COVID-19 Situation at Chennai City – Forecasting for the Better Pandemic Management

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ABSTRACT

Aim: The objective of this study was to investigate the current state of COVID-19 pandemic at Chennai city and understand the possible contributors to the highest number of confirmed and death cases. The secondary aim of the study is to forecast the confirmed cases for the forthcoming days for better planning and execution.

Sample, Technique and Methods: For this study, we have used the data from March 9 to June 6 2020 (89 days). For forecasting the number of COVID-19 cases for Chennai, we have used FORECAST.ETS function in Microsoft Excel. Forecasting calculated from June 7 to August 31 2020 (85 days). Data of Chennai city and Tamilnadu is used for the study.

Results: From the forecasting analysis for Chennai city, by the end of August, the forecasted positive cases would be 121027. The percentage of confirmed cases from the total sample tested may go up to 12.6 by August 31, 2020. The forecasting of Tamilnadu indicates that the majority contribution comes from Chennai city. By the end of August, the number of death cases would be 4565 in Chennai city.

Conclusion: There are various initiatives from the government agencies to control, treat and prevent COVID-19 at Chennai city. However, the number of cases is rising in an uncontrolled manner. Strategical disease management is needed to control the situation better. Forecasting is one of the critical factors that play a vital role in the pandemic management. By using the strategical approaches, we can have better planning, execution and monitoring.

Key Words: Chennai, Causes, Forecasting, COVID-19, Coronavirus

INTRODUCTION

Coronaviruses (CoV) are a large family of viruses that cause illness ranging from the common cold to more severe diseases such as Middle East Respiratory Syndrome (MERS-CoV) and Severe Acute Respiratory Syndrome (SARS-CoV). Coronavirus disease (COVID-19) is a new strain that was discovered in 2019 and has not been previously identified in humans. Standard recommendations to prevent infection spread include regular hand washing, covering mouth and nose when coughing and sneezing, thoroughly cooking meat and eggs. Avoid close contact with anyone showing symptoms of respiratory illness such as coughing and sneezing. As of June 9, there are 6992010 Confirmed cases globally. There are 403128 Confirmed deaths across 216 Countries,

areas, or territories¹. Approximately 2.7 lacks of people affected in India from all the states. Maharashtra is the highly affected state with around 90000 confirmed cases. Sikkim is the least infected state with seven confirmed cases. (As on June 9, 2020)^{2,3}. There are 33,229 positive cases in Tamilnadu state with a death count of 286. (As of June 8). Chennai is the highly affected place in Tamilnadu with 23298 cases, and Dharmapuri is the district with 18 cases that have the lowest confirmed cases⁴.

Overview of Chennai City

Chennai city is the capital of Tamilnadu state and located on the coast of the Bay of Bengal. Being the biggest city in south India, Chennai city played a crucial role in the historical, cultural, educational and health sector growth of the

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country. During British period, Chennai (Madras) was the regional capital of South India, which comprises five states (Currently Tamilnadu, Kerala, Andhra Pradesh, Telangana and Karnataka). Chennai city played an essential role in the Dravidian civilization. Chennai is the 4th largest city of India and has many principal government offices such as High court and Reserve Bank of India. Chennai is one of the most leading commercial centers of South India and well-integrated with the neighbour states for business activities. Various industries such as automobile manufacturing, IT services, which include hardware and software services, petrochemicals such as IOCL, financial services, textiles and hardware manufacturing are resulting in the economy of both Tamilnadu state and India as well. Chennai is well-connected to all the major cities of India as well as with the foreign nations due to its geographical location. Chennai is also considered the cultural hub of South India, which is famous for its rich heritage in classical dance, music, architecture, sculpture and crafts. The official language of the state is Tamil, and other most speaking languages are Telugu, English, Hindi, Urdu and Malayalam. The population of the city is around 6.4 Million and the area of the city is 178.20 sq. Km. The temperature in Summer varies between 21.10 °C to 37 °C. Temperature in Winter varies between 19.81 °C to 32 °C. The altitude of the city is 60 m above sea level^{5,6}

Overview of COVID-19 situation at Chennai:

