A Data Driven Analysis on Growth Factor Of COVID-19 and Its Correlation with Malaria Cases in India

A. P. Sharma, M. Gahlot, S. Deka, R. Kumar

Abstract — Introduction: COVID-19 coronavirus originated from Wuhan, China, had spread to more than 200 countries worldwide up to 3rd May 2020 [1]. The cumulative number of confirmed cases was 84393 in China and 3264847 totals in other countries [1]. All countries have taken measures to contain the outbreak of COVID-19. In India, till March about 15, 24, 266 passengers had been screened at the airports and 12,431 at the seaports [2]. Till 3rd May 2020 total 42533 confirmed COVID 2019 cases had been registered across India [2].

Aim: In this study, we analysed the data collected from different available official websites which reported the situation of COVID-19 infection in India to assess the growth of COVID-19 cases in India and to assess the relationship between Malaria cases and corresponding COVID-19 cases.

Method: A confirmed case of COVID-19 infection was defined as a case with a positive corona test report. Suspected cases were defined as a case with symptoms of COVID-19 infection but not confirmed. Growth factor of more than 1 shows the increasing number of cases, while growth factor between 0 to 1 shows a decline in the number of cases.

Results: The average growth factor from 21 January 2020 to 3rd May 2020 was 1.13 and before the first lockdown and after the first lockdown it was measured 1.10 & 1.18, respectively. On 5th March 2020, the growth factor was highest (Growth factor = 22). Growth factor and number of new cases coming were significantly positive correlated ($r = 0.39$, $p = 0.035$).

Conclusion: The future daily incidence size largely dependent on the change of new upcoming cases day by day. Our findings indicate that the social distancing and regulation measures are working, and COVID-19 spread in India can significantly lessen if these defensive actions continue to be implemented in a fitting way. The study also shows a positive correlation between malaria cases and COVID-19 cases.

Index Term—Observational Study, Growth factor, Retrospective.

I. INTRODUCTION

People often refer to the virus causing disease COVID-19 as “the coronavirus”, Corona is a Latin form of “crown” due to its surface, which looks like a crown. In recent history SARS (2003) and MERS (2012) caused by coronaviruses.[1] In humans, 30% common cold appears due to coronaviruses.[16] The outbreak of corona virus (COVID-19) was at first appeared in the city of Wuhan of Hubei province, China. On December 29, 2019, a conglomeration of same symptomatic cases of pneumonia appeared in Wuhan city, soon these cases were declared to

be caused by novel corona virus which was eventually named SARS-CoV-2.2 or COVID-19. Today the virus is known as “Severe Acute Respiratory Syndrome Coronavirus 2” or SARS-CoV-2. These names were proposed by the World Health Organization and the International Committee on Taxonomy of Viruses [1]. Thailand was the first nation outside of China where the first instances of COVID-19 showed up on January 13, 2020, and then in Japan on January 16, 2020. The virus has now spread across the globe.

The most common indications of COVID-19 are fever, cough, and shortness of breath which may appear after exposure to the virus in 2 to 14 days [13]. These symptoms are usually mild and appear gradually. Some people become infected but do not develop any symptoms and do not feel unwell either. Most people (about 80%) recover from the disease without needing special treatment. Around 1 out of every 5 people who gets COVID-19 becomes seriously ill and develops difficulty breathing. Older people, and those with underlying medical problems like high blood pressure, heart problems, or diabetes, are more likely to develop serious illness. People of any age who experience fever, cough, and difficulty breathing should seek for clinical attention immediately [2]. Coronaviruses are zoonotic, which means they are transmitted among animals and humans [1]. Coronavirus are a huge group of viruses with some causing less severe illness, like common cold, and other more severe ailment such as MERS and SARS. Some transmitted easily from human to human, while others do not [12]. *This new coronavirus spreads human to human* [13]. The disease spreads basically from individual to individual through beads release from the nose or mouth when an individual with COVID-19 hacks or wheezes. Individuals can get COVID-19 by contacting with infected person or by touching objects or surfaces where these droplets land on, and then touching their eyes, nose, or mouth. Therefore, it is important to stay more than 1 meter (3 feet) away from a person who is sick [2]. All countries have taken measures to contain the outbreak of COVID-19. In the absence of a vaccine, reducing contact rates in population has emerged as the most widely adopted strategy for its mitigation and control [18]. The suppression of social contact in workplaces, schools and other public spheres is the target of such measures. India's population as on 1 March 2020 stood at 1,380,004,385 (623.7 million males and 586.4 million females) [11]. In India, till March about 15, 24, 266 passengers had been screened at the airports and 12,431 at the seaports [2]. Passengers were further monitored daily under community surveillance through IDSP (Integrated Disease Surveillance Programme) network. India had reported the first confirmed case of the coronavirus infection on 30 January 2020 in the state of Kerala. The affected had a travel history from Wuhan,

