Case Study of COVID-19 and its Statistical Analysis

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***Abstract*—There 2020 novel-coronavirus (COVID-19) has affected 181 countries with approximately 1197405 confirmed cases. Understanding the transmission dynamics of the infection in Karnataka which got affected on a daily basis and evaluating the effectiveness of control policies are critical for our further actions. To date, the statistics of COVID-19 reported cases show that more than 80% of infected are mild cases of disease, around 14% of infected have severe complications, and about 5% are categorized as critical disease victims. Calculating the total case fatality rate (CFR) of Karnataka, about 23.3% of confirmed cases have passed away. The CFR of Karnataka is too high. Some effective policies that yielded significant changes in the trend of cases were the lockdown policy in Karnataka and shutdown of all nonessential companies, the effect was observed after some days**.

***Index Terms*— Coronavirus, Karnataka, Statistics, CRF.**

I. INTRODUCTION

Human coronaviruses (HCoV) which cause gastrointestinal and respiratory tract infections were first introduced by the discovery of HCoV-229E and HCoV-OC43, from the nasal cavities of human patients with the common cold, in the 1960s. Other discovered human coronaviruses, which have caused serious respiratory tract infections, include SARS-CoV (in 2003), HCoV NL63 (in 2004), HKU1 (in 2005), MERS-CoV (in 2012), and the latest one SARS-CoV-2 (in 2019) resulting in coronavirus disease (COVID-19). The name originates from the morphology of the virus when viewed under 2D transmission electron microscopy and stems from the Latin word "corona," meaning "crown." 5 Concerning the risk factor, HCoVs vary significantly from the relatively harmless ones (ie, the common cold) to the most lethal ones (MERS-CoV, with more than 30% mortality rate in the infected). 6 CoVs spread during cold seasons and cause colds with major symptoms, that is, fever, sore throat, and less commonly pneumonia and bronchitis for the more aggressive strains. To date, there are no vaccines or antiviral drugs capable of preventing or treating HCoV infection

To date, several outbreaks of coronavirus-related diseases have been reported. Severe acute respiratory syndrome (SARS) was the first coronavirus-related outbreak that started in Guangdong, China, in November 2002, and spread to a total of 29 territories, including Hong Kong, Taiwan, Canada, Singapore, Vietnam, and the United States, within 9 months. It infected a total of 8098 people and killed 774 worldwide. 9 The second coronavirus-related outbreak happened in the Middle East in April 2012, officially named Middle East respiratory syndrome (MERS). This virus was first identified in a patient from Saudi Arabia, and later, MERS affected several other countries, including Saudi Arabia, South Korea, the United Arab Emirates, Jordan, Qatar, and Oman. Overall, the virus affected 24 outbreaks of MERS happened again in South Korea, supposedly from a traveler from the Middle East. It happened during May and July 2015 and infected a total of 186 individuals, with a death toll of 36. 11 After 3 years in August 2018, the next MERS outbreak happened in countries of the Arabian Peninsula and resulted in almost 147 infected people and the death of 47. The MERS outbreak had been reported in Saudi Arabia, the United Kingdom, and South Korea.

In December 2019, a pneumonia outbreak was reported in Wuhan, China, and on 31st December, it was attributed to a new strain of HCoV, first named as 2019-nCoV by the World Health Organization (WHO) and later renamed to SARS-CoV-2 by the International Committee on Taxonomy of Viruses. Almost 2 weeks later, on 11th January 2020, Chinese state media reported the first fatality from the newly discovered virus, which led to the infection of dozens more. Until 20th January, multiple countries reported their first cases, including Japan, South Korea, and Thailand. The first confirmed case in the United States came the very next day in the Washington State. As the spread continued, coronavirus presence was confirmed throughout the month of February in the Philippines (2nd February), France (14th February), Iran (21st February), and as reports started in Italy on 23rd February; many more European countries followed the suit, reporting their first confirmed cases. To date, the coronavirus has affected 181 countries with more than 1100000 confirmed cases and around 65000 people have lost their lives. With the United States, Spain, Italy, and Germany experiencing the worst cases of outbreaks and showing no sign of alleviation, the 2019-2020 outbreak of COVID-19 is now officially recognized as a pandemic by WHO. An outbreak or epidemic often refers to a sudden increase in the occurrence of infectious disease, in a particular time and place. Pandemics are near-global epidemic outbreaks, where multiple countries across the world are involved

