

Original Research Article

Vaccine equity: a key to global economic recovery

Rohini Ghosh¹, Arabinda Ghosh^{2*}

¹Junior Resident (Non-academic), Critical Care Unit, Medical College and Hospital, Kolkata, West Bengal, India

²Indian Administrative Service (Retired), Kolkata, West Bengal, India

Received: 11 September 2021

Accepted: 21 October 2021

*Correspondence:

Dr. Arabinda Ghosh,

E-mail: ghosharabinda@gmail.com

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ABSTRACT

Background: The spread of severe acute respiratory syndrome coronavirus- 2 (SARS-CoV-2), the causative agent of coronavirus 2019 (COVID-19), has resulted in an unprecedented global public health and economic crisis. The cumulative number of cases is now over 200 million and the number of deaths exceeds 4.2 million. COVID-19 vaccination provides hope for an end to the pandemic, if and only if there would be equal access and optimal uptake in all countries around the world.

Methods: The study on nine selected countries corroborates the relative importance of vaccination rate in reducing daily death as percentage of confirmed COVID- 19 cases.

Results: Vaccination data has brought forth the gaping disparity in the process whereby lower income group countries with 8.6 percent of world population have received 0.3 percent of total vaccine dose as against high income countries with 15.7 percent of global population and have received 29.0.

Conclusions: Spending for vaccination should be considered as an investment instead of expenditure.

Keywords: COVID-19, Vaccination, Economic recovery, Equity

INTRODUCTION

The COVID-19 shock was unexpected and severe. COVID-19 pandemic has caused significant global morbidity and mortality, in addition to destabilization of the economic and social well-being of individuals and communities.¹ The pandemic continues to be a highly personal, individual experience that is also an unprecedented globally-shared phenomenon with wide-ranging repercussions. It has disrupted lives across all countries and communities and negatively affected global economic growth beyond anything experienced in nearly a century.²

The spread of SARS-CoV-2, the causative agent of COVID-19, was declared a pandemic by the World Health Organization on 11 March 2020.³

As the virus spread internationally, many countries have already taken or will eventually take action to limit the spread, through social isolation policies, such as shutting educational institutions, limiting work and restricting the mobility of people.⁴

The consequences of a pandemic are not only defined in terms of mortality but also by their impact on our daily livelihood and the economy, with globalization accelerating this loss and costing billions (US dollars) in expenditures.⁵ The preventive actions have had an immediate and significant impact on all economies, and through trade and tourism, on partner economies. Pandemics affect the economy in terms of demand and supply. First, consumers and investors tend to lose confidence in marketplaces affected by the pandemic, depreciating the demand side of the market. Second, absenteeism and reduction in the workforce negate the

supply side. Lastly, public health and international response to pandemics affect economics and development policies in trade, travel, and health response.^{6,7}

A pandemic also affects the economy in terms of decelerating the economic growth of affected countries, leading to a reduction in trade and increase in poverty.^{8,9} The vicious circle leading to economic depression has set on a roll. Lower consumption, reduced demand, falling prices, supply cut, job cuts, lower spending, lower consumption—all the blocks look like a perfect fit.¹⁰

SARS-CoV-2 has a strong direct acute impact on population health, not only at the physiological level but also at the psychological level for those who suffer it, those close to them, and the general population, who suffer the social consequences of the pandemic.¹¹ In this line, the economic recession increased, even more so, the social pressure. At the social level, the economic impact hit the most vulnerable families, creating a difficult context for public institutions to address. We are facing one of the greatest challenges of social intervention, which requires fast, effective, and well-coordinated responses from public institutions, the private sector, and non-governmental organizations to serve an increasingly hopeless population with increasingly urgent needs. Long-term legislation is necessary to reduce the vulnerability of the less fortunate, as well as to analyze the societal response to improve the social organization management of available resources.¹²⁻¹⁴

The cumulative number of cases reported globally is now over 199 million and the number of deaths exceeds 4.2 million. Number of cases reported at the end of July 2021 in Asia is over 62 million (31.3%) followed by 51.6 million (25.9%) in Europe, 42.7 million (21.5%) in North America, 35.6 million (17.9%) in South America and 6.8 million (3.4%) in Africa. During the same period, number of people who have died due to COVID-19 is over 4 million. Number of deaths in Europe is over 1.13 million (26.7%) followed by 1.09 million (25.7%) in South America, 0.94 million (22.2%) in North America, 0.90 million (21.2%) in Asia and 0.17 million (4.0%) in Africa. The vast majority of the global population still remains susceptible to COVID-19, highlighting the need for an effective vaccine.