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China. Till 3rd May 2020 total 42533 confirmed cases of COVID-19 had been registered across India [2].

India and China, both are densely populated countries and share geographic borders which means that spread both to and from is extremely easy. Both countries have close-knitted communities which make social distancing a challenge. There, however, is a difference in the population distribution (Figure 1), India has a high younger population compared to China which gives India a slight advantage on the severity of COVID-19.

China
2020
Population: 1,439,323,774

India
2020
Population: 1,380,004,385

Fig. 1. Population pyramids by age and gender of India and China.

TABLE 1: POPULATION DENSITY TABLE OF THE COUNTRIES WITH POPULATION AT PRESENT

Country	Population density (person/Km ²)	Population (2020)
India	419.8	1380004385
China	6787	1439323774

The COVID-19 outbreak is a remarkable global public health challenge. In order for the governments, organisations in the country and individuals to respond to it in an effective manner, it would be crucial that they have easy access to good clear data and a good understanding of what can and cannot be said based on the available data.

In this paper we present the analysis of COVID-19 in India and try to find correlation between numbers of COVID-19 with malaria cases in the state/UT data of India.

Map 1. Global COVID-19 Situation map.

II. OBJECTIVE

A. General Objective

To Assess the growth factor of COVID-19 in India.

B. Specific Objective

Calculate the growth factor of COVID-19 in India.

Assess the relationship between Malaria cases and corresponding COVID-19 cases.

III. METHODOLOGY

Confirmed case of COVID-19 infection was defined as cases with a positive result. Suspected cases were defined as a case with symptoms of COVID-19 infection but not confirmed. Data source, all the data were collected from the official website that reported the situation of COVID-19 infection in India [1], [2]. *The growth factor has been defined as the factor by which a quantity multiplies itself over time.* The formula used every day's new cases / new cases on the previous day. A growth factor above 1 indicates an increase, whereas one which remains between 0 and 1 is a sign of decline, with the quantity eventually becoming zero, whereas a growth factor constantly above 1 could signal exponential growth. The growth rate we defined as percentage growth in cases. The formula for percentage growth change used (Today's Cases-Previous day cases)/Previous day cases *100 and for percentage growth rate used growth change (%)/duration. For mortality rate per 1000, we used (number of deaths in duration/number of cases) *1000.

A. Study design

Observational Study, Retrospective.

B. Study Area

India.

C. Duration

All the confirmed COVID-19 cases from 21 January 2020 to 03 May 2020.

D. Data Collection

Data collected from all the published evidence by the Government of India, the World Health Organisation, and the European Centre for Disease Prevention and Control from the official website related to COVID-19.

E. Statistical Analysis

All outcomes were presented using descriptive statistics. Continuous data were expressed as mean and SD. Categorical data as numbers and percentages. The comparison of mean differences of data was analysed by Mann-Whitney U-test / T-test and categorical variables by Chi-square test.

To estimate the relationships between a dependent variable and one or more independent variables, we used regression analysis, and to see the linear relationship between variables, we used Pearson's correlation coefficient to assess the linear relationship. P-Value equal to or less than 0.05 was considered as statistically significant.

All statistical analyses were performed using R-statistical tool version 3.5.3 and Microsoft excel.

IV. RESULTS

Based on the published evidence we have performed a data-driven analysis primarily on the Indian population as follows:

A. Spreading & Growth

India is the second-largest country in terms of population [19]. In India, the first case of COVID-19 appeared on 30th February 2020 [2]. Till 3rd May 2020, the global situation report indicates 1.91% of global cases reported from south-east Asia, and least number of cases appeared in Africa (0.87%) while the European region had the highest number of cases (45.34%) globally. Till 6th April 2020 total 40023 cases appeared in India [2] and the average growth factor of India was 1.13 since it was greater than 1 which indicates that COVID-19 cases in India are increasing.

