



ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor: 5.2
IJAR 2020; 6(10): 537-541
www.allresearchjournal.com
Received: 21-08-2020
Accepted: 26-09-2020

Dr. Ishita Saha
Department of Physiology,
Medical College and Hospital,
Kolkata, Kolkata, West
Bengal, India

Occurrence of COVID-19 pandemic based on spatio-temporal variation of human immunity and work potentiality: A review on West Bengal

Dr. Ishita Saha

DOI: <https://doi.org/10.22271/allresearch.2020.v6.i10i.7380>

Abstract

A key concept for epidemic control is to grow herd immunity (population immunity, community immunity, or social immunity). It has been observed that only a percentage of a population needs to be immune to stop generating large outbreaks. Based on the large number of infected people it is suggested that this is likely the zoonotic origin of COVID-19. Inter personal transmission of COVID-19 infection led to the isolation of patients that were subsequently administered a variety of treatments. In this study it is seen that 7 districts out of 23 is experiencing a large intensity due to COVID-19. Kolkata and its surrounding districts are found maximum concentration of COVID cases. On the other side, some districts of northern part of West Bengal are also suffering severely from remarkably high number of COVID cases. But the effective measures against community transmission of COVID-19 have been implemented to control the current outbreak. The present review indicates that special attention should be applied, and efforts are to be given for susceptible populations including children, health care providers, and elderly people to protect or reduce transmission of COVID-19. This review is an effort to highlight the district wise immunity building and workflow, epidemiology, transmission analysis and future directions to control the spread of this fatal disease in West Bengal.

Keywords: Herd Immunity; COVID-19; epidemiology, workflow; community transmission

Introduction

Herd immunity or population immunity is a kind of indirect protection from infectious disease that comes when a sufficient proportion of a population becomes immune to an infection, either through previous infections or vaccination (Fine *et al.*, 2011 and Gordis, 2013) ^[10, 14]. Population immunity is typically estimated through cross-sectional surveys of representative samples using serological tests that measure humoral immunity. Surveys performed in countries, affected early, during the COVID-19 epidemic, such as Spain and Italy, suggest that nationwide prevalence of antibodies varies between 1 and 10%, with peaks around 10–15% in heavily affected urban areas (Byambasuren *et al.*, 2020) ^[5]. Interestingly, this is consistent with earlier predictions made by mathematical models, using death counts reported in national statistics and estimates of the infection fatality ratio, that is, the probability of death given infection (Flaxman *et al.*, 2020) ^[11]. Some have argued that humoral immunity does not capture the full spectrum of SARS-CoV-2 protective immunity and that the first epidemic wave has resulted in higher levels of immunity across the population than measured through cross-sectional antibody surveys. Indeed, T cell reactivity has been documented in the absence of detectable humoral immunity among contacts of patients (Sekine *et al.*, 2020) ^[19], although the protective nature and the duration of the observed response are yet unknown.

To eliminate the virus and to preclude disease progression during the non-severe stages, a specific adaptive immune response is required. So an important and well balanced planning is needed to boost immune responses at this stage. An endogenous protective immune response is observed during the incubation and non-severe stages when the host should be in good health. In health, appropriate genetic background that elicits specific antiviral immunity. Genetic differences are well-known to contribute to individual variations in the immune response to pathogens. It has shown that when a protective immune response is low, viral infections impart significant damage to the affected tissues,

Corresponding Author:
Dr. Ishita Saha
Department of Physiology,
Medical College and Hospital,
Kolkata, Kolkata, West
Bengal, India

especially in the organs with high ACE2 expression, such as intestine and kidney. The damaged cells induce innate inflammation in the lungs that is largely mediated by pro-inflammatory macrophages and granulocytes. Lung inflammation is the main cause of life-threatening respiratory disorders at the severe stage of the disease.

A general health may not be advantageous for patients who have advanced to the acute stage. Once massive lung damage commences, trial should be made to control inflammation and henceforth, management should be symptomatic. Surprisingly, after discharge from hospital, some patients remain positive. This indicates that a virus-eliminating immune response to SARS-CoV-2 may be difficult to induce at least in some patients and vaccines may not work in these individuals. These scenarios should be considered when determining the strategies of vaccine development. In addition, there are many types or subtypes of corona virus. Thus, if vaccines directly targeting SARS-CoV-2 prove to be difficult to develop, the Edward Jenner approach should be considered.

