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# POTENTIAL INEQUITIES IN COVID -19 VACCINATIONS

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# Potential Inequities in Covid -19 vaccinations

**Brijesh C Purohit**

## Abstract

*The inequity in vaccination is caused by a variety of factors. With a view to explore the global and interstate factors we used inequity indices. Our research questions are twofold: First, what is the extent of global inequity in vaccination and intercountry disparity? And second, what are the various factors leading to inequitable vaccination benefits at the global level and in the Indian states and their contribution to overall inequity as estimated by our inequity index.?*

*Using the information and computing the index of inequity, we make an intercountry and interstate comparison. Finally, we suggest that how a better management of different factors will have an impact on reduction in inequitable vaccination benefit. We bring out useful insights for public health policy for making it more welfare oriented.*

**Keywords:** *Inequities, Vaccinations, Covid 19, Global; India*
**JEL Codes:** *I140; I180*

# Acknowledgement

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# INTRODUCTION

Vaccination for Covid 19 has been adopted around the world. However, it appears that the benefits of vaccine have been unevenly distributed. If we investigate the trends, we observe that richer countries are better off in this regard relative to many poorer countries. In India with laudable speed to date more than 150 crores have got at least one dose. However, despite aggressive campaigning by the Government, many gaps have been reported by newspaper media. Their focus based on different journalistic assessment[1] suggests the existence of some sort of vaccination gap between states or rural and urban areas, or between male and females.

Unlike many reports in popular dailies, there are only a very few articles that have appeared in either journals or edited volumes or reports by international NGOs. We attempt to investigate these few studies. Among these, the study by Mahendru, Khan and Wankhede(2021)[2] indicates through an index (prepared by the authors), by ranking the states from highest Reduced Inequalities to lowest Reduced Inequalities. The States like Meghalaya, Mizoram and Telangana have the highest scores and the States of Arunachal Pradesh and Uttar Pradesh have the lowest scores as per this index. This prevailing inequality affects access to health services and quality care. Confirmed cases of COVID-19 have a negative relationship with this index. This is interpreted by them as an indication that with more and more reduction in inequality, the confirmed cases will also decline. Thus, the states that have been attempting to reduce inequalities in the past few years have also experienced a lower number of COVID-19 positive cases. Further, has been observed by the same study that there exists a weak negative relationship between confirmed cases and expenditure on health. This

[1] It includes popular dailies like the Indian express, Times of India, Financial Express and Hindustan Times etc.

[2] in chapter 6: Inequality Amidst a Health Emergency Apoorva Mahendru, Khalid Khan and Vikrant Wankhede in Inequality Report 2021: India's Unequal Healthcare Story, OXFAM, India.

implies that states with higher expenditure on health as a percentage of GSDP witness lower confirmed cases of COVID-19. Similarly, there is a positive relationship between recovered cases and expenditure on health. This indicates that states spending more on health also witness a higher recovery from COVID-19. This is attributed by the researchers as a reflection that the marginalised also have poor health-seeking behaviour, and often evade seeking medical treatment due to poor access to affordable and quality healthcare. Higher expenditure on health addresses these concerns. The same study suggests that the Indian vaccination drive ignores the digital divide in the country. At the start of pandemic, only 15 percent rural households had an internet connection and smartphone users in rural India were almost half of that of urban India. More than 60 percent women across 12 States had never used the internet. SCs and STs with smartphones stood at 25 and 23 percent, respectively, 43 percent upper caste had access to a smartphone.

Another collated view in a collection-based article in Economic and Political Weekly (September 21, 2021)[3] discussed different aspects of Indian Covid 19 vaccination programme which ultimately led to intermittent vaccine shortages and revealed vaccine hesitancy which has now changed with various vaccines approved in India and a rapid pace of vaccination overcoming the hesitancy.

Yet another opinion-based publication by USAID (March 2021)[4] suggests that we should ensure that each community has access to enough information to make informed decisions. Understanding the information needs of the community should precede with listening. Thus "Agency builds ownership. Build systems to regularly listen and engage and to involve the community and their preferences in the design of vaccination communication activities and the vaccine rollout". Also, it

[3] Covid-19 Pandemic: Shortages, Hesitancy and Pricing Plague India's Covid-19 Vaccination Programme, 8 September 2021.

