Effect of COVID-19 Testing on Its Containment – An Indian Perspective

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Research Article

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Abstract

India, a country with 28 states and 8 Union territories has seen a rapid increase in COVID-19 cases over a period. While the entry of COVID-19 was random in various states, some states have managed the containment while in some states it has exponentially grown. COVID-19 disease is both virulent and contagious and this disease is not yet having a vaccine or medicine.

In this study, research has been done on 4 months of data in 28 states and 8 Union territories. When the study is being conducted India had close to 1.3 million cases ranking 3rd in the world. Therefore, the sample size is quite enough to establish the hypothesis. The study is focused on analyzing and synthesizing testing levers along with population and number of cases. Two constructs namely "Proactiveness Index and Infection Ration" have been devised considering 3 different levers of population, testing, and cases. A relationship has been established and it has been found that in most of the cases Proactive Index and Infection Ration has an inverse relationship i.e. higher the proactive index, the lower the infection ration.

Introduction

In late December 2019, many cases of pneumonia were reported pneumonia in Wuhan city, China. This was soon identified by scientists that a novel strain of coronavirus is responsible for the disease (COVID-19). Since then, an epidemic of acute respiratory tract infection has been set in swing with the rapid transmission of infection primarily through droplets, respiratory secretions, and direct contact. By the end of July 2020, the infection had spread over 213 countries, infected more than 15,656,766 individuals across the world, and resulted in an approximate 6,36,575 deaths [1]. The exponential rise in the number of cases being witnessed daily has compelled the World Health Organization (WHO) to title this outbreak a pandemic [2].

The first case of COVID-19 in India was identified in Kerala (a state of India), on 30th January 2020 [3]. Current evidence suggests that the gestation period may last for up to 14 days, with a mean duration of 5-7 days [4]. The peak occurs at the end of the gestation period and before the onset of symptoms, suggesting that transmission begins within a day or two of symptoms onset [5]. Rapid infection spread is augmented by the potential for transmission by asymptomatic or minimally symptomatic patients [6]. Until now, our national strategy in tackling the COVID-19 has been predominantly one of containment, an approach typically utilized when a pathogen has slow transmission capacity or is brought in from external sources. This allows for the implementation of measures to limit its spread such as quarantine of individuals coming from a high transmission area, infected individuals to be isolated, tracing of contacts as well as restricting the people movement in containment zones having a high number of cases. Once the infection starts to spread in the community with evidence of sustained local transmission, it becomes impossible to isolate all the infected individuals. In such situations, mitigation measures are needed to slow down the spread of infection[7].

Community mitigation strategies are called 'flattening the curve' in epidemiological terms. The curve gives the projected number of positive COVID-19 cases in specified time duration. The shape of the curve varies according to the rapidity with which the infection spreads in the community. This results in an overloading of the local healthcare systems beyond their capacity, leading to higher case fatality rates. The highest priority at this stage is to keep the mortality as low as possible. If individuals and communities take appropriate steps to slow the spread of the virus, the cases would be stretched out across a longer period, thereby flattening the curve and avoiding overburden of the existing healthcare systems. It also buys time to potentially develop newer drugs and vaccines targeted at the virus. In this research possible interventions to help contain such type of disease in the future will be discussed.

Social Distancing: The influenza outbreak of 1918 has proved that non-pharmaceutical measures such as social distancing are as important as drugs and vaccines in controlling a pandemic [8]. Strict imposing of social distancing by various governments have shown a positive effect on delaying the transmission rates and reducing severe illness and death in the testing time of pandemic [9]. Examples of Social distancing measures are is infected people isolation, quarantine of their contacts, work from home, closing of educational institutions, and cancellation of large public gatherings. Such measures allow our healthcare system to handle the additional burden in a phased manner. The WHO recommends a minimum distance of at least 1 m (3 feet) to be maintained between individuals to prevent the spread of the infection through respiratory droplets [10].

Personal Protection Measures: Individual protection measures, an integral part of infection control, show how the citizens of the country are concerned about their self and community health in containing and mitigating the disease. Past experience also suggests the use of face masks and hand hygiene will reduce respiratory illnesses in shared spaces [11]. Washing of hands with soap or use alcohol-based hand sanitizers may significantly decrease the chance of transmitting or acquiring the virus. Individuals are encouraged to practice respiratory hygiene. In case a person develops respiratory symptoms, using a medical mask is recommended.