The aim of this study is to provide the transmission trend in Karnataka and to report the daily confirmed cases, fatality causes, and surveillance from the first day of the outbreak and, also, to evaluate the effect of each government policy in controlling the outbreak of COVID-19.

II. METHODOLOGY

A. Basic statistics:

A COVID-19 has currently spread to 181 countries and most national authorities have failed to keep its rapid spread contained. WHO reports that it began in Wuhan city, located in Hubei province of China, first reported on 21st January. COVID-19 categorizes in three distinctions concerning it is infected host's severity of disease

Till date, the statistics of its reported cases show more than 80% of infected had a mild case of disease, whereas around 14% of infected experienced a severe one, suffering from breathlessness and pneumonia. And about 5% are categorized as critical disease patients, their symptoms include septic shock, respiratory failure, and the failure of more than one organ.

Reports on 5th April 2020 show that the United States, Italy, and China have the most confirmed fatal and also recovered cases. The order of confirmed cases in Karnataka Confirmed death cases caused by COVID-19 are also observed. About 24% of death cases, 26% of confirmed cases, and 32% of recovered cases located in Karnataka. The overall statistics since state that there are 2921049 confirmed, 36848 deaths, and 2861499 recovered cases.

Table 1: Number of cases, death and recovered data

Sl.No	Date	Cases	Total Case	Recovered	Total Recove	Death	Total Death
1	09-03-2020	1	1	0	0	0	0
2	10-03-2020	3	4	0	0	0	0
3	11-03-2020	0	4	0	0	0	0
4	12-03-2020	0	4	0	0	0	0
5	13-03-2020	2	6	0	0	1	1
6	14-03-2020	0	6	0	0	0	1
7	15-03-2020	0	6	0	0	0	1
8	16-03-2020	0	6	0	0	0	1
9	17-03-2020	5	11	0	0	0	1
10	18-03-2020	0	11	0	0	0	1
11	19-03-2020	3	14	0	0	0	1
12	20-03-2020	1	15	1	1	0	1
13	21-03-2020	0	15	0	1	0	1
14	22-03-2020	11	26	1	2	0	1
15	23-03-2020	7	33	0	2	0	1
16	24-03-2020	4	37	1	3	0	1
17	25-03-2020	4	41	0	3	0	1
18	26-03-2020	14	55	0	3	1	2
19	27-03-2020	0	55	0	3	0	2
20	28-03-2020	0	55	0	3	0	2
21	29-03-2020	21	76	2	5	1	3
22	30-03-2020	7	83	0	5	0	3
23	31-03-2020	0	83	0	5	0	3
24	01-04-2020	18	101	3	8	0	3
25	02-04-2020	9	110	1	9	0	3
26	03-04-2020	14	124	1	10	0	3
27	04-04-2020	4	128	2	12	0	3
28	05-04-2020	16	144	0	12	1	4
29	06-04-2020	7	151	0	12	0	4
30	07-04-2020	24	175	13	25	0	4
31	08-04-2020	0	175	0	25	0	4
32	09-04-2020	6	181	3	28	1	5
33	10-04-2020	16	197	2	30	1	6
34	11-04-2020	17	214	7	37	0	6
35	12-04-2020	12	226	0	37	0	6
36	13-04-2020	21	247	22	59	0	6
37	14-04-2020	11	258	6	65	3	9
38	15-04-2020	19	277	10	75	2	11
39	16-04-2020	38	315	7	82	2	13
40	17-04-2020	38	353	0	82	0	13
300	02-01-2021	877	920373	1084	897200	6	12096
301	03-01-2021	755	921128	976	898176	3	12099
302	04-01-2021	810	921938	743	898919	8	12107
303	05-01-2021	600	922538	1283	900202	3	12110
304	06-01-2021	815	923353	1377	901579	8	12118
305	07-01-2021	784	924137	1238	902817	6	12124
306	08-01-2021	761	924898	812	903629	7	12131
307	09-01-2021	970	925868	657	904286	3	12134
308	10-01-2021	899	926767	872	905158	4	12138
309	11-01-2021	792	927559	593	905751	2	12140
310	12-01-2021	496	928055	797	906548	4	12144
311	13-01-2021	751	928806	1181	907729	5	12149