[4] Why vaccine inequality is our biggest COVID-19 communication challenge yet, USAID, March 2021

should be conveyed to the community at large that "the vaccine is not THE solution: Avoid talking about the vaccine as 'the solution' but rather that is 'part of the solution'. Pair any vaccine discussion with information to manage expectations that preventative measures are here to stay, at least in the short-medium term".

Further a paper by Ferriera (June 2021)[5] suggests that given the educational and labour market dynamics it now appears plausible that even unweighted inequality between countries may well be on the rise in 2021, if the unequal spread of vaccination allows countries such as the United States, the United Kingdom, and parts of developed Asia to recover much more rapidly than India, Latin America, and a major part of Africa. Yet, another study by Ghosh (2021)[6] points out that not only has the production and distribution of Covid-19 vaccines has exposed and intensified global inequality but there has also been a vaccine 'grab' by rich countries which implies that most of the world would get safe and approved vaccines only in 2022, and in some cases not even until 2024. This study also suggests that WHO's approval process is heavily skewed in favor of vaccines developed in the rich countries and as such this greatly prolongs the time taken before vaccines from other countries are approved. This study in fact emphasized that "Overall, domestic distribution of vaccines has mostly mirrored the global distribution: unequal, unjust, and incompetent".

**Methodology**

The inequity in vaccination may be caused by a variety of factors. With a view to highlighting both the global and interstate factors we follow the method of inequity index. For this purpose, we focus on three inequity indices which include coefficient of variation, Gini coefficient and deviations from aggregate population weighted average.

[5] Ferreira Francisco H. G (June 2021)" Inequality in the time of COVID-19", Finance and Development, pp.21-23, June 2021

[6] Ghosh Jayti (2021)" The Political Economy of Covid-19 Vaccines" www.TheIndiaForum.in, pp.1-8, March 5, 2021

We scanned the causes and factors for inequity in vaccination by literature review. This is followed by construction of the inequity index using available data both from government and individual researcher's publications. Using the information and computing the index of inequity, we make an intercountry and interstate comparison. Finally, we suggest that how a better management of different factors will have an impact on reduction in inequitable vaccination benefit. Thus, we bring out useful insights for public health policy for making it more welfare oriented.

For computation of global inequity, we compute the weighted average of population vaccinated. For this aspect, we have included 21 countries which are United Kingdom, France, Spain, Belgium, Brazil, New Zealand, India, Canada, Austria, Argentina, Italy, Denmark, Sweden, Switzerland, Ireland, Norway, Cambodia, Chile, United States, Peru and Poland. The GDP per capita PPP in US$ in 2020 for these countries varies from lowest 4422.045(for Cambodia) to highest 164964.518 (for Ireland). In case of country level data, it is the average of number of vaccinated persons multiplied by the respective population of these countries. This is followed by deviations of vaccinated population of a country from the 21 counties population weighted aggregate average. These deviations of country level vaccinations from the 21 countries population weighted average is our dependent variable. Our research question for country level data is: what is the extent of global inequity in vaccination and intercountry disparity?

For Indian context the state level data is used which aims at pointing out the various factors leading to inequitable vaccination benefits in the Indian states and their contribution to overall inequity. The state level data used for India includes the states namely, Andhra Pradesh, Assam, Bihar, Goa, Gujarat, Haryana, Himachal Pradesh, Jammu and Kashmir, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Rajasthan, Punjab, Tamil Nādu, Telangana, Uttar Pradesh, Uttarakhand, and West Bengal. The per capita income in 2018-