Home Isolation when Sick: Patients with mild illness or suspected COVID-19 can be treated at home. Such patients must be hosted in a well-ventilated single occupancy room with minimizing the shared spaces. Only a single caregiver will be allowed to minimize the contact and no visitors will be allowed. The use of respiratory masks will be mandatory for both the patient and the caregiver. The patient should use separate utensils and cloths. All individuals who were in close contact with the patient suspected/confirmed COVID-19 shall be quarantined and their health should be monitored for 14 days from the latest day of contact [12].

Widening the testing and treatment capacity: In India, COVID-19 testing facilities by reverse transcription-polymerase chain reaction (RT-PCR) were restricted with only government facilities. Indian Council of Medical Research (ICMR) was recommending test only symptomatic patients having international travel history to affected regions or close contact with confirmed positive patients [16]. India has, later on, increased the diagnostic and laboratory testing for COVID-19. The ICMR-National Institute of Virology, Pune, has successfully identified SARS-CoV-2 strain from infected patients, confirming a homology of 99.98 percent with the strain from Wuhan [17]. This implies it is very much important to take proactive strategic actions to restrict transmission.

Objective

In India initially, only 100 tests per day are being carried out due to limited availability of testing kits, testing infrastructure, and trained personnel. But as the Government of India (GoI) has imposed a nationwide lockdown and emphasized to increase the in-house testing capabilities, PPE manufacturing, ventilators manufacturing under 'Atmanirbhar Bharat' (Self Sustainable India) and 'Make in India' campaign in these testing times. By mid of May India has successfully increased its testing capability 1000 times in just 60 days with the help of research institutions, medical colleges, testing laboratories [18].

The need is felt by the authors that a study needs to be done focusing on analyzing and synthesizing testing levers along with population and number of cases in Indian perspective w.r.t particular state. Accordingly, two terms were coined to study the effect of testing in containing the COVID cases within Indian state; Proactive Index and Infection Ration. Proactive Index (PI) is the ratio of the total number of testing carried out in a specific geographical location to that of the total number of positive cases identified for Covid-19. The infection ratio is the ratio between total numbers of COVID-19 infections to that of the population of the particular state.

$$\text{Proactive Index} = \frac{\text{Total No. of Testing}}{\text{Total Positive cases}}$$

$$\text{Infection Ration} = \frac{\text{Number of infections}}{\text{Population of the State(000's)}}$$

Data Collection

India, a country with 28 states and 8 Union territories has seen a rapid increase in COVID cases over a period. While the entry of COVID-19 was random in various states, some states have managed the containment while in some states it has exponentially grown. COVID-19 disease is both virulent and contagious and this disease is having no vaccine or medicine. The cause of spread is also tentative, while some research shows that it also spreads via air, fomites, etc. The levers for control within states are very limited and one of the levers is through testing. India, having a population of ~1.4 billion[23,24] has varied diversity.

In this study, research has been done on 4 months of data (13th March to 23rd July) in 28 states and 8 Union territories [19]. When the study is being conducted India has close to 1.3 million cases ranking 3rd in the world. The number of cases increases in India from 13th March to 23rd July is represented in Figure 1 below. Also, various states of India have been categorized into four zones. It can be seen from Table 1 below that COVID is scattered and spread in almost all parts India and hence this study will give evaluation holistically of what has happened and what action to be taken for testing if in future such virulent pathogen strikes the human being. Therefore the sample size is quite enough to establish the hypothesis.

The study is focused on analyzing and synthesizing testing levers along with population and number of cases. A relationship has been established and it has been found that in most of the cases Proactive Index and Infection Ration has an inverse relationship i.e. higher the proactive index, the lower the infection ration. The purpose of this study is to propose some levers which can help states to mitigate and take preventive actions in the future for tackling with Covid-19 kind of epidemic.