312	14-01-2021	746	929552	765	908494	3	12152
313	15-01-2021	408	929960	564	909058	3	12155
314	16-01-2021	708	930668	643	909701	3	12158
315	17-01-2021	584	931252	676	910377	4	12162
316	18-01-2021	745	931997	855	911232	4	12166
317	19-01-2021	435	932432	973	912205	9	12175
318	20-01-2021	645	933077	807	913012	6	12181
319	21-01-2021	501	933578	665	913677	4	12185
320	22-01-2021	674	934252	815	914492	2	12187
321	23-01-2021	324	934576	890	915382	3	12190
322	24-01-2021	902	935478	542	915924	3	12193
323	25-01-2021	573	936051	401	916325	4	12197
324	26-01-2021	375	936426	1036	917361	3	12200
325	27-01-2021	529	936955	738	918099	4	12204
326	28-01-2021	428	937383	760	918859	3	12207
327	29-01-2021	550	937933	644	919503	2	12209
328	30-01-2021	468	938401	607	920110	2	12211
329	31-01-2021	464	938865	547	920657	2	12213
330	01-02-2021	522	939387	465	921122	4	12217
331	02-02-2021	388	939775	470	921592	3	12220
332	03-02-2021	395	940170	412	922004	3	12223
333	04-02-2021	426	940596	433	922437	2	12225
334	05-02-2021	474	941070	470	922907	2	12227
335	06-02-2021	430	941500	470	923377	3	12230
336	07-02-2021	531	942031	434	923811	3	12233
337	08-02-2021	487	942518	493	924304	3	12236
338	09-02-2021	328	942846	350	924654	3	12239
339	10-02-2021	366	943212	513	925167	2	12241
340	11-02-2021	415	943627	322	925489	3	12244

160	15-08-2020	7908	211108	6940	128182	104	3717
161	16-08-2020	8818	219926	6629	134811	114	3831
162	17-08-2020	7040	226966	6680	141491	116	3947
163	18-08-2020	6317	233283	7071	148562	115	4062
164	19-08-2020	7665	240948	8387	156949	139	4201
165	20-08-2020	8642	249590	7201	164150	126	4327
166	21-08-2020	7385	256975	6231	170381	102	4429
167	22-08-2020	7571	264546	6561	176942	93	4522
168	23-08-2020	7330	271876	7626	184568	93	4615
169	24-08-2020	5938	277814	4996	189564	68	4683
170	25-08-2020	5851	283665	8061	197625	127	4810
171	26-08-2020	8161	291826	6814	204439	148	4958
172	27-08-2020	8580	300406	7249	211688	133	5091
173	28-08-2020	9386	309792	7866	219554	141	5232
174	29-08-2020	8960	318752	7464	227018	136	5368
175	30-08-2020	8324	327076	8110	235128	115	5483
176	31-08-2020	8852	335928	7101	242229	106	5589
177	01-09-2020	6495	342423	7238	249467	113	5702
178	02-09-2020	9058	351481	5159	254626	135	5837
179	03-09-2020	9860	361341	6287	260913	113	5950
180	04-09-2020	8865	370206	7122	268035	104	6054
181	05-09-2020	9280	379486	6161	274196	116	6170
182	06-09-2020	9746	389232	9102	283298	128	6298
183	07-09-2020	9319	398551	9575	292873	95	6393
184	08-09-2020	5773	404324	7897	300770	141	6534
185	09-09-2020	7866	412190	7803	308573	146	6680
186	10-09-2020	9540	421730	6860	315433	128	6808
187	11-09-2020	9217	430947	7021	322454	129	6937
188	12-09-2020	9464	440411	12545	334999	130	7067
189	13-09-2020	9140	449551	9557	344556	94	7161
190	14-09-2020	9894	459445	8402	352958	104	7265
191	15-09-2020	8244	467689	8865	361823	119	7384
192	16-09-2020	7576	475265	7406	369229	97	7481
193	17-09-2020	9725	484990	6580	375809	55	7536
194	18-09-2020	9366	494356	7268	383077	93	7629
195	19-09-2020	8626	502982	10949	394026	179	7808
196	20-09-2020	8364	511346	10815	404841	114	7922
197	21-09-2020	8191	519537	8611	413452	101	8023
198	22-09-2020	7339	526876	9925	423377	122	8145
199	23-09-2020	6974	533850	9073	432450	83	8228
200	24-09-2020	6997	540847	5460	437910	38	8266