Table 1: Shows the number of affected cases, district wise in Tamilnadu⁴

District	Total Positive cases (As on June 6, 2020)
Chennai	20,993
Chengalpattu	1,719
Thiruvallur	1274
Kancheepuram	500
Thiruvannamalai	486
Cuddalore	475
Tirunelveli	384
Ariyalur	379
Villupuram	369
Thoothukudi	315
Madurai	298
Kallakurichi	264
Railway Surveillance	260
Salem	213
Coimbatore	158
Dindigul	156
Virudhunagar	144
Perambalur	143

Airport Surveillance	126
Theni	121
Ranipet	120
Tiruppur	114
Trichy	112
Thanjavur	106
Tenkasi	100
Ramanathapuram	97
Kanyakumari	87
Karur	87
Namakkal	85
Nagapattinam	76
Erode	73
Thiruvarur	58
Vellore	55
Airport Surveillance (Domestic)	41
Krishnagiri	37
Thirupathur	36
Sivagangai	35
Pudukottai	31
Nilgiris	14
Dharmapuri	11

As on June 6, 2020, the total confirmed cases in Tamilnadu are 30152 (Refer Table 2, Figure 1). 69.6 percent of the confirmed cases are only from Chennai city, and 36 districts across Tamilnadu are representing remaining 30.4% confirmed cases⁷

Table 2: Shows the positive cases in Chennai city and other parts of Tamilnadu⁴.

District	Total Positive cases
Chennai	20,993
Other districts and centres	9,159

Figure 1: Shows the proportion of the positive cases in Chennai city and other parts of Tamilnadu⁴.

Figure 2: Shows the number of confirmed cases and death rate⁴.

As on June 6, 2020, Chennai city has 20993 confirmed cases. Out of which, 10223 are active, and under treatment, 10572 patients discharged as they have recovered. 197 patients die due to COVID-19 from Chennai city (Figure 2). Table 3 talks about the positive cases details of Chennai and other parts of Tamilnadu from Day-1 of the confirmed case. Further, it explains about the statistics of the samples tested and percent of the confirmed cases across Tamilnadu which includes Chennai city.

Table 3: Shows the various statistics for Tamilnadu concerning COVID-19.⁷

Date	Positive cases in Chennai	Positive cases in Tamilnadu (Except Chennai)	Total positive cases in Tamilnadu	The sample tested on a particular day	Total Samples Tested (Including previous days)	Percentage of confirmed cases from the total samples tested on a particular day	Percentage of Cases in Chennai from the samples tested on the particular day	Percentage of Cases Except Chennai from the samples tested on the particular day
09-03-2020	0	1	1	59	59	0	0	0
10-03-2020	0	1	1	11	70	0	0	0
11-03-2020	0	1	1	4	74	0	0	0
12-03-2020	0	1	1	0	74	0	0	0
13-03-2020	0	1	1	3	77	0	0	0
14-03-2020	0	1	1	0	77	0	0	0
15-03-2020	0	1	1	9	86	0	0	0
16-03-2020	0	1	1	10	96	0	0	0
17-03-2020	0	1	1	43	139	0	0	0
18-03-2020	1	1	2	95	234	1.05	1.05	0
19-03-2020	2	1	3	1	235	1	0	0
20-03-2020	2	1	3	71	306	0	0	0
21-03-2020	3	3	6	36	342	8.33	2.78	5.56
22-03-2020	3	4	7	101	443	0.99	0	0.99
23-03-2020	4	5	9	69	512	2.9	1.45	1.45
24-03-2020	7	8	15	111	623	5.41	2.7	2.7
25-03-2020	11	12	23	159	782	5.03	2.52	2.52
26-03-2020	14	15	29	180	962	3.33	1.67	1.67
27-03-2020	18	20	38	230	1192	3.91	1.74	2.17
28-03-2020	18	22	40	482	1674	0.41	0	0.41
29-03-2020	19	23	42	89	1763	2.25	1.12	1.12
30-03-2020	24	43	67	157	1920	15.92	3.18	12.74
31-03-2020	28	96	124	434	2354	13.13	0.92	12.21
01-04-2020	29	205	234	372	2726	29.57	0.27	29.3
02-04-2020	49	260	309	546	3272	13.74	3.66	10.07
03-04-2020	84	327	411	412	3684	24.76	8.5	16.26
04-04-2020	91	394	485	564	4248	13.12	1.24	11.88
05-04-2020	95	476	571	364	4612	23.63	1.1	22.53
06-04-2020	110	511	621	403	5015	12.41	3.72	8.68
07-04-2020	149	541	690	290	5305	23.79	13.45	10.34
08-04-2020	156	582	738	790	6095	6.08	0.89	5.19
09-04-2020	163	671	834	1172	7267	8.19	0.6	7.59
10-04-2020	172	739	911	1143	8410	6.74	0.79	5.95
11-04-2020	182	787	969	1432	9842	4.05	0.7	3.35
12-04-2020	200	875	1075	813	10655	13.04	2.21	10.82
13-04-2020	209	964	1173	2091	12746	4.69	0.43	4.26
14-04-2020	214	990	1204	6509	19255	0.48	0.08	0.4
15-04-2020	217	1025	1242	2739	21994	1.39	0.11	1.28