At this juncture of overwhelming burden of COVID-19 cases, it is necessary to highlight the concept of herd immunity which refers to the level of immunity that is present in a population against an infectious agent. Thus, it is the protection of the 'population' at large from infection, such protection being brought about by the presence of immune individuals. If a sufficiently proportion of the members of a population are immune to attack by a pathogen, it decreases the likelihood of transmissibility of that pathogen between infected and susceptible hosts of that population. This decreases the incidence and prevalence of the disease.¹⁵ The concept of herd immunity threshold refers to the specific point in which the portion

of susceptible individuals falls below it. Above it, herd immunity will take effect protecting those susceptible individuals from infection. This concept has marked and consolidated the bases for vaccines and their applications, vaccination programs cost analysis, and the eradication of diseases such as small pox and polio.^{16,17}

There have been massive efforts geared towards finding safe and effective vaccines for COVID-19. By July 2021 there were 184 COVID-19 vaccine candidates in pre-clinical development, 105 in clinical development, and 18 vaccines approved for emergency use by at least one regulatory authority. These vaccines include whole virus live attenuated or inactivated, protein-based, viral vector, and nucleic acid vaccines. To mitigate the mounting burden of COVID-19, vaccine development has occurred at an unprecedented pace.¹⁸ Effective vaccines are now in place and being administered at a rapid pace though new variants are evolving requiring booster shots. By end of July 2021, more than four billion doses of COVID-19 vaccine have been administered around the world, mostly in high-income countries. 28.6% of the world population has received at least one dose of a COVID-19 vaccine. People of lower-middle income and lower income countries have got only 17.6 percent of the total vaccine administered though share of the total population of these countries is around 52 percent. COVID-19 vaccination provides hope for an end to the pandemic, if and only if there would be equal access and optimal uptake in all countries around the world.¹⁹

The objective of the study is to examine the impact of COVID-19 vaccination on overall mortality due to Covid-19 and highlight inter country inequity in vaccination using secondary data of selected countries.

METHODS

This study uses data from the Worldometer and Our World in Data. Nine countries from five continents, Argentina and Brazil (South America), Germany and United Kingdom (Europe), India and Turkey (Asia), Morocco and South Africa (Africa) and USA (North America) have been selected based on their population, number of confirmed cases and vaccination status.

Summary statistics including percentages and means ($\pm$ standard deviations) are used to describe the country wise the rolling 28- day daily average number of new confirmed COVID-19 cases per million population and share of people who received at least one vaccine dose of COVID-19.¹⁹ Deaths due to COVID-19 during the study period from 1st January 2021 to 31st July 2021 has been analysed through the use of a linear regression model. The following linear regression model has been used in this study to identify the contribution of vaccination in controlling mortality rate in selected study area. Date wise data relating to vaccination, number of COVID-19 cases per million populations, and deaths within 28 days of positive test by date of death. have been used to explain the

variations in the death due to vaccination. To have more accurate impact of vaccination, we have used the vaccination percentage of estimated population (all) 14 days prior to the day of death in question and 28 days' rolling average of daily confirmed COVID-19 cases per million populations has been used to identify the number of COVID-19 cases in a day. All analyses were conducted using STATA-15. The following regression model has been used.¹⁵ $Y_i = \beta + \beta_1 X_{1i} + \beta_2 X_{2i} + U_i$, (1) Where, Y_i = death in day 'i' in the study period. X_{1i} = share of people who received at least one vaccine dose of COVID-19 in day 'i' in the study period. X_{2i} = number of COVID-19 cases per million populations in day 'i' in the study period. U_i = error term for ith day. Here the study period is from 1st January 2021 to 31st July, 2021.