Region	Population (millions)	Reported Cases	Population Contribution	Cases Contribution
WEST	**240**	**3,84,516**	18%	30%
NORTH	**494**	**3,37,683**	36%	26%
SOUTH	**276**	**4,16,136**	20%	32%
EAST	**361**	**1,49,795**	26%	12%
Total	**1371**	**12,88,130**	100%	100%

Table 1: Data of population and Covid-19 reported cases in different regions of India (13th March to 23rd July 2020)

Theoretical Framework

Previous studies have shown that there are some keys such as lockdown, immunity building, testing, use of PPE, etc to manage the spread of contagious disease. However, it is very important to establish some key metrics which can relate and emerge as evidence to control such disease in the future if it emerges. One such important lever is testing for the disease. In the study, testing in various geographies of India has been correlated with population and infections. To propose a lever for making a relationship between testing and infection in various states of India, two constructs have been derived. The first construct is the Proactiveness Index. Proactiveness Index measures the total tests conducted for each positive case. The index gives a measure of how proactive tests have been performed to prevent the spread of the disease. Since there is no vaccine or medicine, it becomes important that the spread of diseases is known to the best of the extent. The disease is also highly contagious in nature hence if the spread of the disease is not known then it could lead to further spread. Hence proactiveness index is a lever to contain the spread of the virus. The other construct is Infection Ration. The infection ratio is the ratio of the total positive case in the state to the total population(000's) of the state. The infection ratio indicates how many infections of the disease have happened per thousand population of the state. Thus two constructs have been formed taking into account 3 variables viz. population, testing, and infections.

Data from the period 13th March to 23rd July has been gathered [19], during this period the total number of reported cases in India rose to ~1.3 million, ranking 3rd all across the world. Hence the data for the study is sufficient to evaluate the hypothesis. Also over a while, the cases have spread more so over uniformly in all the states, hence 4 months period is a suitable time to measure every state at an independent and relative scale. The two constructs have taken into account the relationship between 3 crucial metrics viz. population, the number of tests performed, and the number of cases.

Hypothesis

H1: Higher the proactiveness index of the state lower the infection ratio

Data Analysis

The data has been collected from various states and central government sites. Some of the data have also been collected from websites that are tracking Covid-19 data for India [19].

To analyze the data, infection ration has been classified into 3 different classes. Class 1, with an infection ration of less than 0.6, there are 16 states in this class, it can be seen that the weightage average proactive index of these states is 27, which is highest amongst the three classes. The next class of infection ration is the range between 0.6 to 1.2, there are 10 states in this class, the proactiveness index in this class has reduced to 16. The next class of infection ratio is above 1.2, there are 9 states in this class. The proactiveness index of class 3 has further reduced to 9. Thus the relationship clearly states that the places where the proactiveness index is high the infection ratio is lower. The population data has been gathered from the UIDAI estimation of the population of India. The proactiveness index and infection ratio have been plotted against each other for all the states in Figure 2. The data for the various states have been plotted in Table 2. Also, the relationship between proactiveness index and infection ration has been plotted in Figure 3 for various states. It could be observed that for most of the states with few exceptions, the relationship is inverse.

State Class	Range of Infection Ratio	No. of States / UTs	Average of Proactiveness Index
Class1	<0.6	16	27
Class2	0.6-1.2	10	16
Class3	>1.2	9	9
Total		35	14

Table 2: Indian States / UTs were divided into three different classes based on Range of Infection Ratio

