Significance of Testing for Identification of COVID-19
A State-level Analysis

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The official and media discourse in India often focuses on the cumulative or daily detection of infected cases irrespective of the number of people tested and thus confuses the issue of disease progression. Based on the analysis of the number of infected cases identified and the number of people tested in eight states in India, it is emphasised that identification and quarantine of those who are infected slows down the spread of the disease. Mobilising resources towards the primary healthcare system for expanding contact tracing and investing in additional facilities to quarantine and treat infected patients is suggested.

As of 27 April 2020, over 3 million people worldwide have been infected with the novel coronavirus, out of which more than 0.2 million people have died, while India has identified a total of 29,451 positive cases with 939 deaths. India, on 24 March 2020, implemented a complete nationwide lockdown that has now been extended up to 17 May 2020. The global experience has shown that lockdowns may have helped gain time for preparing to handle the rush of cases needing institutional care, setting up systems for case tracking, and, above all, in mobilising resources. But, by themselves, lockdowns are not effective. In India, however, the official as well as media discourse at this time is mostly centred around the lockdown and the rate of growth in the number of infected cases in the country in addition to whether it is accelerating or slowing down and, in turn, its implications for possible lifting or relaxing or extending the ongoing lockdown. Even this debate first requires a careful examination of the trends before any inference can be drawn.

The trend of infected cases in any region must be seen in the context of the number of people tested, and this should be compared on a daily basis (Reddy 2020). In India, daily detection of infected cases closely corresponds to the number of people tested daily (Figure 1), exactly like in other countries during the relatively early phase of the disease spread. Only when there is a decline in the number of infected persons detected daily without a similar decline in daily testing, as witnessed in South Korea or New Zealand around 6 March 2020 and 6 April 2020 respectively (Figure 1), can we state that the spread of the disease is slowing down. India has not yet reached that stage. It indicates that in the coming days, more infected people will be identified as testing increases, or else, inadequate testing will result in underestimating the number of infected persons. Given the inter- and intra-state variations, it is important to assess the number of tests conducted and the corresponding cases reported in order to comment on the trend of disease progression.

Data and Method
Three types of data were observed. First, the trend of the number of infected cases identified daily over a period of time. Second, the trend of the number of people tested daily over a period of time, and third, the number of people tested for every confirmed case (testing rate). Based on the current strategy of the Indian Council of Medical Research (ICMR), which is to test the direct contacts (both symptomatic and asymptomatic) of laboratory-confirmed COVID-19 cases (ICMR 2020), a state that has a lower number of cases may conduct a lower number of tests. Hence, it is useful to look at the testing rate that

Figure 1: Daily People Tested vs Infected Identified
India, South Korea and New Zealand (till 26 April 2020)

Source: Compiled by Johns Hopkins University, CSSE, https://github.com/

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serves as an indicator of the extent of contact tracing and not the total number of tests or the number of tests per unit population as these are neither conducted at random nor conducted for the whole population.

We have analysed the data for the seven worst affected states (Maharashtra, Delhi, Gujarat, Rajasthan, Madhya Pradesh [MP], Tamil Nadu [TN] and Uttar Pradesh [UP]) up to 27 April 2020. The trends in Kerala, the state that has thus far managed to considerably slow down the spread of the disease, are used for comparison. These eight states taken together account for 81% of total number of infected cases reported from India. Among these states, the district-level data on cumulative tests conducted is available for Rajasthan and Gujarat. The test data are manually compiled over a period of time from the daily bulletins of the respective state governments.

**Variations across States in Testing**

Delhi and MP have the lowest testing rates, which means they are the worst in terms of contact tracing. TN was also at the bottom till mid-April, after which its testing rate increased quite significantly. Currently, Kerala tops the list followed by TN, Rajasthan and UP. Although rate declined till the second week of April in Rajasthan, it became stable and has increased since 14 April 2020 (currently at roughly 37 people tested for each positive case) and so has that of Kerala, TN and UP (implying increased case tracking in these states over time). Maharashtra and Gujarat are gradually sliding much below the all-India average of around 22 people tested for each positive case (Figure 2).

