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Commentary

Geo-prioritization framework for COVID-19 vaccine allocation in India

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A B S T R A C T

Up until now, countries have adopted a ‘isolate-test-treat-trace’ strategy to contain the COVID-19 pandemic. The next critical intervention in the fight against COVID-19 will be effective delivery of safe and efficacious vaccines. Various countries such as the USA, the UK, Canada, Israel, etc., have started administering vaccines to priority population groups. India is gearing up its critical components of the vaccine delivery system to effectively deliver vaccines across the country and has prioritized certain population groups to whom the vaccine will be administered. Considering India’s ambitious target to vaccinate close to 300 million people in the first phase of the vaccination drive with limited initial supply (which will be ramped up gradually), it is critical for stakeholders at all the levels – national, state and district – to understand the estimated need for vaccines across geographies based on the vulnerable population and disease epidemiology with the objective of preventing maximum number of future infections from the disease. This paper aims to describe a comprehensive geo-prioritization framework based on existing prevalence of COVID-19, high-risk co-morbidities, and demographic analysis to identify states/districts that could be most in need of the COVID-19 vaccines.

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1. Introduction

Since the detection of SARS-CoV-2 in China in Dec’19, it has rapidly spread worldwide emerging as a pandemic in March 2020. As per WHO, countries need to continuously isolate, test, treat and trace to effectively suppress and control the COVID-19 pandemic [1]. Since its first case of COVID-19 on 30th Jan 2020 [2], India has been following the same approach. Scale up of COVID-19 testing has been a critical pillar of the response to pandemic. COVID-19 testing in India has scaled up more than 200 times since March end when the country was conducting close to 5,000 tests per day.

With vaccines now on the horizon, the Ministry of Health & Family Welfare (MoHFW), Govt. of India has issued Operational Guidelines on COVID-19 Vaccine delivery [3]. The guidelines identify priority population groups (Priority Groups) – Healthcare Workers (HCWs), Frontline Workers (FLWs), and people above 50 years of age and people under the age of 50 years with comorbidities – who will receive the vaccine first. However, the guidelines mention that the prioritization amongst these groups will depend on ‘disease incidence and prevailing pandemic situation’. The guidelines also state that the vaccine rollout will also depend on the supply side and infrastructure constraints and is not necessarily sequential. Since these three groups cover ~ 300 million population and the vaccine supply will be highly constrained in the first phase [4], it is imperative to devise an objective geo-prioritization framework to ensure supply of vaccines to the states/districts which are in most need of the same with the primary objective of preventing maximum number of future infections in the meantime.

2. Methodology

The vaccination drive is expected to start in early 2021 [5], with delivery of COVID-19 vaccines expected to happen across multiple tranches. This paper describes an analytical approach to calculate the share of each state/district, in a batch of vaccines, based on the vulnerability to the disease and the recent and emerging epidemiological trends therein.

Data sources –

• State population – State wise estimated population by Unique Identification Authority of India [6]
• District Population – Census 2011/District Administration

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Vulnerable population is estimated as the total population in Priority Groups (as defined by MoHFW Operational Guidelines – HCWs, FLWs, people with age > 50 years and with comorbidities) in the state/district which is susceptible to the infection. The Priority Group population can be estimated by using the methodology adopted by MoHFW in their calculations used in Operational Guidelines (OGs). The Vulnerable Population is calculated using Priority Group population and subtracting Disease Burden in the respective state/districts to prioritize coverage of healthy individuals which have not yet been infected with COVID-19.

\[
\text{Vulnerable Pop} = \frac{\text{Population in Priority Groups (as per MoHFW OGs) - Disease Burden in PGs}}{\text{Projected population of the state/district}}
\]

If the data on Disease burden in PGs is unavailable, we can adopt the following methodology to estimate the vulnerable population for vaccination in each state/district.

\[
\text{Vulnerable Pop} = \text{Projected population of the state/district} \times \left(1 - \frac{\text{Number of people on immunosuppressant therapy + Number of pregnant and lactating mothers}}{\text{Total population of state/district} \times 100}\right)
\]

Immunosuppressant therapy regimens include antineoplastic chemotherapy, radiation therapy and immunosuppressants to induce transplant tolerance, among others.
2. Positivity % in the most recent week –

\[
\text{Positivity(\%)} = \frac{\text{Total Positives in last week}}{\text{Total Tests in the last week}} \times 100
\] (5)

3. Tests per million in the most recent week

\[
\text{Tests per million per day (TPMD)} = \frac{\text{Total samples tested in the recent week}}{\text{Total population of the state/district} \times 7} \times 1,000,000
\] (6)

2.1. Calculations for Geo-prioritization

1. Total Vulnerable Individuals Tested (TVIT) per day

\[
\text{TVIT} = \text{Vulnerable Population} \times \text{TPMD} \times 1,000,000
\] (7)

2. Expected Positives (EP) per day

\[
\text{EP} = \text{TVIT} \times \text{Positivity(\%)} \text{ in the most recent week}
\] (8)

3. State’s/District’s share of vaccine doses [%]

\[
\text{Di (\%)} = \frac{\sum \text{Epi}}{\sum \text{EP}} \times 100
\] (9)

Where,

\[\text{Epi} = \text{Expected positives in the State i/District i}\]

3. Discussion

Allocation of vaccines to the appropriate population at the right time will be crucial in slowing down the course of pandemic. When the supply of vaccines is limited, it is essential to identify and supply to the most vulnerable areas/groups. Vulnerability matters not only for determining the amounts of vaccines to be shipped, but also for planning critical elements before and after, such as dispensing site, or outreach and communication strategies, as allocations that are sensitive to vulnerability are worth little if the prioritized populations, then are not able to take up the offers.

The methodology discussed in this paper helps in calculating each State’s/District’s share in every batch of vaccine that is available for distribution. It can help the relevant policymakers and administrators to decide how to distribute the vaccine doses, at least in the initial stages of the vaccination drive when the production capacity is limited and still being augmented. This methodology can also be employed in other cases of public health emergencies wherein vaccine supplies are constrained. While devising this methodology, it has been assumed that the number of beneficiaries registered for vaccine uptake is greater than the vaccine production capacity and the health systems are adequately equipped to administer the vaccine to the same. Additionally, the reported data is assumed to be representative of the testing/positivity in the respective states/districts. Also, this methodology does not consider socio-political factors which may form a part of the decision-making process.

Apart from the index/methodology described in the paper, other indexes like the Social Vulnerability Index and the Disadvantage index [7,8,9] can be used to identify priority groups for administration of the vaccine in case the other clinical data sets to estimate vulnerability are found to be inadequate and/or incomplete.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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