16-04-2020	217	1050	1267	4011	26005	0.62	0	0.62
17-04-2020	228	1095	1323	3668	29673	1.53	0.3	1.23
18-04-2020	235	1137	1372	5363	35036	0.91	0.13	0.78
19-04-2020	285	1192	1477	5840	40876	1.8	0.86	0.94
20-04-2020	303	1217	1520	6109	46985	0.7	0.29	0.41
21-04-2020	358	1238	1596	6060	53045	1.25	0.91	0.35
22-04-2020	373	1256	1629	5978	59023	0.55	0.25	0.3
23-04-2020	400	1283	1683	6954	65977	0.78	0.39	0.39
24-04-2020	452	1303	1755	6426	72403	1.12	0.81	0.31
25-04-2020	495	1326	1821	7707	80110	0.86	0.56	0.3
26-04-2020	523	1362	1885	7495	87605	0.85	0.37	0.48
27-04-2020	570	1367	1937	7176	94781	0.72	0.65	0.07
28-04-2020	673	1385	2058	7093	101874	1.71	1.45	0.25
29-04-2020	768	1394	2162	8087	109961	1.29	1.17	0.11
30-04-2020	906	1417	2323	9787	119748	1.65	1.41	0.24
01-05-2020	1082	1444	2526	9615	129363	2.11	1.83	0.28
02-05-2020	1257	1500	2757	10127	139490	2.28	1.73	0.55
03-05-2020	1458	1565	3023	10617	150107	2.51	1.89	0.61
04-05-2020	1724	1826	3550	12863	162970	4.1	2.07	2.03
05-05-2020	2008	2050	4058	11858	174828	4.28	2.4	1.89
06-05-2020	2328	2501	4829	13413	188241	5.75	2.39	3.36
07-05-2020	2644	2765	5409	14195	202436	4.09	2.23	1.86
08-05-2020	3043	2966	6009	13980	216416	4.29	2.85	1.44
09-05-2020	3330	3205	6535	13254	229670	3.97	2.17	1.8
10-05-2020	3839	3365	7204	13367	243037	5	3.81	1.2
11-05-2020	4371	3631	8002	11862	254899	6.73	4.48	2.24
12-05-2020	4882	3836	8718	11788	266687	6.07	4.33	1.74
13-05-2020	5262	3965	9227	12780	279467	3.98	2.97	1.01
14-05-2020	5637	4037	9674	11965	291432	3.74	3.13	0.6
15-05-2020	5946	4162	10108	11672	303104	3.72	2.65	1.07
16-05-2020	6271	4314	10585	10535	313639	4.53	3.08	1.44
17-05-2020	6750	4474	11224	13081	326720	4.88	3.66	1.22
18-05-2020	7117	4643	11760	11121	337841	4.82	3.3	1.52
19-05-2020	7672	4776	12448	10333	348174	6.66	5.37	1.29
20-05-2020	8228	4963	13191	11894	360068	6.25	4.67	1.57
21-05-2020	8795	5172	13967	12464	372532	6.23	4.55	1.68
22-05-2020	9364	5389	14753	12653	385185	6.21	4.5	1.72
23-05-2020	9989	5523	15512	12155	397340	6.24	5.14	1.1
24-05-2020	10576	5701	16277	12275	409615	6.23	4.78	1.45
25-05-2020	11131	5951	17082	11835	421450	6.8	4.69	2.11
26-05-2020	11640	6088	17728	10289	431739	6.28	4.95	1.33
27-05-2020	12203	6342	18545	11231	442970	7.27	5.01	2.26
28-05-2020	12762	6610	19372	12246	455216	6.75	4.56	2.19
29-05-2020	13362	6884	20246	11334	466550	7.71	5.29	2.42
30-05-2020	13980	7204	21184	12605	479155	7.44	4.9	2.54
31-05-2020	14802	7531	22333	12807	491962	8.97	6.42	2.55
01-06-2020	15770	7725	23495	11377	503339	10.21	8.51	1.71
02-06-2020	16585	8001	24586	11094	514433	9.83	7.35	2.49
03-06-2020	17598	8274	25872	14101	528534	9.12	7.18	1.94
04-06-2020	18693	8563	27256	16447	544981	8.41	6.66	1.76
05-06-2020	19826	8868	28694	15692	560673	9.16	7.22	1.94
06-06-2020	20993	9159	30152	16022	576695	9.1	7.28	1.82