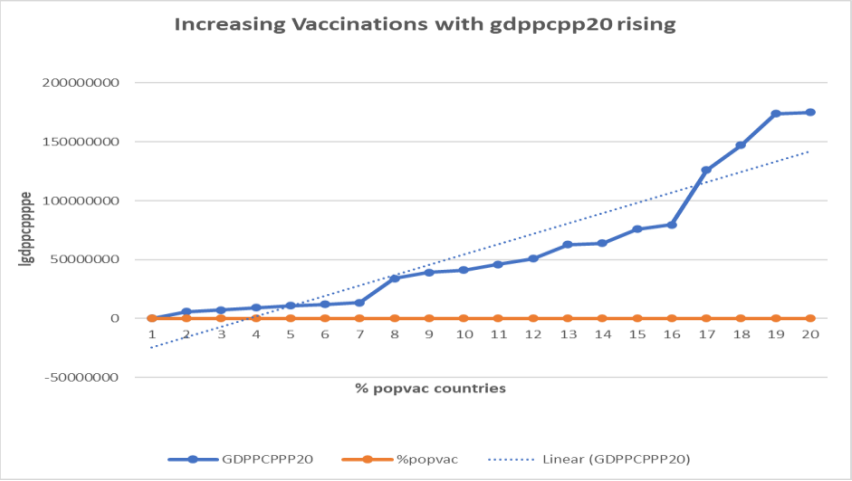
19 for these states varies from lowest (Rs.31626 for Bihar) to the highest (Rs.376215 for Goa). Weighted total vaccinations and deviations from weighted average is calculated from these states data. The deviations from the weighted total vaccinations of individual state are taken as the dependent variable.

The results of Factor analysis are presented for country level data and state level data in the Tables below from Tables 2 (a)-2 (c) and 4(a)-4(c).

**Analysis of Global Results**

At the global level, there is a pattern across countries which indicates that richer countries have got a larger share of vaccinations relative to poorer ones. This pattern is clearly notable in Figure 1 below where the graph depicts increasing numbers of vaccinations with per capita GDP rising.

**Figure 1: The Disparity in Covid Vaccinations at Global level**




**Source:** https://www.bloomberg.com/graphics/covid-vaccine-tracker-global-distribution/

The Gini coefficient and coefficient of variation using country level data are presented in Table 1 below. The value of Gini coefficient for total population vaccinated is very high (=.925802) and it is statistically significant at 10 percent level. Likewise, coefficient of variation is also 3.904. Both values corroborate our diagrammatic presentation in Figure 1 and reinforce the fact of higher inequality across countries in covid 19 vaccinations.

**Table 1: Gini Coefficient and Coefficient of Variation: Country level data of Population Vaccinated**

| | No. of observations | Index value | Std. error | p-value |
|---|---|---|---|---|
| Gini coefficient country level data of population vaccinated | 21 | 0.925802 | 0.457162 | 0.0571 |
| coefficient of variations population vaccinated for country level data | 21 | 3.904253 | | |

**Source:** our estimates.

The factoral analysis results as presented in Tables 2(a) to 2(c) indicate that one could delineate six factors for the deviations of a country from the weighted world average represented through these 21 countries in our sample which is based on availability of requisite and reliable information as given in World Covid tracker and other socio-economic variables obtained from World bank publication. These six factors as numbered from 1 to 6 in turn are having loadings from different variables which include, life expectancy in 2019, air pollution exposure in microgram, population density, unemployment in 2020, medical beds per thousand population, female labor percent 2019, GDP per capita at PPP, and rural population percent in 2020 (Table 2(a). To have zero collinearity, these factors are rotated to orthogonality. The rotated factors explain the adequate variation in the dependent variable which we have considered, namely deviations of a country average from the global weighted average Table 2(b)).

Out of these six factors three factors cumulatively explain more than 88 percent of variations (Table 2(b)). Generated factor scores based upon these results have been used further in our causal analysis. These results are presented in Table A 1 in Annexure A. These results indicate that factor 1 and factor 2 are only statistically significant. Even factor 2 is also significant slightly above 10 percent level (Table A1, Annexure A). But if we consider population vaccinated as dependent variable than factors 1 and 2 are both significant at respectively 1 percent and 5 percent level. Thus, we focus on these factors' respective loadings which is presented in Table 2(c). Thus factor 1 has a high loadings (more than .80) from three variables. The latter include air pollution exposure in microgram, female labor percent 2019 and rural population percent in 2020. Out of these air pollution exposure in microgram and rural population percent in 2020 have negative influence and female labor percent 2019 has a positive influence. For factor 2, two variables namely life expectancy in 2019 and GDP per capita at PPP have higher loadings. Both variables have a positive and high influence on factor 2. These results therefore suggest that the pace and magnitude of vaccinations have been largely influenced by these five variables.

