachi city the behavior of the people toward the COVID-19 vaccination was analyzed. The questionnaires helped to understand the clear thinking of the people. It is clear from Figures 1 that 94% people are agreeing to follow the SOPs however, 75% are following the SOPs shown in

figures 6 and 51% like to get vaccination from the governments established vaccinated centers as depicted in figure 2. Figure 3 clears the choice of the people as 54% like to get Sinovac. The satisfactory conditions of the mass after getting vaccine regarding the care and attitude of the vaccination centers is not too much remarkable as clear from figure 4 & 5. The 25% people were reported the side effects after getting vaccination and 83% feels satisfaction as clear from figures 7 and 8 respectively.

CONCLUSION

The overall work was performed through this Questionnaire (survey form) sort of reflect the vaccination procedure happening in Karachi. How well they are vaccinating the people and how many different types of vaccines are used in Karachi. The sole purpose of this survey was to get real response from people so that it can be helpful to others who are considering to get their vaccination but either they are afraid or may be some negative rumors have trashed their decision to get vaccinated. COVID-19 is an RNA virus which can affect the vaccinated persons again, so whichever vaccine are taking, just bears in mind that this virus will remain with us for 3 to 4 years with different types of variants. Furthermore, using the data for few stations of Pakistan for the future trend analysis MLR models were constructed. The higher authorities can use such models for the prediction and forecasting purposes in future.

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Authors' contributions:

Hassan: Conceptualization, Methodology **Usama Raza, Zaubaria Malick, Abu Bakar. Muhammad Amir:** Visualization, Investigation **Hamza Khan, Muhammad Danish khan and Kashif Javed** Software, Validation **Hamza Khan:** Writing-the final version.

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