State	Class of States / UTs	Code	Population (Million)	Test (Million)	Test %	Confirmed	Proactiveness Index	Infection Ration (Cases / Thousand Population)
Andaman and Nicobar	Class 1	AN	0.4	0.02	5.0%	240	88	0.58
Himachal Pradesh	Class 1	HP	7.5	0.12	1.7%	1,834	68	0.25
Mizoram	Class 1	MZ	1.2	0.02	1.5%	326	58	0.26
Meghalaya	Class 1	ML	3.4	0.03	0.9%	534	57	0.16
Arunachal Pradesh	Class 2	AR	1.6	0.05	3.1%	991	49	0.63
Dadar Nagar/ Daman	Class 3	DN+DD	0.6	0.04	6.4%	820	48	1.33
Punjab	Class 1	PB	30.1	0.50	1.7%	11,739	43	0.39
Sikkim	Class 2	SK	0.7	0.02	2.9%	473	42	0.69
Chhattisgarh	Class 1	CT	29.4	0.27	0.9%	6,370	42	0.22
Rajasthan	Class 1	RJ	81.0	1.30	1.6%	33,220	39	0.41
Kerala	Class 1	KL	35.7	0.61	1.7%	16,111	38	0.45
Manipur	Class 2	MN	3.1	0.07	2.4%	2,115	35	0.68
Tripura	Class 2	TR	4.2	0.13	3.1%	3,677	35	0.88
Jharkhand	Class 1	JH	38.6	0.24	0.6%	7,166	34	0.19
Jammu and Kashmir	Class 3	JK	13.6	0.55	4.0%	16,429	33	1.21
Uttar Pradesh	Class 1	UP	237.9	1.70	0.7%	58,104	29	0.24
Nagaland	Class 1	NL	2.2	0.03	1.4%	1,174	27	0.52
Goa	Class 3	GA	1.6	0.12	7.4%	4,350	27	2.74
Madhya Pradesh	Class 1	MP	85.4	0.66	0.8%	25,474	26	0.30
Assam	Class	AS	35.6	0.72	2.0%	28,792	25	0.81

	2							
Uttarakhand	Class 1	UT	11.3	0.13	1.2%	5,445	24	0.48
Andhra Pradesh	Class 3	AP	53.9	1.50	2.8%	72,711	21	1.35
Odisha	Class 1	OR	46.4	0.42	0.9%	21,099	20	0.46
Haryana	Class 2	HR	28.2	0.49	1.7%	28,975	17	1.03
Chandigarh	Class 2	CH	1.2	0.01	1.0%	800	15	0.69
West Bengal	Class 1	WB	99.6	0.76	0.8%	51,757	15	0.52
Ladakh	Class 3	LA	0.3	0.02	5.9%	1,210	14	4.19
Puducherry	Class 3	PY	1.4	0.03	2.4%	2,421	14	1.71
Karnataka	Class 2	KA	67.6	1.10	1.6%	80,863	14	1.20
Bihar	Class 1	BR	124.8	0.42	0.3%	31,691	13	0.25
Tamil Nadu	Class 3	TN	77.8	2.20	2.8%	1,92,964	11	2.48
Gujarat	Class 2	GJ	63.9	0.59	0.9%	52,563	11	0.82
Delhi	Class 3	DL	18.7	0.89	4.8%	1,27,364	7	6.81
Telangana	Class 3	TG	39.4	0.32	0.8%	50,826	6	1.29
Maharashtra	Class 3	MH	123.1	1.70	1.4%	3,47,502	5	2.82

Table 3: Statewise Proactiveness Index and Infection Ration (13th March to 23rd July 2020)

Conclusion And Future Work

When the contagious disease emerges such as COVID19, whose spread is moreover undiscovered, the control measures are very limited (Lockdown, PPEs, etc). In such a scenario testing becomes a critical factor for containment, although how much testing becomes a challenge for any state. Through the study, it has been found that the metric of the Proactiveness Index is related to the Infection Ratio in the majority of the states. States are divided according to the class of infection ratio and the respective average proactiveness index has been plotted. The results indicate that the class of states whose infection ratio is low has a higher proactiveness index. Therefore, it's been evident that the proactiveness index is very important to contain disease especially during the initial stage of such an unknown and contagious virus.

The pro-activeness in testing will not only help in better management but also will help in the spreading of disease. When such type of contagious disease arises in the future it's very important that along with other measures such as lockdown, use of PPES, etc., the state should devise a target of proactiveness index and start taking measures for testing. Although the study is focused on various states of India, further work could be carried out in classifying this in the rural or urban place. Also, another area of work could be to measure these two constructs along with other factors such as lockdown, demographics, medical facilities, etc. The work of research could be seen with the perspective of other countries too.

Declarations

Funding: Not applicable.

Conflicts of interest/Competing interests: Not applicable.

Availability of data and material: Data were collected from open access data from the Government of India (GoI) websites mentioned in the reference section below.

