



Comparison of First and Second Waves of COVID-19 in Metropolitan Chennai City

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Abstract: The study aims to perform a comparative analysis of new cases of COVID-19 reported during the peak time of two waves in Chennai city in 2019-2020. Eight zone-wise variables for 15 zones of Chennai City were studied. They were reduced to fewer factors using a dimension reduction technique called factor analysis, and a standardized index value for each zone and two waves was obtained. The region of hot spots was identified using the Kriging interpolation method using the standardized index value. During wave 1, the average daily number of deaths, new cases, and active cases was 37, 2071, and 21163, respectively, but it was 76, 6663, and 39385 in the second wave. The second wave has a two times higher number of deaths, 3.2 times higher number of new cases, and 1.8 times of active cases. The first wave had a higher percentage of infected people aged 40 years or older, whereas it was more people aged 10-39 years in the second wave. The Krigged estimates showed comparison showed the regions at a higher risk of COVID-19 transmission. Population demographics play a vital role. The zone with a more slum population (Sholiganallur) does not show much intensity of new cases.

Keywords: COVID-19, Two waves, Hot spots, Chennai city

COVID-19, a new virus from SARS-Cov-2 that arose in 2019 during a pneumonia outbreak in Wuhan, China, has sparked a global pandemic and caused significant health problems worldwide. The two waves have affected many countries. The first case of COVID-19 was reported in India on 30 January 2020, while the index case in Tamil Nadu was reported on 7 March 2020 from Chennai City, Tamil Nadu (Chennai Corporation 2020). One of the metropolitan cities, Chennai, has the highest daily number of Covid-19 cases and the fastest growth rate of new cases (Chennai Corporation 2020). In the last week of June 2020, new cases peaked. As a result, the Indian government has implemented a series of preventative measures, including four phases of lockdowns (24 March 2020 to 14 April 2020; 15 April 2020 to 3 May 2020; 4-17 May 2020 and 18-31 May 2020) (Directorate of public health 2021), followed by a gradual return to normalcy in social interaction, workforce, and commercial activity. Except for the necessary wearing of face masks, maintaining social distance, and hand washing routines, life in the city has returned to normal as of July 2020. Unfortunately, the number of new Covid-19 cases has begun to rise, reaching a peak in the second week of May 2021 (Directorate of public health 2021). The State Government was forced to reintroduce the Janata curfew, which meant a strict regional lockdown (Greater Chennai Corporation 2021), in which people were asked to stay at home, avoid national and international travel, industrial

lockdown, educational institution closures, avoid mass community gatherings, close bars, and restaurants, wear masks, and maintain social distance. The government's priority is to keep the workload on the healthcare system to a minimum, limit population infection, and provide better health care to sick people (Indian Institute of Technology 2020). This study aims to compare new Covid-19 cases reported in Chennai city during the peak of two waves in 2019-2020. A dimension reduction technique, factor analysis was used for each zone and two waves, and a standardized index value was obtained. Further hot spots were obtained using the standardized index values and the Kriging method.

MATERIAL AND METHODS

Chennai city profile: Chennai is the fourth largest metropolitan city in India, with a population of 8 million (Indian Institute of Technology 2020). It is located in the north-eastern part of Tamil Nadu and lies between latitude 12°50'4" and 13°17'24" and longitude 79°58'53" and 80°20'12". It is the capital of Tamil Nadu, one among the 38 districts, and comprises an area of 626.435sq Km. It is divided into 200 wards and 15 zones, namely Thiruvottiyur, Manali, Madhavaram, Tondiarpet, Royapuram, Thiruvikanagar, Anna Nagar, Teynampet, Kodambakkam, Valasaravakkam, Alandur, Perungudi, and Sholinganalur (India Today 2021, Jain VK 2021).