## Factor Analysis for Country Level Data

### Table 2(a): Factors Delineated at Global Level

factor deviations from global weighted average, life expectancy in 2019, air pollution exposure in microgram, population density, unemployment in 2020, medical beds per thousand population, female labor percent 2019, GDP per capita at PPP, rural population percent in 2020
(obs.=20)

Factor analysis/correlation Number of obs.= 20*
Method: principal factors Retained factors = 6
Rotation: (unrotated) Number of parameters =36
LR test: independent vs. saturated: chi2(36) = 159.31 Prob>chi2 = 0.0000

| Factor | Eigenvalue | Difference | Proportion | Cumulative |
|---|---|---|---|---|
| Factor1 | 4.70722 | 3.27293 | 0.6789 | 0.6789 |
| Factor2 | 1.43429 | 1.0212 | 0.2069 | 0.8858 |
| Factor3 | 0.41309 | 0.10265 | 0.0596 | 0.9454 |
| Factor4 | 0.31044 | 0.09271 | 0.0448 | 0.9901 |
| Factor5 | 0.21772 | 0.14783 | 0.0314 | 1.0215 |
| Factor6 | 0.0699 | 0.08167 | 0.0101 | 1.0316 |
| Factor7 | -0.01177 | 0.06255 | -0.0017 | 1.0299 |
| Factor8 | -0.07432 | 0.05875 | -0.0107 | 1.0192 |
| Factor9 | -0.13308 | . | -0.0192 | 1 |

**Note:** *One observation for Cambodia is dropped due to non-availability of data on medical beds: Source: our estimates.

### Table 2(b): Rotated factors at global level

Rotate
Factor analysis/correlation Number of obs. = 20
Method: principal factors Retained factors = 6
Rotation: orthogonal varimax (Kaiser off)
Number of parameters =36

LR test: independent vs. saturated: chi2(36) = 159.31 Prob>chi2 = 0.0000

| Factor | Variance | Difference | Proportion | Cumulative |
|---|---|---|---|---|
| Factor1 | 3.90399 | 2.49067 | 0.5631 | 0.5631 |
| Factor2 | 1.41332 | 0.60799 | 0.2038 | 0.7669 |
| Factor3 | 0.80533 | 0.27766 | 0.1162 | 0.8831 |
| Factor4 | 0.52767 | 0.1206 | 0.0761 | 0.9592 |
| Factor5 | 0.40708 | 0.3118 | 0.0587 | 1.0179 |
| Factor6 | 0.09527 | | 0.0137 | 1.0316 |

**Source:** our estimates.

**Table 2(c): Rotated Factor Loadings (Pattern Matrix) and Unique Variances: Global Level**

| Variable | Factor1 | Factor2 | Factor3 | Factor4 | Factor5 | Factor6 | Uniqueness |
|---|---|---|---|---|---|---|---|
| deviations from global weighted average | 0.8558 | 0.222 | 0.0987 | -0.0928 | 0.1833 | 0.2231 | 0.1165 |
| life expectancy in 2019 | 0.65 | 0.6459 | -0.0508 | 0.0522 | 0.1169 | 0.1686 | 0.1129 |
| air pollution exposure in microgram | -0.9016 | -0.3495 | 0.0604 | 0.2262 | -0.0746 | 0.1081 | -0.0071 |
| population density | -0.5062 | -0.0467 | 0.2413 | 0.6319 | 0.0385 | -0.0038 | 0.2826 |
| unemployment in 2020 | 0.05 | -0.2475 | -0.7337 | -0.1625 | -0.0956 | -0.0077 | 0.3623 |
| medical beds per thousand population | 0.2932 | 0.1524 | 0.2316 | 0.0766 | 0.5076 | 0.0189 | 0.5733 |
| female labor percent 2019 | 0.9295 | 0.2738 | 0.0842 | -0.1674 | 0.0994 | -0.0078 | 0.0161 |
| GDP per capita at PPP | 0.289 | 0.8119 | 0.2768 | -0.0613 | 0.0319 | -0.0473 | 0.1736 |
| rural population percent in 2020 | -0.8025 | 0.062 | 0.2355 | -0.0425 | 0.2741 | 0.0513 | 0.2171 |

**Source:** our estimate.

## Inequity in Vaccinations: Analysis for India

In Table 3 below the two of the inequity indices for vaccinated population are presented. Out of this Gini coefficient is statistically highly significant but its value is less than 0.50 thus indicating low inequity in the vaccinations across Indian states. Likewise, coefficient of variation is also very low and less than unity which reinforces the fact of low inequity.