Figure 3 shows the number of positive cases in Chennai and across Tamilnadu as of June 6, 2020. The total number of confirmed cases across Tamilnadu (other than Chennai) is not near the Chennai city's confirmed cases. The Graph indicates the outburst which is happening in Chennai concerning COVID-19 cases.

Figure 3: Shows the highest contribution of Chennai and the lowest contribution from other Dist.⁴

Figure 4 shows the COVID-19 increasing trend for Tamilnadu state (Except Chennai) and Chennai city. For better graphical representation, the data separated into two parts, below diagram representing from March 9, 2020 till April 22, 2020. Though we see the increasing trend for both Tamilnadu state (Except Chennai) and counts are less at Chennai City during this period.

Figure 4: Shows the trend of positive cases in Chennai and TN, from March 9 to April 22,2020.⁷

Figure 5 shows the COVID-19 increasing trend for Tamilnadu state (Except Chennai) and Chennai city. Below diagram representing the data from April 23, 2020 till June 6, 2020. We see the growing trend for both Tamilnadu state (Except Chennai) and Chennai city till May 4. It is important to note that the Koyambedu vegetable market of Chennai was closed by the state government by 1st week of May 2020 and around 10000 people who worked in the market left to their native districts. The number of confirmed cases is tremendously increasing at Chennai city from May 5, 2020 onwards. As on June 6, 69.4 percent cases are in Chennai and 30.4 percent cases are at the whole Tamilnadu (other than Chennai).

Figure 5: Shows the trend of positive cases in Chennai and TN, from April 23 to June 6,2020.⁷

Figure 6 shows the pattern of cases increased from first case to 20993. On March 18,2020, the first case identified at Chennai. On March 25, the number of confirmed cases increased to *double-digit*. On April 6, the number of confirmed cases reached *triple-digit*. With the constant increasing pattern, on May 1, the number of confirmed cases is 1082. As on May 24, 2020, within 24 days, the confirmed cases increased by ten times (10576). As per the data from the Tamilnadu government's health department, the total confirmed cases from Chennai city are 20993, as of June 6, 2020.

Figure 6: Shows the increasing trend of positive cases in Chennai and TN, from March 18 to June 6,2020.⁷

As on June 8, 234 people died in Chennai city due to COVID-19 (Refer Figure 7). The first death occurred on April 18, 2020. From May 5 onwards, there were continues deaths noticed. On June 8, authorities announced 12 death cases on that particular day in Chennai city. By seeing the increasing pattern, it looks like the death count may continue to rise in the coming days⁸

Figure 7: Shows the increasing trend of death cases in Chennai⁸

The percent of confirmed cases from the total sample tested on that particular day. From March 9 to April 22 2020, more cases were identified across Tamilnadu and less in Chennai city. (Figure 8). From April 23 onwards, more confirmed cases found in Chennai city. At one point in time, the proportional difference between Chennai city and the whole Tamilnadu was huge (figure 9). On June 6, 2020, 576695 sample tested, and 9.1 percent found positive. Out of which, 7.28percent from Chennai City alone and 1.82 percent from the other parts of Tamilnadu (36 districts).

Figure 8: Shows the positive cases from the sample tested for Chennai and Tamilnadu⁷.