TABLE 2. SPREADING OF CORONAVIRUS AROUND THE GLOBE AND IN INDIA
TABLE 2A: GLOBAL SPREAD OF CORONA VIRUS

COVID-19 Situation	Total Cases	New Cases	Deaths	Cases (%)
Globally	3349786	82763	238628	100
Western Pacific	151444	1041	6229	4.52
European	1518895	27032	142667	45.34
South-East Asia	64047	3557	2375	1.91
Eastern Mediterranean	200609	5618	7871	5.98
America	1384641	44050	78409	41.33
Africa	29438	1465	1064	0.87

TABLE 2B: CORONA CASES IN INDIA

Month	Cases	Deaths	Case (%)	Death (%)
January (21/01/2020)	1	0	0.02	0.00
February	2	0	0.05	0.00
March	1291	32	3.23	2.46
April	31799	1042	79.45	80.09
May (03/05/2020)	6930	227	17.32	17.45

B. Growth Factor

In the absence of a vaccine, social distancing had emerged as the most widely adopted strategy for the mitigation and control of COVID-19 spread, therefore Government of India took the decision to declare nationwide lockdown. On the 22nd March 2020, first lockdown in India came into effect for 21 days. As the end of the first lockdown, period approached, on 14th April 2020 the nationwide lockdown was extended till 3rd May 2020. In the lockdown period, a drop in the average growth factor was observed as compared to the period before the lockdown (Table 3A). While the growth factor was greater than 1 depicting that the number of cases was growing, the speed of growth had slowed down, the same pattern was observed in average growth rate too.

TABLE 3A: OUTCOMES BEFORE AND AFTER LOCKDOWN

Effect of Lockdown	Before lockdown (21 Jan - 22 March)	Lockdown phase 1 (23 March - 14 April)	Lockdown phase 2 (15 April - 3 May)
Number of cases	363*	10043*	29617*
Avg. Growth Factor	1.29	1.28	1.06
Mortality	4	335	962
Mortality Rate (per 1000)	11.02	33.35	32.48

*Data were taken till 3rd May 2020 from WHO, European Center for Disease Prevention and Control (ECDC), Ministry of health and family welfare, Govt. of India.

TABLE 3B: DISTRIBUTION OF AVERAGE GROWTH FACTOR & MORTALITY

Month	Cases	Avg. Growth Factor	Mortality Rate (per 1000)
January (21/01/2020)	1	0.00	0
February	2	0.00	0
March	1291	2.51	24.78
April	31799	1.18	32.76
May (03/05/2020)	6930	1.15	32.75

According to the data published by the European Center for Disease Prevention and Control (ECDC) [20], the number of total confirmed deaths globally took 20 days to get multiplied. But, in India, it took 11 days to get doubled. The average growth factor of death was 1.07 (1st death on 13th March 2020), which was greater than 1 and indicated that the number of deaths was increasing.

TABLE 4: EFFECT OF LOCKDOWN ON GROWTH FACTOR

Growth factor in Lockdown	Mean	SD
Before lockdown (21 Jan - 22 March)	1.29	3.84
Lockdown phase 1 (23 March - 14 April)	1.28	0.76
Lockdown phase 2 (15 April - 3 May)	1.06	0.18

* Growth factor calculated since the 1st case registered in India.

As shown in Table 4, the growth factor reduced after the lockdown. Comparing the growth factor before lockdown and after lockdown, was statistically significant ($p < 0.001$), as our hypothesis was the growth factor between before lockdown and after lockdown was the same.

TABLE 5: GROWTH FACTOR COMPARISON BEFORE AND AFTER LOCK-DOWN

Comparison	Min	Max	Mean	SD	p-value
Before lockdown	0.00	22.00	1.29	3.84	$P < 0.001$
After lockdown	0.45	3.89	1.18	0.58

Graph 1. State-wise COVID-19 situation till 3rd May 2020.

As from the above graph, we can see the highest number of cases as well as mortality, registered in Maharashtra followed by Gujarat.