Data collection: The study used secondary data that has

been collected from various sources (Jain 2021, Manly BFJ 1986, Rukmini 2021, Sekhar 1991). During wave_1 (w1), the number of new cases peaked in the last week of June 2020 and during the wave_2 (w2) in the second week of May 2021. The zone-wise average number of deaths, new cases, and active cases per day during the peak week has been considered for the analysis. Five zone-wise variables considered for the analysis are the area in sq km, the number of households (HH), total population, male population, and slum population (Jain VK 2021). A dimension reduction technique of factor analysis (State planning commission 2017, Times of India 2021, The Economic Times 2021, Vasna J 2012) has been used to reduce the above eight variables into fewer factors highly inter-correlated variables are the necessary measure for factor analysis. The suitability of the data set for the study has been assessed using Bartlett's test of sphericity, Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy.

The steps involve examining the correlation matrix and then extracting factors that can be improved using varimax rotation. It helps to maximize the variance of each factor. The eigenvalues show the variance explained by each factor. The factor analysis technique extracts common variance from all variables given as input and assigns fewer factor scores. A standardized index value for each zone (factor score of each zone minus minimum score / Maximum score minus minimum score) was obtained using the factor scores, and the percentage of variation was explained as weights. The index value was obtained for each wave then individually integrated into ArcGIS 10 software (ESRI, Redlands, CA, USA). The centroid point of the zone has been considered as

a location parameter (latitude and longitude). The spatial interpolation method of kriging has been applied for points not measured. Finally, a map with kriged estimates of Covid transmission using eight variables for the Chennai Metropolitan City was obtained.

RESULTS AND DISCUSSION

The total number of new cases during the peak week of w1 (starting from 28 June 2020 and ending 4 July 2020) had 14497 new cases and 264 deaths. The total number of new cases during the peak week of w2 (9 May 2021 and ending 15 May 2021) had 46642 new cases and 529 deaths. The per-day average number of deaths, new cases, and active cases during w1 was 37, 2071, and 21163, whereas, in w2, was 76, 6663, and 39385, respectively. Comparing deaths per day in w1 was higher in Tondiarpet and Teynampet and in w2, it was Thiru-vi-ka Nagar. When it comes to new and active cases, Anna Nagar was in both waves (Table 1). All the eight variables included have been standardized to eliminate different scales of measurement. The correlation coefficient was >0.3 in absolute value. Bartlett's test is highly significant, and KMO's test value was 0.7, an acceptable value for factor analysis. The reduction technique extracted two factors from the eight variables studied. The male population, slum population, number of HH were identified as the priority factor. The second factor consists of the zonal area. Both the waves have shown similar results except for the percent of variation explained. Using w1 data, the percentage of variation explained by the two factors were 62.7 and 19.7%, respectively; and in w2, was 63 and 16.6%, respectively. Comparing two waves independently as per the index value,

Table 1. Demographic details and COVID-19 case details of Metropolitan Chennai City

Zone No	Zone name	Lat	Long	Area in sq Km	No. of Households	Population	Male population	Slum population	Wave_1 (28.6.2020 to 3.7.2020)			Wave_2 (9.5.2021 to 15.5.2021)			
									Average Deaths per day	Average New cases per day	Average Active cases per day	Average Deaths per day	Average New cases per day	Average Active cases per day	
1	Thiruvottriyur	13.1643	80.3001	28.51	70300	322600	162107	23325	2	98	1080	2	229	1368	
2	Manali	13.1779	80.2701	42.33	19161	131868	69007	0	0	53	456	1	131	619	
3	Madhavaram	13.1488	80.2306	40.55	49007	196027	99954	0	1	84	889	3	322	1583	
4	Tondiarpet	13.1261	80.2880	23.83	161927	647694	324430	39098	6	172	1879	4	449	2342	
5	Royapuram	13.1137	80.2954	42.33	158687	634742	322703	11045	4	200	2241	3	350	2033	
6	Thiru-vi-ka nagar	13.1199	80.2342	42.33	178923	751695	368105	38440	3	168	1712	12	561	3128	
7	Ambattur	13.1143	80.1548	43.07	127519	509460	256411	636	1	134	1059	6	647	3880	
8	Anna ngar	13.0850	80.2101	25	160968	643895	321690	26984	3	243	2739	11	686	4155	
9	Teynampet	13.0405	80.2503	25.19	125401	754670	380957	68032	6	227	2142	7	560	3521	
10	Kodambakkam	13.0521	80.2255	22.4	167630	670504	338001	39098	4	234	2339	10	628	3903	
11	Valasaravakkam	13.0405	80.1723	28.51	88120	345961	174641	6410	2	115	1104	4	500	3141	
12	Alandur	12.9975	80.2006	41.5	66133	265297	133153	0	1	60	789	3	332	2092	
13	Adayar	13.0012	80.2565	136.32	128724	1157053	588940	45540	3	136	1551	6	656	3879	
14	Perungudi	12.9654	80.2461	42.33	85607	343518	173751	0	1	106	674	3	391	2266	
15	Sozhangannallur	12.9010	80.2279	42.23	49102	172094	87458	124000	0	41	509	1	221	1475	
Total					626.43	1637209	7547078	3801308	422608	37	2071	21163	76	6663	39385