**Table 3: Gini coefficient and coefficient of variation: population vaccinated India**

| Gini coefficient and coefficient of variations Indian vaccinations | | | | |
|---|---|---|---|---|
| Index: | No. of obs. | Index value | Std. error | p-value |
| Gini | 21 | 0.362394* | 0.021857 | 0.0000 |
| Coefficient of variation for total vaccinations | | 0.66631* | | |

**Note:** *We used information for January 11, 2022, and September 9th, 2021, separately but the value of coefficient remains the same. For September 9th, 2021 information, this value was 0.362394 with standard error and P value respectively as.02155 and 0.0000

**Source:** our estimates: primary data source: covintrackker.gov.in, January 11, 2022, and September 9th, 2021.

The factoral analysis for Indian data of vaccinations is presented in Tables 4(a) to 4(c). There are six factors which are delineated. However, for orthogonality the factors are rotated and only three of them are retained as these combinedly explain more than 91 percent of the deviations of states from population weighted total average. Using the generated factor scores, the results of regression analysis are presented in Table A2 (annexure A). The results indicate that only factor 2 is statistically significant. Thus, we focus on underlying loadings for this factor which are presented in Table 4(c). This factor has taken a little higher loading (-.4051) pertaining to percent of BPL population percentage. This indicates that poverty has to some extent might have led to transport constraint due to low income and the lack of digital literacy.

**Table 4(a): Factors Delineated Using Data for Indian States:**

factor deviations from 21 States weighted average, sex ratio GSDP per capita at constant prices, BPL population percent, unemployment rate august 21, rural percent population
(obs.=21)

Factor analysis/correlation — Number of obs. =21
Method: principal factors — Retained factors = 3
Rotation: (unrotated) — Number of parameters =15
LR test: independent vs. saturated: chi2(15) = 37.39 Prob>chi2 =0.0011

| Factor | Eigenvalue | Difference | Proportion | Cumulative |
|---|---|---|---|---|
| Factor 1 | 1.97906 | 1.18723 | 0.7186 | 0.7186 |
| Factor 2 | 0.79183 | 0.33043 | 0.2875 | 1.0061 |
| Factor 3 | 0.4614 | 0.50096 | 0.1675 | 1.1736 |
| Factor 4 | -0.03956 | 0.11194 | -0.0144 | 1.1593 |
| Factor 5 | -0.15149 | 0.13566 | -0.055 | 1.1043 |
| Factor 6 | -0.28715 | | -0.1043 | 1 |

**Source:** our estimates.

**Table 4(b): Rotated Factors: Indian states**

rotate
Factor analysis/correlation Number of obs.=21
Method: principal factors Retained factors = 3
Rotation: orthogonal varimax (Kaiser off)
Number of parameters =15

LR test: independent vs. saturated: chi2(15) = 37.39 Prob>chi2 = 0.0011

| Factor | Variance | Difference | Proportion | Cumulative |
|---|---|---|---|---|
| Factor1 | 1.71879 | 0.91613 | 0.6241 | 0.6241 |
| Factor2 | 0.80266 | 0.09182 | 0.2914 | 0.9155 |
| Factor3 | 0.71084 | | 0.2581 | 1.1736 |