B.Finding linear relations:

There is not much known at the moment about COVID-19, so there is a small amount of data about its comprehensive effects and behaviors. In this study, relations are assumed to be linear, when, initially the drawn plot shows obvious linear relations, and later, the fitted linear regression line shows a small enough error to preserve the values given and the linear regression results can be interpreted with relative ease. Besides, fitting regression lines with higher order causes overfitting, resulting from the amount of data. There is no evidence yet about the relationship of other conditions with the outbreak and its case fatality rate (CFR), so by using linear regression line, policies and behaviors can be compared. In the prediction cases, by using linear regression, we can compare future trends of countries in earlier stages, with the ones in later stages. By considering the above-mentioned statements, we will find the best linear relation between arrays of data. In some cases, the linear relation can be observed but it may exhibit linear relation with some date shift of others (ie, death cases should have a linear relation with earlier values of confirmed cases, given the fact that it should take time from confirmation to death).

CFR could be calculated by the following formula:

$$\mathrm{CFR} = \frac{D_{\mathrm{eath}}(T)}{C_{\mathrm{onfirmed}}(T - dt)}, \tag{1}$$

In Eq. 1, D eath and C onfirmed functions calculate the value of death cases and confirmed cases at that date, T is the date we want to inspect the CFR, and dt is the mean duration of confirmed to death

I.RESULT

Karnataka a state in India is reported to COVID-19 on 19th March 2020, a lockdown in Karnataka was implemented to control the outbreak of the COVID-19. These decisions were made to prevent the further expansion of COVID-19. Lockdown plays a serious role in the further reduction of cases in Karnataka.

Even though there is no reason to argue the lockdown's positive impact on Karnataka, the decrease in new confirmed cases shows that emergency circumstances and movement limitations yield positive results in the reduction of confirmed cases. In 23rd March 2020, the Karnataka government issued a shutdown of all nonessential companies, including manufacturing plants.

Table 2: Measurement of central tendency

Statistics

		Cases	Recovered	Death
N	Valid	520	520	520
	Missing	0	0	0
Mean		5617.16	5502.87	70.86
Median		1783.00	1600.00	20.50
Mode		0	0	0
Std. Deviation		9498.608	9579.618	115.996
Variance		90223548.64	91769083.22	13455.166
Skewness		2.803	3.122	2.689
Std. Error of Skewness		.107	.107	.107
Kurtosis		7.888	11.034	7.363
Std. Error of Kurtosis		.214	.214	.214
Range		50112	61766	624
Minimum		0	0	0
Maximum		50112	61766	624