six zones were at higher risk of transmission of COVID-19 infection, whereas nine zones were in w2. The index value greater than 50 (average value) in w1 (Table 2) zones are Kodambakkam, Anna Nagar, Teynampet, Tondiarpet, Royapuram, and Thiru-vi-ka-Nagar was at greater risk of Covid_19 transmission of infection. In contrast, zones Madhavaram, Alandur, Sholiganallur, and Manali have shown less risk of transmission. In w2, Anna Nagar, Kodambakkam, Thiru-vi-ka-Nagar, Teynampet, Ambattur, Adayar, Tondiarpet, Valasaravakkam and Royapuram have shown a greater risk of Covid-19 transmission of infection. In contrast, zones Madhavaram, Thiruvottriyur, Sholiganallur, and Manali showed less risk of transmission. During the peak week of w1 and w2, the infected persons of ≥40 years were higher in w1 than w2. The infected persons of less than 10 yrs and ≥80 years were

almost similar in both the waves. In contrast, the percentage of infected persons aged 10-39 years was higher during w2 than w1. The percentage of males has been significantly higher than the females (Fig. 2). The central region was at higher risk compared to the North and South regions (Fig. 3A and 3B). The map showed in w1 the hot spot zones were mainly Royapuram, partly Tondiarpet, Thiru-vi-ka-Nagar, Anna Nagar, and Kodambakkam. The map of w2 shows the cold spots diminished, and high concentration has moved up to Ambattur.

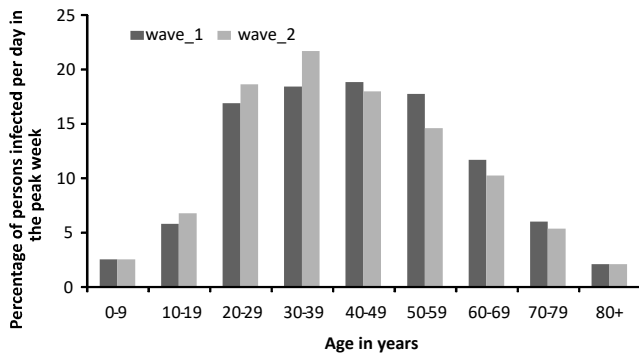


Fig. 1. The age distribution of COVID-19 infected persons in wave_1 and wave_2 during the peak week

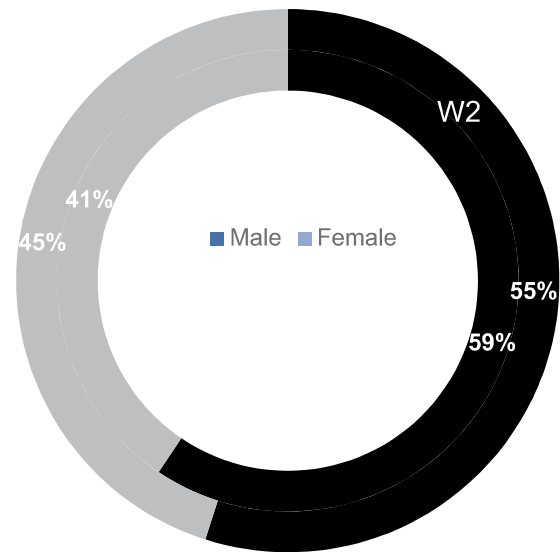


Fig. 2. Percentage distribution of COVID-19 infected persons in wave_1 and wave_2 during the peak week