Figure 9: Shows the positive cases from the sample tested for Chennai and Tamilnadu⁷.

From the date of first COVID-19 case till June 6 2020, 5,27,212 samples performed in total across Tamilnadu, which includes Chennai City (Refer Table 4, Figure 10). Out of which, 121950 samples tested in Chennai city alone and found around 17.21 percent positive (20993 cases) and out of 405262 samples performed across Tamilnadu (Except Chennai), only 2.26 percent found positive. Day by day, we see a huge increasing trend for Chennai city. [9]. It is important to note that, from the total sample (527212) tested across Tamilnadu, only 23.12 percent belong to Chennai city. However, the confirmed rate is high i.e. 17.21 percent. Whereas 2.26 percent confirmed cases found from the 76.88 percent of the sample performed from other parts of Tamilnadu.

Table 4: Shows the Total Sample Tested in TN and Chennai city⁷

Location	Total Sample Tested	Confirmed cases	% of confirmed cases
Other districts (36) in TN	405262	9159	2.26
Chennai	121950	20993	17.21

Figure 10: Shows the ratio of confirmed cases and total sampled tested for Chennai and TN⁷.

Possible causes for more COVID-19 cases at Chennai:

- Higher Population density
- Public exposure in the Koyambedu market during lockdown¹⁰
- Lockdown was not followed up properly¹¹
- People visit from profoundly impacted states and countries.
- Quarantine and suspected people travel in the city without social responsibility.
- Unaffected people roam with improper precaution¹¹
- Lack of awareness and negligence.

Forecasting analysis

In this paper, we have used FORECAST.ETS function in MS EXCEL to predict the future number of COVID-19 cases for Chennai. The Excel Forecast.Ets function uses an exponential smoothing algorithm to predict a future value on a timeline, based on a series of existing values. The forecasted number is a continuation of the past values in the defined target date, which should be a continuance of the timeline. This function can be used to foresee forthcoming marketing, asset and configuration requirements and or customer's usage patterns¹²

Syntax:

FORECAST.ETS(target_date, values, timeline, [seasonality], [data_completion], [aggregation])

Point forecasts are obtained from the models by iterating the equations for $t=T+1, \dots, T+ht=T+1, \dots, T+h$ and setting

all $\varepsilon_t=0$ for $t>T$.

For example, for model $ETS(M,A,N)$, $y_{T+1} = (\ell_T + b_T)(1 + \varepsilon_{T+1})$. Therefore $\hat{y}_{T+1|T} = \ell_T + b_T$. Similarly,

$$\begin{aligned} y_{T+2} &= (\ell_{T+1} + b_{T+1})(1 + \varepsilon_{T+1}) \\ &= [(\ell_T + b_T)(1 + \alpha\varepsilon_{T+1}) + b_T + \beta(\ell_T + b_T)\varepsilon_{T+1}](1 + \varepsilon_{T+1}). \end{aligned}$$

Therefore, $\hat{y}_{T+2|T} = \ell_T + 2b_T$, and so on. These forecasts are identical to the forecasts from Holt's linear method, and also to those from model $ETS(A,A,N)$. Thus, the point forecasts obtained from the method and from the two models that underlie the method are identical (assuming that the same parameter values are used). ETS point forecasts are equal to the medians of the forecast distributions. The forecast distributions are normal for models with only additive components, so the medians and means are equal. For ETS models with multiplicative errors, or with multiplicative seasonality, the point forecasts will not be equal to the means of the forecast distributions.¹³

1. Forecasted positive cases in Chennai. June 7 - August 31, 2020

As on June 6, 2020, the number of confirmed cases is 20993. By the end of June, the forecasted positive cases would be 48909. By the end of July, the predicted positive cases would be 84968. By the end of August, the forecasted positive cases would be 121027 (Table 5 and Figure 11). Figure 12 shows the positive cases in the past and the future forecast with lower and upper bound. Transparent data above orange indicates the upper bound and the line within orange shows the lower bound (figure 12)

Table 5: Forecasted positive cases in Chennai. June 7 - August 31, 2020.¹³

Date	Forecasted positive cases in Chennai. June 7 - August 31 2020
13-06-2020	29135
20-06-2020	37277
27-06-2020	45420
04-07-2020	53562
11-07-2020	61704
18-07-2020	69847
25-07-2020	77989
01-08-2020	86131
08-08-2020	94273
15-08-2020	102416
31-08-2020	121027