**Source:** our estimates.

**Table 4(c) Rotated factor loadings (pattern matrix) and unique variances: Indian States**

| Rotated factor loadings (pattern matrix) and unique variances | | | | |
|---|---|---|---|---|
| Variable | Factor1 | Factor2 | Factor3 | Uniqueness |
| deviations from 21 States' weighted average | -0.1409 | 0.6992 | -0.0096 | 0.4912 |
| Sex ratio | -0.214 | 0.1072 | 0.5811 | 0.5811 |
| GSDP per capita at constant prices | -0.8183 | 0.3208 | 0.0655 | 0.2231 |
| BPL population percent | 0.4813 | -0.4051 | 0.1185 | 0.5902 |
| Unemployment rate August 21 | 0.01 | 0.1795 | -0.5692 | 0.6437 |
| rural percent population | 0.8671 | 0.055 | -0.082 | 0.2384 |

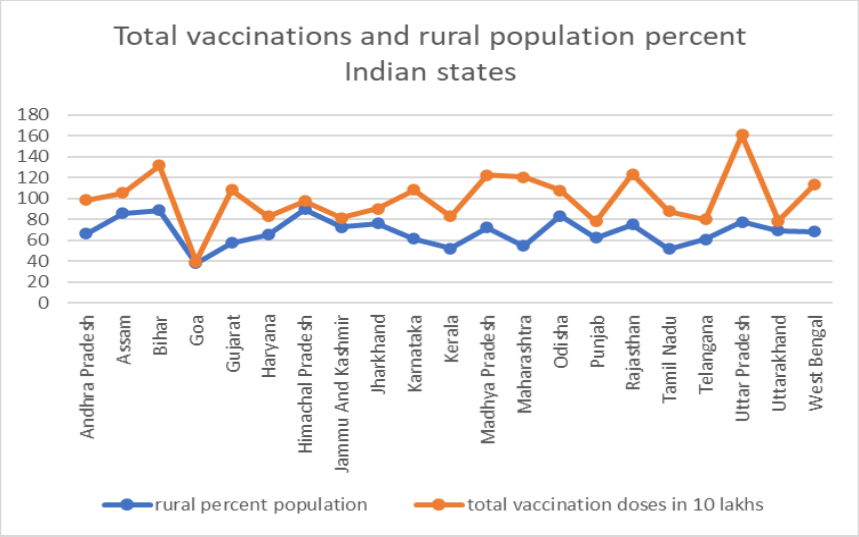
**Source:** our estimates.

## Discussion

Viewing these results of inequity indices in the Indian context, we further investigate some of the other causes that have been cited in newspaper media. It has been reported, for instance, that there is a skewed pattern in Covid 19 vaccination coverage which has favored urban population. Thus, we plotted total vaccinations and rural percentage of population in 21

for the states covered by us. The graph below in Figure 2 seems to show that that there is uniformity and pattern of vaccinations synchronizes smoothly with variations in rural population percentage. Likewise, it has also been asserted in some reports that more density of population might have become a constraint in vaccination coverage. However, our graph in Figure 3 below seems to refute this. The plot indicates that vaccinations have moved smoothly with population density variations. Another assertion in news media relates to male female differential in vaccination suggesting a pattern of male bias. Again, the graph in Figure 4 plotting sex ratio and vaccinations does not corroborate this[7].

**Figure 2: Total vaccinations and Rural Population**




[7] There is some opinion that literacy levels might have been related to vaccination pace. However, we observed by plotting the graph between literacy and population vaccinated which indicates no pattern between these two variables.