To assess the inter-district trend of spreading potentiality of COVID-19, readiness, exposure and resilience capability have been studied intensively. With the help of the captured data, the outbreak scenario, growth rate, testing amenities have been computed. The study reflects that there is an enormous disparity in growth rate and total COVID-19 cases. COVID-19 amplified very swiftly with exponential growth in every four to seven days in main affected districts during first phase of lockdown. The result shows vibrant disproportion with regard to hospital bed ratio, corona virus case-hospital bed ratio, provision of isolation and ventilators, test ratio, distribution of testing laboratories and accessibility of test centres all over West Bengal. The study indicates the sharp inequality in transmission potentiality and resilience capacity of different Districts. Every state and union territory is not well-prepared to contain the spreading of COVID-19. In every district of West Bengal a strict protective measures and uniform resilience system must be implemented to battle against the menace of COVID-19.

A new respiratory tract infectious disease COVID-19 caused by corona virus 2019 has emerged out of the city of Wuhan, China (Chen *et al.*, 2020) [6] in December 2019, which has already spread worldwide with its deadly effect. Suddenly, it has been transformed into an extraordinary catastrophe towards the world's geopolitical scenario, economic structure and health system (Djalante *et al.*, 2020) [8, 9]. The magnitude of its aftermath is extraordinary (UN, 2020). Reuters has released a statement of UN Secretary-General, where he has warned that the world will encounter the most challenging emergency situation since World War II with COVID-19. On 30th January 2020, World Health Organization (WHO) announced this health disaster as Public Health Emergency of International Concern (PHEIC) and ultimately on 11th March 2020, WHO has considered this disease as a pandemic. This emergency situation has an extensive impact on the national economy, social and psychological issues as well as on the international affairs of every affected territory (Hua and Shaw, 2020) [15]. WHO has coined a new term 'infodemic' (Zaroncostas, 2020) and information circulated through social media would traumatize people in several avenues (Shaw *et al.*, 2020) [20]. The prime and initial factor of COVID-19 must be identified as a challenge on the basis of humanitarian ground (Mckinsey, 2020) [17]. WHO has estimated that worldwide

37,920,185 people are confirmed as diseased till June 30, 2020 while 1,083,694 people have lost their lives across 216 countries in the world. The outbreak of Corona virus indicates the deficiency of preparedness of several government worldwide (Djalante *et al.*, 2020) [8, 9]. In this aspect, West Bengal is not an exception. As of June 30, 2020, a total number of 1,82,143 COVID-19 positive cases are identified including a number of 5164 deaths.

The present review focuses on the spatio-temporal variation in Covid-19 affected cases with special emphasis to the deceased rate and trend of recovery cum immunity built up in West Bengal.

Study area

The study has been taken in all districts of West Bengal. It is well known that the state of West Bengal has lots of diversity regarding its demography, physiography, climate, soil, natural vegetation and of so many cultural landscapes. At present there are 23 districts in West Bengal and they are located at different geographic locations. Himalayan high altitude region, Gangetic plain land, coastal region near Purba and Paschim Medinipur, Gangetic delta, Lateritic zones in southern districts are creating the diversity.

Materials and methods

The present study is based on secondary data sources. State and district wise data regarding the confirmed case of COVID-19 and test records from 30th January to 8th October 2020, have been collected from publicly available portal of "covid19India.org" and the Department of Health and Family Welfare, Govt of West Bengal. The data are validated by a group of volunteers. It was an online survey which was conducted using Google Forms with link sent using WhatsApp. A 38-item self-designed questionnaire was used for the study. The survey questionnaire would take around 5–7 min to complete. Total 507 responses were received by the stipulated time (Table 1 and Figure 1).

Table 1: District wise intensity (Per Sq.km) of Covid-19 effected cases

District	Population Density (per Sq.km)	Confirmed Case	Covid-19 Intensity (Per Sq.km)
Alipurduar	400	5193	13
Bankura	523	6023	12
Birbhum	771	4430	6
Cooch Behar	833	6500	8
Dakshin Dinajpur	753	5759	8
Darjeeling	859	8634	10
Hooghly	1,753	14110	8
Howrah	3,306	19881	6
Jalpaiguri	621	6714	11
Jhargram	374	1002	3
Kalimpong	239	1091	5
Kolkata	24,252	62131	3
Malda	1,071	7465	7
Murshidabad	1,334	6646	5
Nadia	1,316	8336	6
North 24 Parganas	2,463	57081	23
Paschim Bardhaman	1,100	7822	7
Paschim Medinipur	636	10691	17
Purba Bardhaman	890	5582	6
Purba Medinipur	1,076	11871	11
Purulia	468	3947	8
South 24 Parganas	819	19083	23
Uttar Dinajpur	956	3972	4