Code availability: Not applicable.

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Figures

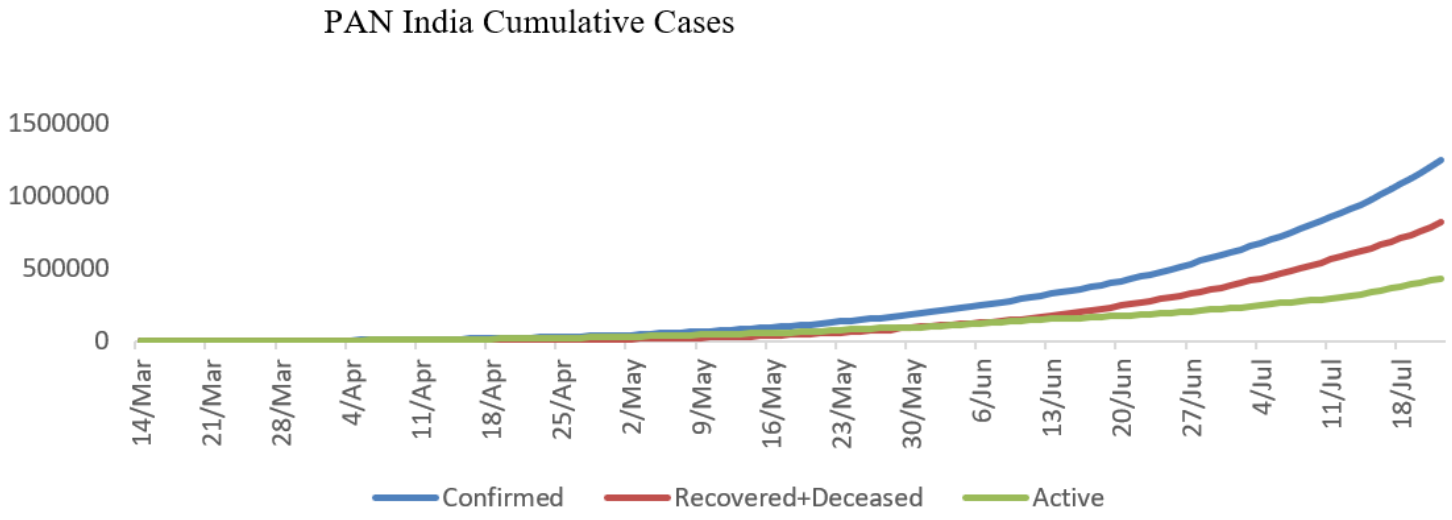

Figure 1

Showing plot of confirmed, recovered + deceased, and active cases at Pan India Level.