**Figure 3: Vaccinations and Population Density**

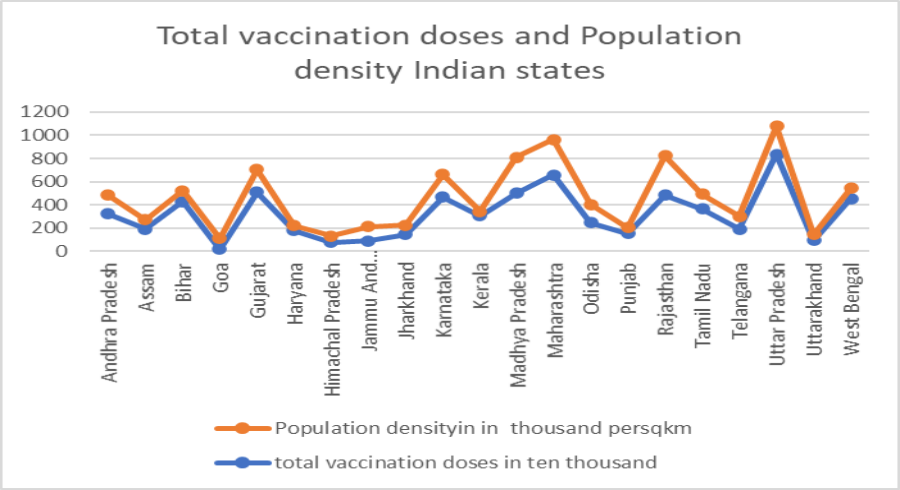
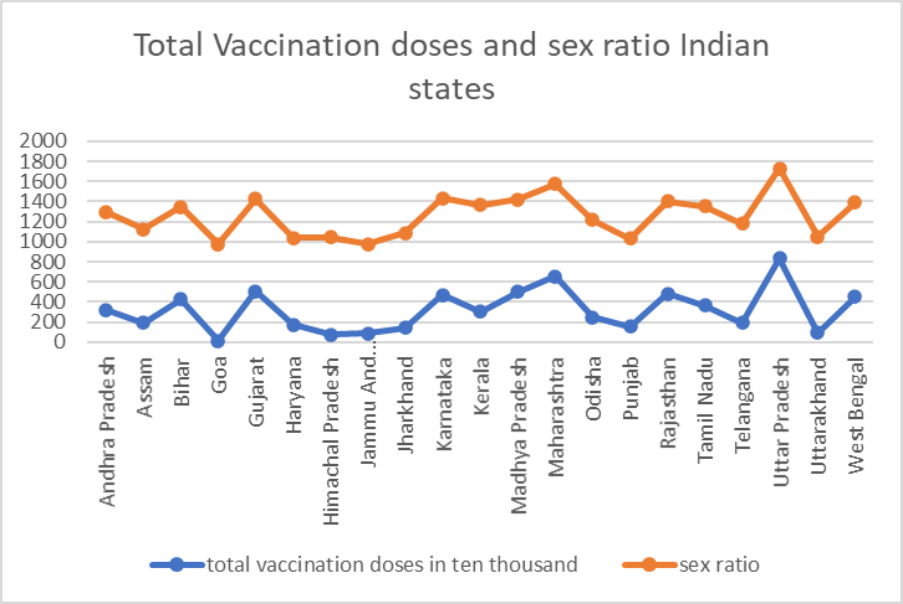



**Figure 4: Vaccinations and sex ratio**



Overall Indian vaccination drive does suggest a better equity relative to global country level data. The reasons for this lie in a uniform policy guideline for all the States in India which being part of national pandemic control measures. Secondly, the central procurement of vaccines has put less financial burden on the States thus only the individual State's vaccination drive and pace of inoculations are the factors that to some extent led to State level difference in vaccinations. Thirdly, unlike at the global individual country levels where many nations depended on export of vaccines, the large production by Indian manufacturers of two most distributed vaccinations across the country namely, Covaxin and Covishield reduced the requirement for imports of outside vaccine. Finally, to add to these factors, the keenness of both the Centre and States to save lives at the fastest pace also helped a faster inoculation drive and more equity. Though at times these efforts have been partly nullified due to non-adherence to social distancing norms which have been either due to ignorance or mixing of crowds due to social functions and festivals.

**Conclusions**

Thus, our results indicate that a better equity has been exhibited in vaccinations in India due to various policy factors. Yet it is noteworthy that many bottlenecks appeared in the implementation of vaccination drive. These suggest that there could be a better management of vaccination drive by innovative services like mobile check-ups and vaccination units on wheels for reaching the remote areas and digitally illiterate population and the people who do not own smartphones. Besides it, a good deal of better management of hospitals and material supplies is required which has been indicated by beds and oxygen supply shortages temporarily that led to losing precious lives in India.

However, at the global country level data a more inequitable vaccination pattern is noted. The latter has been the outcome of variations in per capita income of countries which is very clearly coming out from inequity indices like Gini coefficient and coefficient of variations.