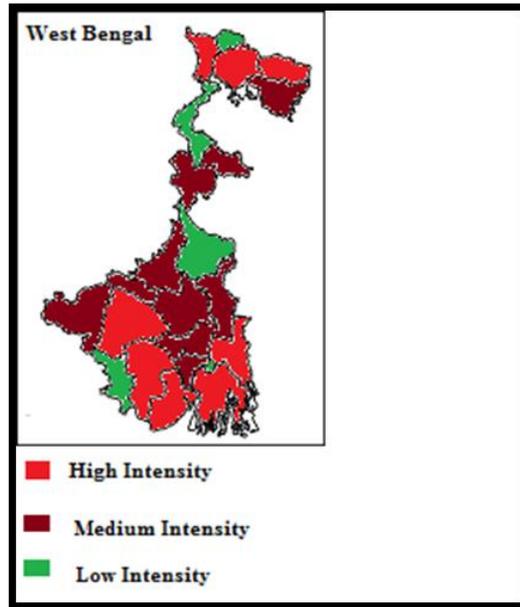


Fig 1: Spatial Intensity of Covid-19 in West Bengal

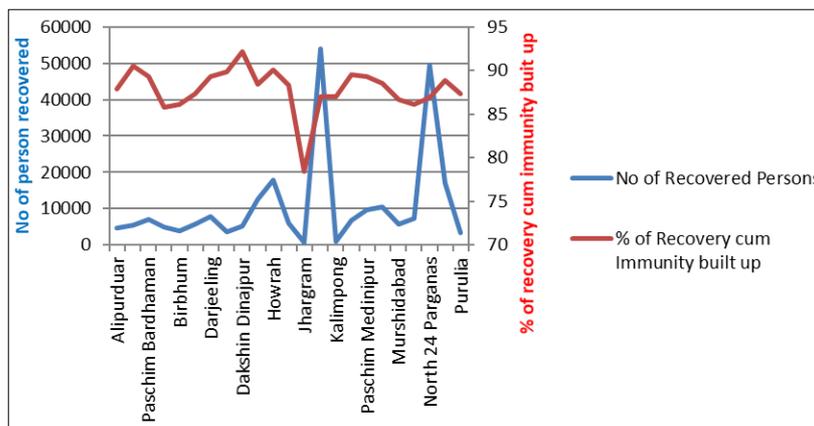


Fig 2: District wise % of recovery trend

Due to lack of medical facility and lack of people awareness in Jhargram districts, recovery rate are not improved (Figure 2). Though the rate of spreading of corona virus in urban area like Kolkata, and nearby Howrah districts, are quiet alarming, but good and highly accessible medical facility provide a great support to mitigate the situation. Census of India's report has been used to obtain the state wise population of 2020. COVID-19 test centres locational information has been gathered from the Indian Council of

Medical Research (ICMR) official bulletin (June 30, 2020). National Health Profile - 2019 report has been used to obtain the state wise hospital bed, per capita health expenditure, poverty ratio and aged population (above 60 years). Slum household information has been gathered from Census of India (2011) slum house section. Several newspaper reports have also been used to interpret the problem in different Districts in West Bengal.

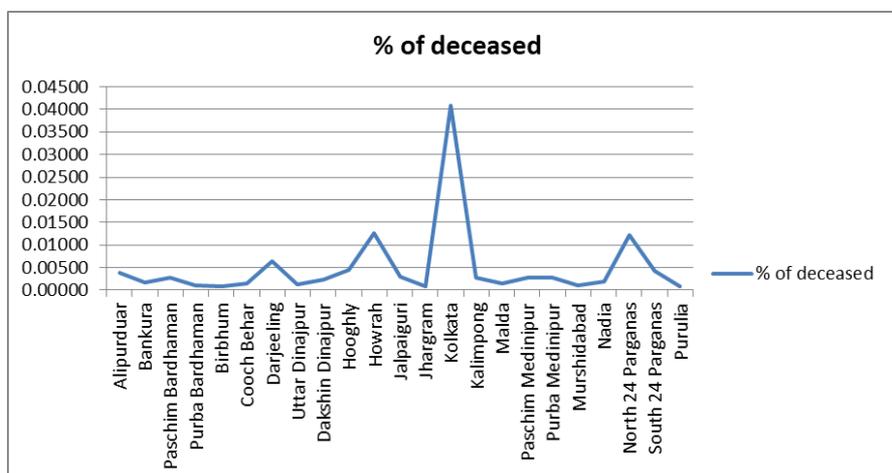


Fig 3: District wise deceased rate (%) in West Bengal

Table 2: One way ANOVA to find out the inter dependency between population density and death due to Covid-19

ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	38282858.27	1	38282858	3.045399	0.08828	4.072654
Within Groups	527970211.4	42	12570719			
Total	566253069.6	43				

Deceased rates in Kolkata and their adjoining districts like south 24 Pargonas, North 24 Pargonas, Howrah, Hooghly are high in comparison to other districts (Figure 3). Better standard of living, lack of physical activity might be the causal factors of this decrement in normal resistance towards various pathogens.