RESULTS

Table 1 shows the descriptive statistics on country wise status on share of people who received at least one vaccine

dose of COVID-19, 28 days' rolling average of confirmed COVID-19 cases in a day and daily death. The study area covers 30 percent of global population and depicts picture of more than 54 percent of total confirmed cases during the study period. It is revealed that daily death as percentage of 28 days' rolling average of COVID-19 confirmed cases in a day varies widely among the selected countries during the study period.

Minimum daily death rate is as low as 0.16 percent in United Kingdom against 1.89 percent in South Africa. On the other hand, maximum daily death rate is as high as 9.53 percent in South Africa against 1.48 percent in Turkey. There is wide disparity in vaccination. Lower income group countries having 8.6 percent of world population have administered only 0.3 percent of total vaccine dose administered till 31st July, 2021. Lower middle income group countries representing 43.1 percent of world population have administered only 17.4 percent of total vaccine dose.

Table 1: Descriptive statistics.

Country	Daily death as % of confirmed Cases*			confirmed COVID-19 cases in a day per million populations			Vaccination ** (%)	Total confirmed cases (Million)	Total Population (Million)
	Min	Mean	Max	Min	Mean	Max	As on 31st July, 21	Jan to July 21	
Argentina	1.36	1.91	2.47	133.10	330.61	645.11	55.24	3.3	45.38
Brazil	1.67	2.86	4.41	192.66	271.73	338.75	49.43	12.24	212.56
Germany	1.18	2.51	4.82	8.81	134.81	260.14	61.39	2.02	83.24
India	0.66	1.18	2.39	8.76	72.08	255.27	26.67	21.37	1380.00
Morocco	0.75	1.52	2.32	7.04	19.62	74.34	36.93	0.18	36.91
South Africa	1.89	4.00	9.53	17.45	106.32	282.94	10.33	1.39	59.31
Turkey	0.64	0.93	1.48	64.09	205.13	603.63	48.63	3.52	84.34
United Kingdom	0.16	1.13	2.58	30.59	236.22	723.79	68.96	3.38	67.22
USA	0.99	1.56	2.16	38.55	250.29	658.12	57.10	14.88	329.48

* Daily death as % of 28 days' rolling average of COVID-19 cases in a day. **share of people who received at least one vaccine dose

Table 2: Linear regression model.

Variables	Standardized β coefficients	Std. error	t-Statistics	P value	95.0% confidence interval		Collinearity statistics	
					Lower bound	Upper bound	Tolerance	VIF
Vaccination rate	-0.0252927	0.0014206	-17.8	0	-0.028079	-0.022507	1.01	0.9902
Cases per MM population	-0.0001037	0.000154	-0.67	0.501	-0.000406	0.000198	1.01	0.9902

Dependent variable: daily death as percentage of confirmed COVID-19 cases. N = 1908, adjusted R² = 0.1422, Darbin-Watson statistic = 0.031779, F = 159.09.

On the other hand, high income group countries with 15.7 percent of global population have administered 29.0 percent of total vaccine dose during the same period. In the study area also, there is wide disparity in administering vaccine. Share of people who received at least one vaccine dose is 68.96 percent in United Kingdom, followed by 61.39 percent in Germany, USA (57.10 percent) and Argentina (55.24 percent).

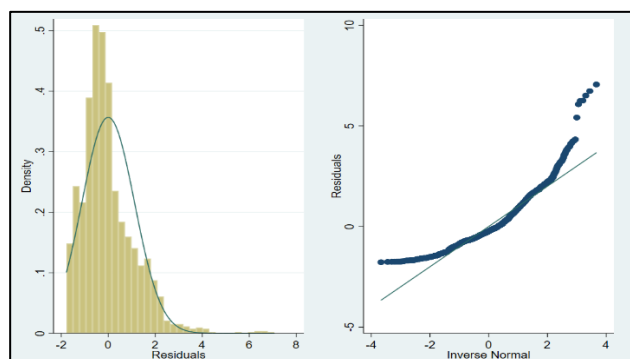


Figure 1: Histogram and Q-Q plot of residuals.