Figure 11: Forecasted positive cases in Chennai. June 7 - August 31, 2020.¹³

Figure 12: Shows the positive cases in the past and the future forecast with lower and upper bound.¹³

2. Forecasted percentage of cases in Chennai from the samples tested (June 7 - August 31, 2020)

As on June 6, 2020, in Chennai city, the rate of confirmed cases from the total sample tested is 7.28. From the forecasting analysis, by the end of June, the forecasted percent of the positive cases from the samples would be 8.95. By the end of July, the predicted percent of positive cases from the total sample would be 11.23. By the end of August, the predicted percent of positive cases would be 12.6. (Table 6 and Figure 13,14). Transparent data above orange indicates the upper bound and the line within orange shows the lower bound (figure 14)

Table 6: Forecasted percentage of cases in Chennai from the samples tested (June 7 - August 31, 2020)¹³

Date	Forecasted percentage of cases in Chennai from the samples tested (June 7 - August 31, 2020)
13-06-2020	7.90
20-06-2020	7.60
27-06-2020	8.16
03-07-2020	9.29
10-07-2020	8.99

17-07-2020	9.54
24-07-2020	10.61
31-07-2020	11.23
07-08-2020	10.93
15-08-2020	11.49
23-08-2020	12.04
31-08-2020	12.60

Figure 13: Forecasted percentage of cases in Chennai from the samples tested (June 7 - August 31, 2020)¹³

Figure 14: The percentage of positive cases per sample tested in the past and the future forecast¹³

Forecasted percentage of confirmed cases (Tamilnadu) from the total samples tested on a particular day

As on June 6, 2020, at Tamilnadu state (Including Chennai), the percentage of confirmed cases from the total sample tested is 9.10. From the forecasting analysis, by the end of June, the forecasted percent of the positive cases from the samples would be 10.08. By the end of July, the predicted percent of positive cases from the total sample would be 11.36. By the end of August, the forecasted percent of positive cases would be 12.63. Forecasting Tamilnadu pattern is critical as we need to understand how Tamilnadu's overall number is influenced by the Chennai city's count. (Table 7 and figure 15,16). Other than the forecasted percentage of confirmed cases for Tamilnadu Vs. sample tested, the upper

bound (above orange line) and lower bound (below orange line) is indicated for better understanding (figure 16)

Table 7: Forecasted percentage of confirmed cases for Tamilnadu Vs sample tested¹³

Date	Forecasted percentage of confirmed cases (Tamilnadu) from the total samples tested on a particular day
13-06-2020	9.39
20-06-2020	9.67
27-06-2020	9.96
04-07-2020	10.25
11-07-2020	10.54
18-07-2020	10.82
25-07-2020	11.11
01-08-2020	11.40
08-08-2020	11.69
15-08-2020	11.97
23-08-2020	12.30
31-08-2020	12.63

Figure 15: Forecasted percentage of confirmed cases for Tamilnadu Vs sample tested¹³

Figure 16: Shows the past and forecasted percentage of confirmed cases for Tamilnadu Vs. sample tested¹³

3. Forecasted Death cases in Chennai) June 9 - August 31, 2020

As of June 8, 2020, at Tamilnadu state, the number of death cases is 234. From the forecasting analysis, by the end of June, the number of death cases would be around 773. By the end of July, the number of death cases is 2255. By the end of August, the number of death cases in 4565 (Table 8, Figure 17).

Table 8: Forecasted Death cases in Chennai) June 9 - August 31, 2020.¹³

Date	Forecasted Death cases in Chennai) June 9 - August 31 2020
09-06-2020	16
15-06-2020	21
22-06-2020	27
30-06-2020	34
06-07-2020	39
13-07-2020	45
20-07-2020	51
27-07-2020	57
03-08-2020	63
10-08-2020	69
17-08-2020	75
24-08-2020	81
31-08-2020	87