**Trends of case detection in states:** In all states (except for the later stage in Kerala), the trend of the daily numbers of covid-19 cases closely follow the trend of the number of people tested daily (Figure 3). It implies that in all these states, except Kerala, case identification is limited by the number of tests conducted. Kerala has passed through the phase when the daily identification of positive cases increased with more testing. From 6 April 2020 onwards in Kerala, there has been an overall decline in the daily number of positive cases without a decline in the number of people tested (Figure 3) and an increase in case tracking (Figure 2). This indicates that the spread of the disease is slowing down in Kerala.

Daily case detection and daily tests in Maharashtra, Gujarat, Rajasthan and UP...
show an overall rising trend, with daily fluctuations. Rajasthan and UP are doing relatively better, testing around 35 and 37 persons for every positive case, respectively. The efforts of Maharashtra and Gujarat, both with testing rates of approximately 15 and declining, are not up to the mark. Daily case identification in Gujarat has declined in the last 10 days or so due to the slowdown of daily testing (Figure 3).

In Delhi and MP, daily detection of cases has not increased to the extent of the four aforementioned states. With low testing rates (around 12 and 14 respectively), we can infer that there may be a gross underestimation of the levels of infection in these two states because of inadequate testing.

TN had been quite slow to start adequate testing, for its average testing rate was around 13 till 15 April 2020, but this has increased considerably since then. From 19 April onwards, we observe that the number of daily cases has been declining to some extent, even though the number of people tested daily has increased (Figure 3). However, it is too early to comment on whether the disease progression is slowing down.

In notations:

$$\text{Case}_{ij} = \beta_0 + \beta_1 \text{Test}_{ij} + \text{Test}_{ij}^2$$

[for 1st state and jth day]

### Table 1: Summary Statistics of Dependent and Independent Variable

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>Std Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily positive cases</td>
<td>204</td>
<td>105</td>
<td>123</td>
</tr>
<tr>
<td>Number of people tested daily</td>
<td>204</td>
<td>2,235</td>
<td>1,999</td>
</tr>
</tbody>
</table>

### Table 2: Results of Panel Least Squares Regression

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>StdErr</th>
<th>p-value</th>
<th>95% Conf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test</td>
<td>0.040</td>
<td>0.013</td>
<td>0.004</td>
</tr>
<tr>
<td>Test$^2$</td>
<td>-0.0000026</td>
<td>0.0000021</td>
<td>0.23</td>
</tr>
<tr>
<td>Constant</td>
<td>38.73</td>
<td>14.37</td>
<td>0.011</td>
</tr>
<tr>
<td>Prob &gt; F</td>
<td>0.0000</td>
<td>Number of observations = 204</td>
<td></td>
</tr>
<tr>
<td>R-sq within</td>
<td>0.16</td>
<td>Number of groups = 8</td>
<td></td>
</tr>
</tbody>
</table>

In TN, which will become clear as more tests are done.

### Intra-state Disparity

Disparity of testing also exists within the states across districts. In Rajasthan and Gujarat, we observe the pattern in that the districts with the higher number of cases have lower testing rates with a possibility of greater under-reporting in heavily affected districts (Figures 4a and 4b). On the other hand, there are some districts that have a relatively low number of detected cases as well as testing rates. It indicates a possibility that the number of positive cases in these districts, namely Tonk, Ajmer, and Nagaur in Rajasthan, and Anand, Aravalli and Panchmahal in Gujarat, might not be as low but under-reported due to low testing.

We thus see regional as well as daily variations of testing, and find that identification of positive cases is closely dependent upon testing.