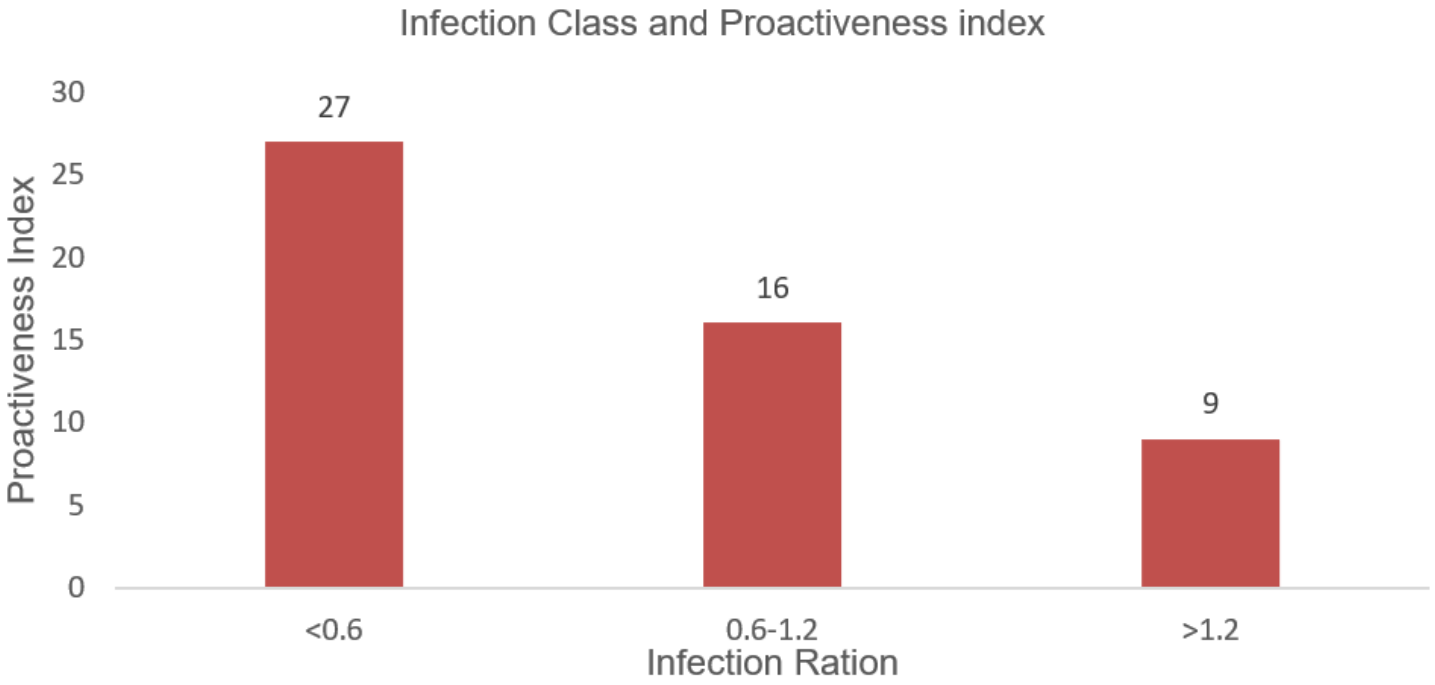

Figure 2

Plot of Proactiveness Index (PI) vs different range of Infection Ratio (IR)

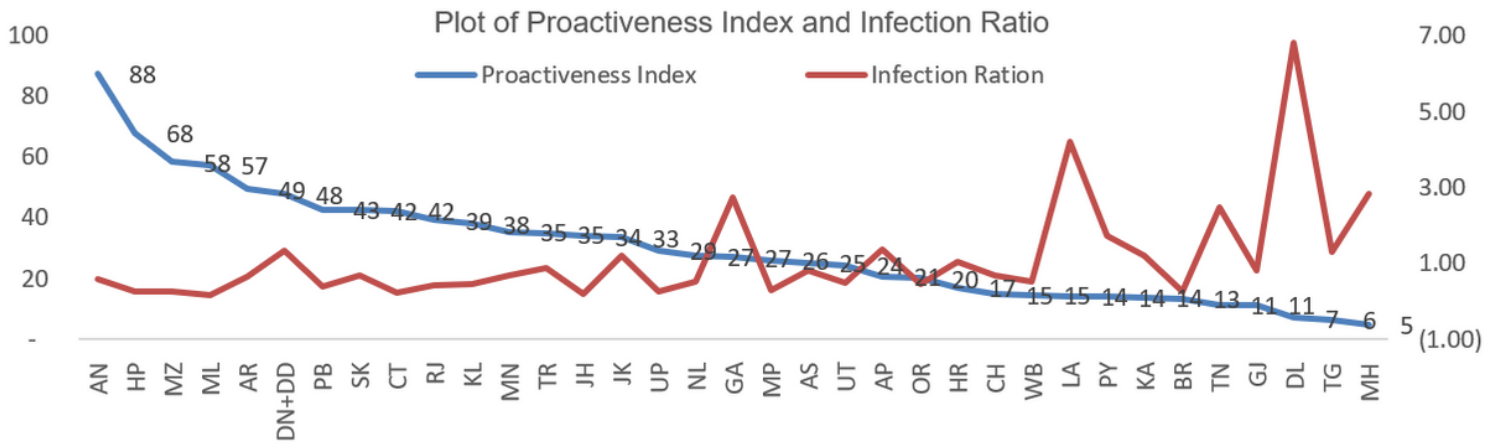

Figure 3

Plot of Proactiveness Index and Infection Ratio of States and UTs of India under study.