Figure 17: Forecasted Death cases in Chennai) June 9 - August 31, 2020.¹³

DISCUSSION AND INTERPRETATION

Chennai is one of the cities in India severely affected by the COVID-19. Tamilnadu state has 38 districts (table 1). The number of positive cases and the percent of death cases of all 37 districts is pretty less when compared with the Chennai city. As of June 6, 69.4 percent are from Chennai, and 30.6 percent cases from other parts of Tamilnadu (figure 1). Twenty thousand nine hundred ninety-three cases were

confirmed from Chennai and 9,159 cases from all other parts of Tamilnadu state (table 2). The first case identified at Tamilnadu on March 9 and until March 23, it was a single-digit case. On March 24, the number of confirmed cases was 15 (table 3). The reason for sudden changes in the number of cases was the contribution from Chennai city. The first case identified at Chennai on March 18. On March 24, the number of confirmed cases was 7 (table 3). On March 25, the number increased to double-digit. On April 6, the confirmed cases reached triple-digit (table 3). With the constant increasing pattern, on May 1, the number of confirmed cases is 1082 (figure 4). As on May 24, within 24 days, the confirmed cases increased by ten times (10576). As per the data from the Tamilnadu government's health department, the total confirmed cases from Chennai city are 20993, as of June 6, 2020 (figure 5).

It is evident that the majority of the top cities such as Mumbai, Delhi and Chennai are poorly affected due to COVID-19 and Kolkata is exceptional. There could be various reasons for this worst situation. Population density at the Chennai city is one of the primary reasons for more confirmed cases. The Koyambedu market was kept open and operational during lockdown even after the confirmed cases at Chennai, which was another contributor. At one point of time, Government of Tamilnadu closed the market in the first week of May 2020, which made the workers to return to the native places. However, infected people might have roamed around without knowing that they are affected.

It appears that lockdown 1.0 was productive and successful. Lockdown 2.0 announced with no relaxations. However, the effectiveness was less comparatively. Further, lockdowns were not much helpful as people perceived the negligence and started roaming across the city. People who were healthy and unaffected by COVID-19 were moving around, which added more cases as an opportunity to pick the disease from others. Also, some of the people who were affected and quarantined at home were roaming without social responsibility and infected others. Additionally, there are so many people affected by coronavirus without any symptoms, which is a significant cause to add more confirmed cases at Chennai city. Symptoms vary from person to person, which is also adding more difficulties to medical professionals. The first death happened on April 18. From May 5 onwards, there were continuous deaths noticed. On June 8, authorities announced 12 death cases in Chennai city and the total death count is 234 (figure 7).

The neighbour districts and borders of Chennai cities such as Kanchipuram, Thiruvallur and Chengalpattu also impacted severely than other regions of Tamilnadu. This is because of the people's exposure to Chennai and people are roaming between these districts as Chennai city is well connected with all those cities. We have used FORECAST.ETS in MS

Excel function to predict the expected number of COVID-19 cases for Chennai in the future. If the current pattern continuous, by the end of August, the forecasted positive cases would be 121027 (figure 11,12). As on June 6, 2020, in Chennai city, the percentage of confirmed cases from the total sample tested is 7.28. and it may go up to 12.6 by August 31, 2020 (figure 13,14). As on June 6, 2020, at Tamilnadu state, the percentage of confirmed cases from the total sample tested is 9.10 but the majority contribution for Tamilnadu comes from Chennai city. From the forecasting analysis, by the end of August, the forecasted of positive cases would be 12.63 percent (figure 15,16). The forecasting of Tamilnadu indicates that the majority contribution comes from Chennai city. As on June 6, 2020, at Tamilnadu state, the number of death cases is 197. From the forecasting analysis, by the end of August, the number of death cases 4565 (figure 17).

The forecasting is predicted based on the recent past trend on confirmed cases, percent of sampling and number of death cases. Prediction is carried by using the Excel Forecast.ETS function with the use of an exponential smoothing algorithm to predict a future value on a timeline, based on a series of existing values. The forecasted numbers will remain valid if the current conditions exist. If the people get more awareness, Chennai corporation takes additional measures to control the pandemic, announce the lockdown in the severely affected zones and the nature of the virus changes itself, may contribute to the lower numbers in the future, which may be different from the forecasted figures. Another side, there could be various factors that may play a role for an increasing number of cases. They are: If the virus changing the nature of the symptoms, more people affected without any symptoms, more positive cases due to unexpected reasons, and recent and forthcoming returnees from other state and countries due to lockdown relaxations.