### Case Tracking and Quarantine

Testing the contacts of people identified as infected for possible infection and quarantining those found infected can break the chain of transmission of the disease. We test the hypothesis as to whether increased testing slows down the spread of the disease. We have used panel data of the aforementioned eight states, spanning from the period of 24 March 2020 (the onset of nationwide complete lockdown) till 27 April 2020. We assume that the daily identified cases (Case) is a function of number of people tested daily (Test) and its squared term (Test$^2$). The squared term is introduced to see if there is any inflexion point, that is, if the nature of relation between the dependent and independent variable changes after a certain point.
The summary statistics of the dependent and independent variables are reported in Table 1 (p 14) and the results of the fixed effect panel least squares regression are reported in Table 2 (p 14). A fixed effect model controls for all time-invariant differences between the states, and hence, the estimated coefficients are not biased because of omitted time-invariant characteristics. We have reported Driscoll and Kraay’s (1998) standard errors to produce heteroskedasticity and autocorrelation consistent standard errors, which are robust to general forms of spatial and temporal dependence.

Plotting the fitted values of daily positive cases against the number of people tested daily reveals a bell-shaped curve (Figure 5). The plausible explanation is that with increasing number of persons being tested daily, initially, the number of daily positive cases increases as case identification improves. But, as more cases are identified and quarantined, the chain of transmission is weakened and the number of daily cases gradually reduces.

For the optimal use of resources and personnel as well as for prioritising risk, it is more practical to conduct tests through tracking the contacts of confirmed positive cases and quarantining the infected. This is similar to the strategy used for vaccination to create a zone of immune contacts around a case to slow down disease transmission (Deen and Seidelin 2018; Ali et al 2016). However, the criteria of testing in India should be extended to secondary contacts as well. How much testing and quarantining of the infected is required to bring down the daily number of positive cases can only be understood on the ground once we aggressively increase testing. If the figures from the places that have so far been able to contain the disease serve as an indication, then it is worthwhile to mention that Kerala as of now has tested 48 persons for every positive case. Countries like South Korea, Australia and New Zealand have testing rates of 53, 67, 56 respectively, which, notwithstanding their different testing strategies, is clearly much higher than India’s overall testing rate of 22.

Conclusions

Our findings from data gathered from the eight Indian states underline the importance of the relationship between case identification and number of tests done. Seen together with the cases identified daily, it helps indicate whether the system has been able to contain the disease progression. Any estimation of daily disease count trends without considering the corresponding testing-rate trend will be inaccurate by varying degrees across time and region and, hence, would be inappropriate for critical public health decisions. Hence, all the states, particularly the ones lagging behind, need to address the barriers in order to increase testing for a dependable picture of the disease spread for policy formulations.

The barriers to testing are the same as that of building infrastructural facilities, which would eventually put a cap on the numbers of infected people that can be identified, isolated and treated. The lack of primary healthcare facilities is a crucial barrier. As our results show, Kerala alone, with its strong district health services, has managed to contain the infection given its health infrastructure. Most other states lag behind and addition of activities for containment of the covid-19 infection disrupt all other routine and emergency services (Rukmini 2020). Field workers are over-stretched and forced to perform without protective gear. The investment in the much-needed primary healthcare system, pending for long, thus is a critical imperative and the only viable exit strategy from this complete lockdown. The lockdown itself creates obstacles, like restricted movement, non-availability of transport and materials required for testing and treating, for the states to evolve area-specific strategies for testing and containment. Yet another barrier is the low level of citizen’s participation, which crucially depends on transparency, access to information, and trust. Shifting to a “people-led” campaign from the current lockdown requires building that trust, especially among the poor who are disproportionately bearing the economic cost of the lockdown. This cost might be greater than that of the disease itself. On the other hand, even a partial exit from the lockdown without the aforementioned measures may result in the rapid spread of the disease.

NOTES

1 Even if there are differences in the degree of testing errors across countries, this conclusion will still hold if testing errors are not drastically increasing over time.

2 Apart from symptomatic healthcare workers and individuals with travel history and patients with severe and acute respiratory illness.

REFERENCES