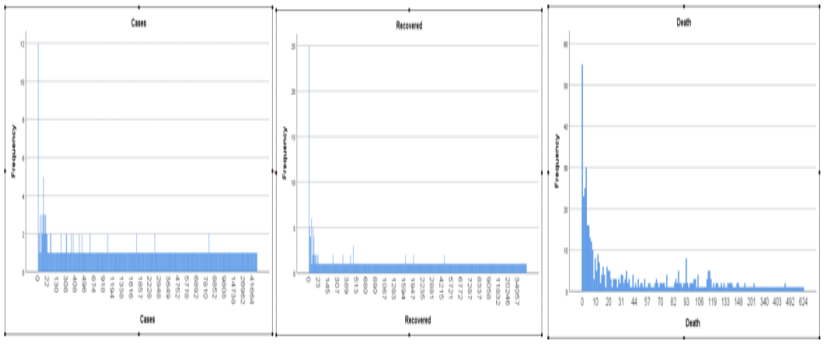

Figure 1: Chart of cases, Recovered and death day by day

The number of deaths is far lower than the confirmed cases. So, to investigate the relation of confirmed cases trend with the CFR, the normalized plot will be investigated. By observing normalized plot of confirmed deaths and recovered cases, it can be seen that the CFR trend behaves the same as the confirmation, with a shift (in date). Visually, it could be seen that the value of shift in date varies and increases during this time. In earlier cases, the period of confirmation cases leading to death was shorter. It seems, one reason for this variation is that confirmed cases consist only of just laboratory cases and, by adding clinically diagnosed cases, the time of confirmation to death increases. In other words, the number of confirmed cases gets closer to the real value, and the cases are announced sooner than they did before. Other possible reasons include the advancements in developing treatments, further delaying fatal cases, and the increase in public awareness, as more people with ossible signs of infection come forward to be diagnosed. To estimate the expected value of confirming a case up to the death stage, assuming a linear relationship between the death and confirmed rates, we draw a linear regression line for confirmed and death cases' value, each time increasing the duration and finding the mean absolute error (MAE) of the regression line.