C. Comparison between Malaria cases & COVID-19 cases in India:

In 2018, an estimated 228 million cases of malaria occurred worldwide. Most malaria cases in 2018 were in the World Health Organization (WHO) African Region (213 million or 93%), followed by the WHO South-East Asia Region with 3.4% of the cases and the WHO Eastern Mediterranean Region with 2.1%. The WHO said that the number of deaths from malaria in Sub-Saharan Africa could be doubled this year, and COVID-19 may be the reason for increasing numbers [1]. Malaria is a public health problem in India. There is a similarity in symptoms of COVID-19 and malaria. "The early symptoms of COVID-19, including fever, myalgia, and fatigue, might be confused with malaria and lead to challenges in early clinical diagnosis. The peak season for malaria starts from May and a spike is seen after the monsoon, in July and August. Most malaria cases were reported from the eastern and central part of the country and from states which have the forest, hilly and tribal areas. These states include Odisha, Chhattisgarh, Jharkhand, Madhya Pradesh, Maharashtra, and some north-eastern states like Tripura, Meghalaya, and Mizoram [2]. The current situation with COVID-19, however, poses a threat to India's progress in reducing malaria cases.

TABLE 6A: COMPARISON OF MALARIA AND COVID-19 CASES

Malaria Vs. COVID	Mean	SD	r	P-value
Log COVID	2.26	1.14	0.39	0.035
Log Malaria	3.18	1.07		

*r: Correlation coefficient

TABLE 6B: COMPARISON OF MALARIA AND COVID-19 CASES WITH PER-CENTAGE

State/UT	Malaria 2019	Malaria (%)	COVID (3rd May)	COVID (%)
A.N. Islands	201	0.06	33	0.08
Andhra Pradesh	3104	0.93	1583	3.72
Arunachal Pradesh	160	0.05	1	0.00
Assam	1459	0.44	43	0.10
Bihar	1441	0.43	503	1.18
Chandigarh	5	0.00	94	0.22
Chhattisgarh	60575	18.10	57	0.13
D & N Haveli	55	0.02	0	0.00
Daman & Diu	8	0.00	0	0.00
Delhi	713	0.21	4549	10.70
Goa	272	0.08	7	0.02
Gujarat	13431	4.01	5428	12.76
Haryana	967	0.29	442	1.04
Himachal Pradesh	109	0.03	40	0.09
Jammu & Kashmir	105	0.03	701	1.65
Jharkhand	36552	10.92	115	0.27
Karnataka	3333	1.00	614	1.44
Kerala	655	0.20	500	1.18
Ladakh	0	0.00	41	0.10
Lakshadweep	11	0.00	0	0.00
Madhya Pradesh	13757	4.11	2846	6.69
Maharashtra	8866	2.65	12974	30.50
Manipur	15	0.00	2	0.00
Meghalaya	2615	0.78	12	0.03
Mizoram	8277	2.47	1	0.00
Nagaland	19	0.01	0	0.00
Orissa	39557	11.82	162	0.38
Puducherry	23	0.01	8	0.02
Punjab	1143	0.34	1102	2.59
Rajasthan	2060	0.62	2886	6.79
Sikkim	6	0.00	0	0.00
Tamil Nadu	2088	0.62	3023	7.11
Telangana	1711	0.51	1082	2.54
Tripura	12437	3.72	16	0.04
Uttar Pradesh	92732	27.71	2645	6.22
Uttarakhand	303	0.09	60	0.14
West Bengal	25928	7.75	963	2.26
Total	334693	100.00	42533	100.00

Due to high dispersion in the numbers of COVID-19 and Malaria cases, we took log (numbers) of both variables as a result which shows that there is a significantly positive correlation between malaria cases and COVID-19 cases.

V. CONCLUSION

India was doing better in comparison to several other nations and the growth factor of Coronavirus cases had declined 40 percent in India. The doubling rate of positive cases was down to 6.2 days, compared to 3 before the

nationwide lockdown that began on March 25. It had been witnessing an average growth factor at 1.2 since April 1 which stood at 2.1 between March 15 and March 13. Nineteen States/UTs (Kerala, Uttarakhand, Haryana, Ladakh, Himachal, Chandigarh, Puducherry, Bihar, Odisha, Telangana, Tamil Nadu, Andhra Pradesh, Delhi, UP, Karnataka, J&K, Punjab, Assam, Tripura) had shown a lower rate of increase of cases to some extent. This study indicates that the social distancing and regulation measures were working and capability of COVID-19 to spread in India can diminish if these defensive estimates will act in a fitting way.

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