On the other hand, it is only 10.33 percent in South Africa, preceded by India (26.67 percent) and Morocco (36.93) percent. Country wise confirmed COVID-19 cases in a day per million population varies widely in the study area. Minimum number of confirmed COVID-19 cases in a day per million populations is as low as 7.04 in Morocco against 192.66 in Brazil. Maximum number of confirmed COVID-19 cases in a day per million populations is 74.34 in Morocco against 658.12 in USA. Table 2 shows the regression results with daily death as percentage of confirmed COVID-19 cases as the dependent variable and vaccination rate as the predictor variables and confirmed COVID-19 cases per million populations in a day. The model reveals that 14.2 percent of the variation in daily death rate due to COVID-19 is accounted for by the estimated sample regression plane (SRP), which uses vaccination rate and confirmed COVID-19 cases per million populations in a day. The regression results as shown in Table 2 indicate that daily death rate per hundred cases will reduce by 0.025 percentage point for every 1 percentage point increase in vaccination rate. This is true only if the effect of confirmed COVID-19 cases per million populations in a day is held constant. The relative importance of vaccination rate in reducing daily death as percentage of confirmed COVID-19 cases is very high. Also, the p-value indicates its statistical significance beyond the 1 percent level while the confirmed COVID-19 cases per million populations in a day coefficient is not significant even at 5 percent level. Additional diagnostic tests are conducted to explore possible contamination of regression results because of multicollinearity and endogeneity problems. Since the VIF values are all well below 5 and the tolerance statistics are all well above 0.2, it appears that collinearity may not be an issue within the

used data. One of the assumptions behind this regression model is that the error term should follow a normal distribution. This is validated by making a histogram and a Q-Q plot of the residuals. Figure 1 shows a minor and trivial deviation from normality. The residuals are close to a normal distribution and we can conclude that the regression model is appropriate.

Figure 2 having country wise scatterplot with a regression line illustrates the association between death rate (dependent variable) and vaccination rate (predictor variable). In United Kingdom, 68.96 percent of total population has received at least one vaccine dose as on 31st July 2021. It is revealed that 94.4 percent variation in death rate in United Kingdom is explained by two predictors i.e., share of people who received at least one vaccine dose and confirmed COVID-19 cases per million populations in a day.

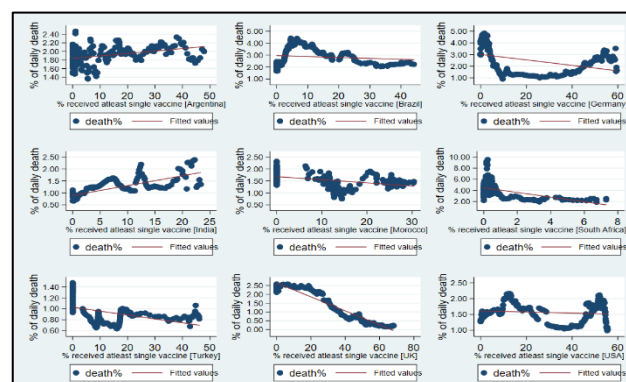


Figure 2: Scatterplot with regression line.

Figure 3 uses box plots to illustrate the wide range of share of people with at least one dose of COVID-19 vaccine as on end of July, 21 in 149 countries with a population above 1 million. China has been excluded due to non-availability of data. The box plots provide a summary of the median, quartile and extreme values and represent the interquartile range (i.e., contain the middle 50% of all values). They also show the lowest value (the bottom horizontal line on each plot) and the highest value (the top horizontal line of each plot) through the 'whiskers', the lines that extend from the box to those highest and lowest values, excluding outliers. The line across the box indicates the median, and the center of the circle within the box indicates the mean. In Africa, share of people with at least one dose of COVID-19 vaccine of 47 countries varied from 0.09% (Democratic Republic of Congo) to 53.76% (Mauritius). The vaccination rate in the countries of Asia varied between 0.7% (Syria) and 78.9% (United Arab Emirates). In Europe, it varied from 8.17% (Ukraine) to 72.57% (Denmark). It varied from 0.10% (Haiti) to 71.49% (Canada) and 10.2% (Venezuela) to 74.05% (Uruguay) in North America and South America respectively. Outliers are also indicated in the figure.