Understanding the forecasted number is critical for pandemic management. Government of Tamilnadu, Chennai Corporation, disaster management from the revenue department, health department and Police department should have a better understanding of the current number of confirmed cases, future predicated cases, death cases and the various contributors for the same. Public awareness is critical in this pandemic situation. By involving famous personalities, awareness programmes can be conducted. Before it becomes a tragedy, the administrators should attempt to find the ways to control the spread of COVID-19, which will help them to prove the forecasted numbers are wrong, which can save the life of valuable human being's life.

Recommendations

1. Health workers can be deployed ward by ward and door to door for accessing and identify the symptomatic people as a preventive method.
2. Government of Tamilnadu and Chennai corporation may initiate the control of private hospitals across the Chennai city and neighbour districts for a certain period (Say 1 year) on compensation basis.
3. Hospitals, Doctors, Technicians, Labs and infrastructure facilities from the neighbour districts can be used to treat the COVID-19 patients of Chennai city. The availability of Human resources and infrastructure should not become a barrier to manage the contemporary situation.
4. Batch sampling test can be attempted by understanding the segment of the most affected people so that the disease can be detected in advance and a higher number of suspicious people filtered at the earliest.
5. Government of India, Government of Tamilnadu and Chennai corporation, either collaboratively or individually to take necessary steps for research related to the vaccination and therapeutic medicine by funding for such activities. While we are focusing on identifying the affected people, this approach is much needed as long term approach. Though there are few such initiatives, the rigorous research approach is needed by considering the present situation.
6. Severely affected areas to be identified as containment zones and implement the lockdown for that particular zones, including the movement restriction in and out the zone.
7. Health workers to be assigned to various zones in the Chennai city from other parts of Tamilnadu and do the necessary inspection at the different zones at Chennai, as a proactive approach.
8. Chennai Corporation should be equipped well with various factors such as a more significant number of doctors, nurses, health workers, hospitals, beds and testing equipment so that more testing and treatments can be done as a proactive approach and reactive approach as well.
9. The number of sampling per day should be increased so that affected cases can be identified earlier, which can help to treat them in the initial phase itself without any advance medical treatment, which includes ventilation. Also, this will help to prevent further spread to other people.
10. As the number of cases is increasing exponentially in Chennai city due to the dense population, sealing of Chennai city can be considered to avoid further spreading to other Tamilnadu regions.
11. It is worth considering getting an expert opinion from the health and statistical organizations of other state and central government medical organizations such as ICMR and AIIMS. By doing this, we would be able to gather better and adequate ideas, methodologies, tools, and techniques to control and flatten the pandemic's spread.
12. Finance plays a critical role in Pandemic management. It is understood that there are fund allocations from the

government of Tamilnadu and government of India. However, for better and improved management of the COVID-19 situation, a committee can be formed by including the financial, administrative, statistical and medical experts who can appropriately work with the respective authorities in the central government which can help to get more financial support based on the actual facts and figures in the state.

CONCLUSION

Disaster and pandemic come suddenly and make an enormous change in society with substantial negative impacts. The human community cannot predict, and a proactive approach is not appropriate to the Disaster and Pandemic. The reactive approach is more suitable as we need to deal with it once we are affected by them. When COVID-19 identified first in Wuhan city in China, it was just news for others from various part of the world. Now, India is one of the majorly affected countries and stands at 6th place. Most of the states and big cities are affected. Chennai, which is the capital of Tamilnadu, is severely affected by a considerable number, and the count is increasing day by day. There are various initiatives from the Tamilnadu government and Chennai corporation to control, treat and prevent COVID-19. However, the number of cases is rising in an uncontrolled manner. Strategical disease management is needed to control the situation better. Forecasting is one of the critical factors that play a vital role in the pandemic management. Unless otherwise, we predict the future trend in increasing spread, it is challenging to deal and control infection and death rate. As mentioned in the recommendations sections, few additional measures and actions to be taken by the respective authorities will help manage the situation better. Though the COVID-19 falling under medical, biological, and health departments, combined management initiatives are essential. Doctors can treat the patients, but it is challenging to manage other administrative and associated activities related to the pandemic. It is possible with the strategical approaches where we can have proper planning, execution and monitoring.

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