The other variables that have led to this inter countries variations include air pollution exposure, percentage of female labor and rural population percentage. Out of these air pollution exposure and rural population percentage had a negative influence and female labor proportion had a positive influence. Likewise, at global level, two variables namely life expectancy and per capita income had a positive and high influence. These results thus suggest that the pace and magnitude of vaccinations at the global level have been largely influenced by these five variables. Therefore, a better policy strategy could be adopted by considering these factors that may lead to a higher equity at global vaccination level. By contrast, Indian vaccination strategy may be helped by future planning by keeping in view the onset of third Covid 19 wave, new strains of Covid viruses like Omicron, efforts for children vaccination coverage as well as more media focus on the need for administering requisite vaccination doses by individuals, booster doses for elderly population with vulnerability and a careful adherence to social distancing norms.

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# ANNEXURE A

## Table A1: Regression Deviations from Total Weighted Average

| source | ss | df | MS | | No. of observation | =20 |
|---|---|---|---|---|---|---|
| Model | 1.3759e+17 | 3 | 4.5862e+16 | | F(3,14) | =23.32 |
| Residual | 3.147e+16 | 16 | 1.9670e+15 | | Prob.>F | =0.0000 |
| Total | 1.690e+17 | 19 | 8.8978e+15 | | Adj. R square | =0.7789 |
| Dev from wt. average | Coeff. | Standard error | t values | P>(t) | 95% conf. Interval | |
| F1 | 8.33e+07 | 1.04e+07 | 7.99 | 0.000 | 6.12e+07 | 1.05e+08 |
| F2 | 1.90e+07 | 1.12e+07 | 1.70 | 0.109 | -4760785 | 4.28e+07 |
| F3 | 1.29e+07 | 1.16e+07 | 1.11 | 0.283 | -1.17e+07 | 3.76e+07 |
| constant | 2.26e+08 | 9917149 | 22.75 | 0.000 | 2.05e+08 | 2.47e+08 |

| Regression population vaccinated | | | | | | |
|---|---|---|---|---|---|---|
| source | ss | df | MS | | No. of observation | =20 |
| Model | 2.748e+35 | 3 | 9.1606e+34 | | F(3,14) | =69.36 |
| Residual | 2.113e+34 | 16 | 1.3208e+33 | | Prob.>F | =0.0000 |
| Total | 2.9595e+35 | 19 | 1.5576e+34 | | Adj. R square | =0.9152 |
| Pop.vaccinated | Coeff. | Standard error | t | P>(t) | 95% conf. Interval | |
| F1 | -1.20e+17 | 8.54e+15 | -14.06 | 0.000 | -1.38e+17 | -1.02e+17 |
| F2 | -2.08e+16 | 9.19e+15 | -2.26 | 0.038 | -4.02e+16 | -1.28e+15 |
| F3 | 8.72e+14 | 9.53e+15 | 0.09 | 0.928 | -1.93e+16 | 2.11e+16 |
| constant | 3.28e+16 | 8.13e+15 | 4.03 | 0.001 | 1.55e+16 | 5.00e+16 |

## Table A2: Regression Deviations from Total Weighted Average1*

| source | ss | df | MS | | No. of observation | =21 |
|---|---|---|---|---|---|---|
| Model | 7.8036e+15 | 3 | 2.6012e+15 | | F(3,17) | =36.08 |
| Residual | 1.2257e+15 | 17 | 7.2103e+13 | | Prob.>F | =0.0000 |
| Total | 9.2093e+15 | 20 | 4.5147e+14 | | Adj. R square | =0..8403 |
| Dev from wt. average1 | Coeff. | Standard error | t values | P>(t) | 95% conf. Interval | |
| F1 | -632205.9 | 2128875 | -0.30 | 0.770 | -5123740 | 3859328 |
| F2 | 2.62e+07 | 2551555 | 10.25 | 0.000 | 2.08e+07 | 3.15e+07 |
| F3 | 1609669 | 2731304 | 0.59 | 0.563 | -4152880 | 7372218 |
| constant | 1.52 e+07 | 1852958 | 8.20 | 0.000 | 1.13e+07 | 1.91e+07 |

**Source**: Tables A1 and A2=our estimates: * = deviations from total weighted average multiplied by minus sign since many deviations were negative.

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