On the other hand, agriculture-based districts have a large no of hard workers who are commonly involved in various laborious jobs in agricultural fields, in households as maid so on and so forth. So comparatively, a better immunity has been observed to evolve in them.

One way ANOVA reveals that there are no significant differences in between two variables i.e. between population density and death due to Covid-19 (Table 2). That means the population density and death rate vary at different rates. Normally, it is found in most of the cases that higher the population density causes higher the deaths. Districts with medium density and low density are commonly found to have medium to low death rates.

Discussion

COVID-19 positive case growth rate in different Districts and Union territories are calculated based on the confirmed cases of present day and earlier. The median values of the growth rate of all phases of lockdown have been identified. Locations of COVID-19 test laboratories are mapped, and 100 km of buffer zones of each laboratory are identified to analyse the accessibility of testing laboratories in different parts of West Bengal. Areas, which are not covered by 100 km buffer zone is marked with yellow colour to identify the inaccessible zone or the zone of very hard to access the nearest test centres. COVID-19 test ratio (test per 1000 per persons) has been estimated by considering the state wise total number of samples tested till 8th October 2020 and projected population of 2020. COVID-19 case in West Bengal shows a rapid increasing trend with exponential growth in every four to seven days in major affected Districts during the 2nd phase of lockdown. Daily COVID-19 data of all the Districts in West Bengal portray huge disparity in number of cases as well as in growth rate. Median value of growth rate at national level is found 13.74, 6.88, 5.58 and 4.88 during first, second, third and fourth phases of lockdown, respectively. With the increasing number of corona virus cases during the last three months creates a fast and massive demand for health care infrastructures. Hospitals in major corona affected Districts of West Bengal have been overturned with corona virus patients, and the acute shortage of medical equipment is the biggest problem. To understand the actual scenario of corona virus and to know whether the current interventions are adequate or falling short, appropriate data of various administrative units all over the country in temporal basis is required.

Slum area is characterised by high population density and shared access to basic amenities which makes them extremely vulnerable for spreading of the corona virus. The urban population density is conducive to the clustering

effect of virus transmission (Zhu *et al.*, 2020) [26]. Census data 2011 shows that a significant number of populations live in slum area of Kolkata and adjacent few districts. There is a great inter-state variation in preparedness to fight with the pandemic and most of the Districts have very poor healthcare infrastructures with lesser no. of hospital beds and ventilators. The inter-state variation is extremely prominent in case of availability of hospital beds and calculated case-bed ratio is acutely disproportionate across West Bengal districts. Maharashtra experiences out number of COVID-19 positive cases in respect of state's availability of hospital beds.

Conclusion

The first case of COVID-19 was reported on January 20, 2020 and spreading pace was not uniform throughout the county. Presently in West Bengal, the intensity of severity and casualty are increasing daily in a steady rate and yet to reach at the peak. The Government of West Bengal has already issued strict interventions to build resilience for tackling COVID-19 crisis. But there is a sharp disparity among the districts in the ground of hospital beds, ICU units, testing laboratories, ventilators, isolation wards, quarantine arrangements, health expenditure etc. (Ghosh *et al.*, 2020 and Singh, 2020) [12, 13, 21]. The existing remedial measures are insufficient in several districts according to their present demographic status, socio-economic structure, day-wise increasing trend of positive cases and rate of fatality. Daily growth rate of confirmed case in different districts depicts that there is a vibrant contrast among the districts in West Bengal. Thus, it is extremely hard to project the probable scenario of corona virus case in different districts with fixing a same model in all districts. In this context, the Government should adopt priority-basis essential actions based on the continuous monitoring of the severity of outbreak hotspots located in different districts. Close monitoring and continuous evolution are needed to provide actionable information to the vulnerable populations (Heymann *et al.*, 2020) [7]. Community-dependent disaster managing system and preparation (Allen, 2006) [3] is significant to diminish the resultant fatalities and damages (Djalante *et al.*, 2020) [8, 9]. Although, the present study identifies the outbreak hotspots at district, scaling up of hotspot area identification to village or municipality (local administrative unit) may help to better monitoring system. Most emphasis should be given to enhance the testing activities of the suspected people and enforce them to stay isolated. A strategy of community quarantine could be helpful to prevent the people being exposed to the virus (Zhu *et al.*, 2020) [26]. The accurate and updated information of every district across the state and country may be circulated to prevent the spreading of corona virus contagion and to build resilience against this disease. So, the development of proportionate resilience system in every part of West Bengal is a mostly crucial issue, which may support to achieve speedy and sustainable retrieval from the menace of COVID-19 in our state and country.

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