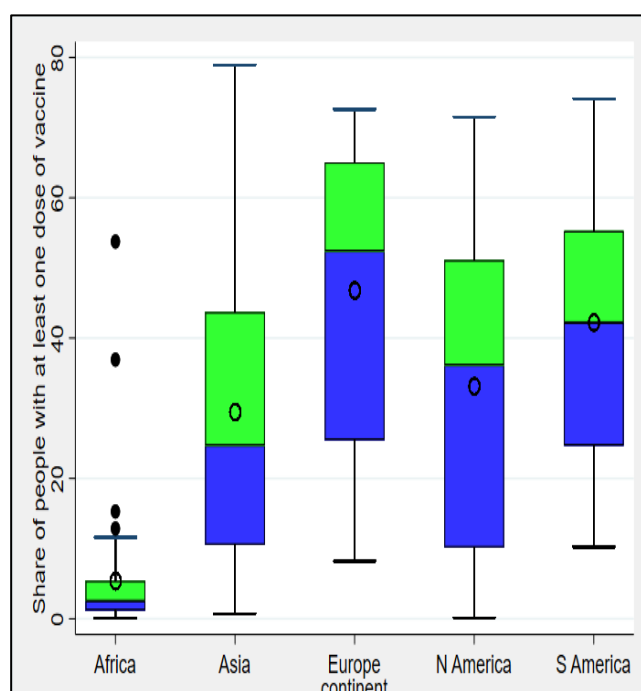


Figure 3: Share of people with at least one dose of COVID-19 vaccine in 149 countries showing means, medians, quartiles, extremes and outliers.

DISCUSSION

The COVID-19 pandemic has caused substantial mortality and plunged national economies into deep recessions. Although the spread of the virus can be mitigated through physical distancing, face coverings, and testing and tracing—and potentially with therapeutics—the risk of outbreaks and disruption to economic and social life will probably remain until effective vaccines are administered to large portions of the global population to prevent hospitalization and severe disease, and preferably achieve herd immunity to halt transmission of the virus.

The societal value of safe and effective COVID-19 vaccines is enormous. Yet new vaccines will mean little to individuals around the world if they are unable to get vaccinated in a timely manner. This objective requires vaccines to be affordable and available to countries around the world, and governments to have the administrative and political capacities to deliver them locally.²⁰ Vaccine for children is still a major issue to be taken care of.

Vaccination data has brought forth the gaping disparity in the process whereby lower income group countries with 8.6 percent of world population have received 0.3 percent of total vaccine dose as against high income countries with 15.7 percent of global population and have received 29.0 percent of total vaccine as of July 31, 2020.

To arrest the deepening of inequality in vaccination among countries leading to widening of wealth gap, as well as promote faster socio-economic recovery, universal and

impartial vaccination is the pivotal key. There are still substantial uncertainties ahead of us regarding the course of vaccine distribution. While the economic costs in the absence of equitable vaccine distribution are rather devastating, the economic interdependencies of countries imply that the economic drag in one country has immediate grave consequences for the others. The economic losses of the pandemic can only be mitigated through a multilateral coordination ensuring the equitable access of vaccines, tests and therapeutics.

The journey from vaccine discovery to global herd immunity against COVID-19 presents significant policy challenges that require collaborative, global responses.²¹ In order to provide fair access to COVID-19 vaccines, the WHO devised the COVAX equitable vaccine access plan and partnered with GAVI, the vaccine alliance and the Coalition for Epidemic Preparedness Innovations.²²

CONCLUSION

Viruses know no boundaries. In this connected world, no one is safe until everyone is safe. Pandemic policy is economic policy, as there is no durable end to the economic crisis without an end to the health crisis. Vaccination for all is critical for global macro and financial stability and accelerated economic recovery. Spending for vaccination should be considered as an investment instead of expenditure.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Ghosh R, Ghosh A. Vaccine equity: a key to global economic recovery. *Int J Community Med Public Health* 2021;8:5837-42.