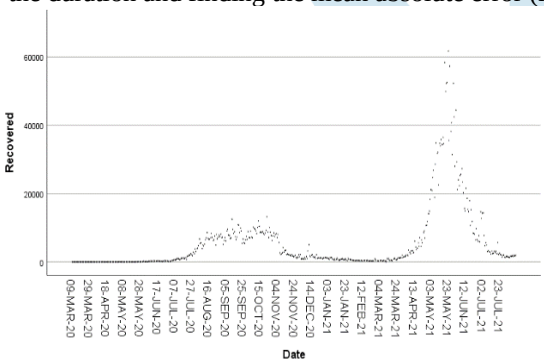

Figure 2: Number of cases increased day by day

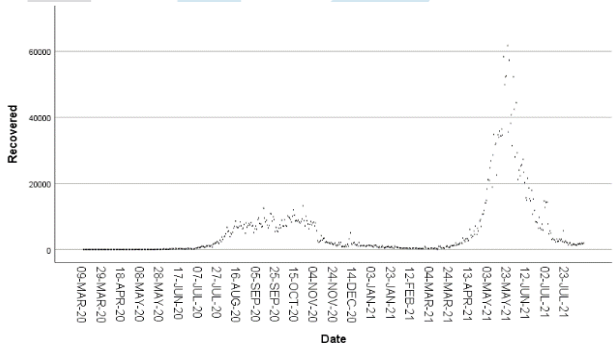

Figure 3: Number of Recovered patient day by day

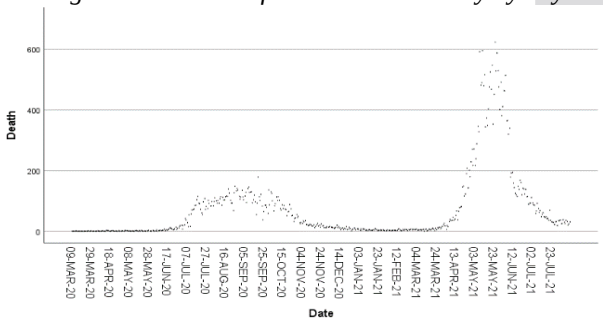

Figure 4: Number of Death day by day

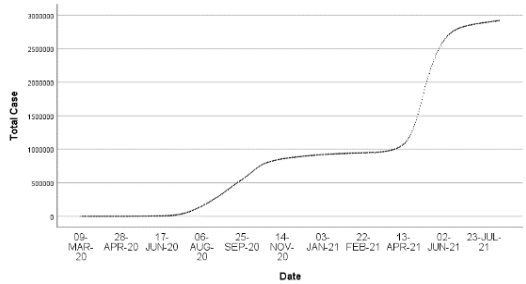

Figure 5: Total Number of Cases

Recovered cases are defined as active cases-patients recovered after a certain amount of time, with its trend. By comparing recovered cases with confirmed ones, a relation is observed after date shifts. Unlike death cases, recovered cases shifts are initially longer and reduce over time. The assumed reasoning is that as time passes, more medical treatments develop, healthcare providers gain more experience in handling patients care and as more people are informed, increasing numbers of them get checked in

hospitals at the early stages of their disease, resulting in an even more efficient treatment. However, this reduction does not break the linear relation between confirmed cases and recovered ones enough to be significant.

Table 3: Chi-Square Test

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	243880.000[a]	243411	.251
Likelihood Ratio	6324.930	243411	1.000
Linear-by-Linear Association	71.390	1	.000
N of Valid Cases	520		

a. 244400 cells (100.0%) have expected count less than 5. The minimum expected count is .00.

Table 4: One sample Test

One-Sample Test

	Test Value = 0					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Cases	13.485	519	.000	5617.160	4798.84	6435.47
Recovered	13.099	519	.000	5502.873	4677.58	6328.17
Death	13.931	519	.000	70.863	60.87	80.86

Table 5: Anova Test

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Cases	Between Groups	4.683E+10	519	90223548.64	.	.
	Within Groups	.000	0	.		
	Total	4.683E+10	519			
Recovered	Between Groups	4.763E+10	519	91769083.22	.	.
	Within Groups	.000	0	.		
	Total	4.763E+10	519			
Death	Between Groups	6983231.306	519	13455.166	.	.
	Within Groups	.000	0	.		
	Total	6983231.306	519			

Table 6: Correlation

Correlations

		Cases	Recovered	Death
Cases	Pearson Correlation	1	.775**	.841**
	Sig. (2-tailed)		.000	.000
	N	520	520	520
Recovered	Pearson Correlation	.775**	1	.920**
	Sig. (2-tailed)	.000		.000
	N	520	520	520
Death	Pearson Correlation	.841**	.920**	1
	Sig. (2-tailed)	.000	.000	
	N	520	520	520

**. Correlation is significant at the 0.01 level (2-tailed).

III. CONCLUSION

Reports on 8th August 2021 show that the Karnataka state have the most confirmed, fatal, and recovered cases, respectively, and in terms of confirmed cases. Confirmed death cases lead in numbers. The daily statistics showed that lockdown is effective in the reduction of incidence of confirmed cases with COVID-19. However, they implement some policies such as in addition to isolation of people, social avoidance, and quarantine policies for infected, and faster detection of infected cases which were effective in a decrease in the new confirmed case and also case fatality, even though a temporal reduction in new cases could be observed due to a nationwide implemented policy reducing working hours. The CFR in China was 4% in Karnataka which could represent the effectiveness of their policies in control of the COVID-19.

Social distancing is one of the most effective policies to control the past epidemic disease by limiting human to human transmission and reducing mortality and morbidity. However, studies suggest that a combination of multiple policies can boost effectiveness.

During the COVID-19 outbreak, researchers predicted that the mass movement of people at the end of the Lunar New Year holiday would increase the spreading of disease. Facing this concern, government of Karnataka implemented policies which was helpful in controlling the disease such as, extending the holiday so that the holiday would be long enough to shelter the incubation period of COVID-19, isolation of confirmed cases in hospitals, quarantining mild or asymptomatic persons in different hospitals, home-based quarantine of people from Karnataka province, and the most important one was to prevent individuals with asymptomatic infections from spreading the virus.

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