Table 2. Standardized score for wave_1 and wave_2 of Metropolitan Chennai city

Zone	Name	wave_1 standardized index value	wave_2 standardized index value	Difference in the value
z10	Kodambakkam	100.00	95.40	4.60
z8	Annanagar	99.80	100.00	-0.20
z9	Teynampet	99.00	77.4	21.60
z4	Tondiarpet	92.50	63.3	29.20
z5	Royapuram	86.50	52.4	34.10
z6	Thiru-vi-ka nagar	75.90	91.90	-16.00
z7	Ambattur	44.00	75.50	-31.50
z11	Valasaravakkam	42.20	53.90	-11.70
z13	Adayar	40.20	70.40	-30.20
z1	Thiruvottriyur	36.40	23.70	12.70
z14	Perungudi	27.00	39.10	-12.10
z3	Madhavaram	19.50	24.00	-4.50
z12	Alandur	18.30	31.30	-13.00
z15	Sholiganallur	2.60	7.90	-5.30
z2	Manali	0.00	0.00	0.00

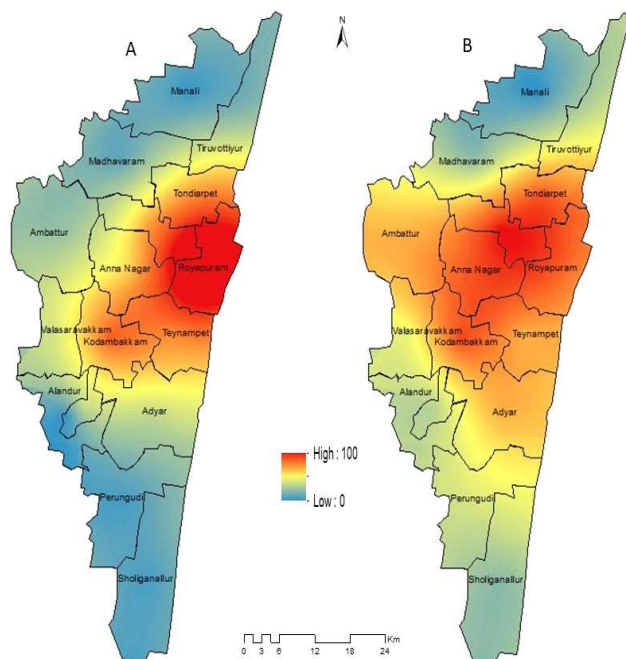


Fig. 3. Zonal variation of the kriged estimates of COVID-19 disease during wave_1 and wave_2

CONCLUSION

The Metropolitan Chennai city was considered a hot spot area covering nearly 63 and 50% of the cases during the first and second waves of Tamil Nadu (Vasna Joshua 2021, Wikipedia 2021). The second wave has a two times higher number of deaths, 3.2 times higher number of new cases, and 1.8 times of active cases. Population demographics play a vital role, whereas the zone with a more slum population (Sholiganallur) does not show much intensity of new cases. The study has used zone as a unit of analysis. If finer grid points like wards have been used more precisely, it would be possible to pinpoint the hot and cold spots. The data used have been reported from different sources that are openly available. The demographic data have been to refer to the year 2017. The analysis has used the average number of new cases in a peak week rather than the peak day since the rise in many COVID-19 cases on any particular day may not be exact. Since there may be a delay in reporting the test results and also due to more testing done in the second wave (Wikipedia 2021). Due to limited information, the trend pattern could not be assessed.

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