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Doubling Time and its Interpretation for COVID 19 Cases

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INTRODUCTION

Doubling time is the number of days required for the number of cases in an epidemic to double, based on the rate of cumulative increase in number of cases. The doubling time is a crude estimate of the *current* rate of spread of the virus. It is comparable across time as well as countries at different stages of spread, and additionally, it is not affected by the proportion of true cases that are being identified, as long as this proportion does not change substantially. For uncontrolled exponential growth, we expect the doubling time to remain constant. If measures are being effective, we should see the doubling time increasing.[1]

For a given day, the doubling time tells the number of days passed since the number of cases was half of the current count. A higher doubling time means it is taking longer for the cases to double and indicates that the infection is spreading slower. Conversely, a lower doubling time suggests a faster spread of infection. For an infection growing at a constant exponential rate, the doubling time is constant. However, as observed in the COVID-19 situation, due to interventions like social distancing, lockdown and containment of hotspots of infection, the doubling time fluctuates and is a function of time. It also varies between districts, states, and countries which may be in different stages of infection.[2]

The main purpose of this article is to demonstrate how to calculate and interpret the doubling time for infectious disease.

OBJECTIVE

The primary objective of this article is calculation of doubling time of COVID19 cases and its interpretation.

METHOD OF CALCULATION

According to the objective of this study the data has been taken from the Website of Surat Municipal Corporation and covers the time period from 17th March to 30th April 2020 to calculate doubling time/rate based on prior 7 days.[2]

$$T_d = (t_2 - t_1)\frac{\ln(2)}{\ln\left(\frac{q_2}{q_1}\right)} \quad (2)$$

Where q_1 is growing quantity of time t_1, q_2 is growing qu4antity of time t_2.

Example of Surat city

Table 1 shows data wise cumulative COVID19 cases reported in Surat city.[3] According to Formula[2] using the data of COVID19 Doubling rate/time calculated for 24th March 2020 considering 17th March 2020 is day 1 ($t_1 = 1$), 24th March 2020 is Day 8 ($t_2 = 8$) , q_1 is number of cases on day 1 (17th March 2020) = 1 ,q_2 number of cases on day 8 (24th March 2020) =5 , ln(2) is natural logarithmic value of 2 .

$$T_{24th\ March2020} = (8-1)\frac{\ln(2)}{\ln\left(\frac{5}{1}\right)} = 7 * \frac{0.6931}{1.6094} = 3.01$$

Similarly, it can be calculated for any particular day.

The first case of COVID19 was found on 17th March 2020 in Surat city. Initially the doubling rate/time was 14.4 days on 29th March 2020 indicating that the number of cases increasing very slowly. After 29th March 2020, the number of cases increased gradually and the doubling time/rate also decreased gradually.

In Surat city the doubling time of COVID19 was 6.2 on 8th April but it went down and from 16th to 22nd April 2020 it was 2.8,2.6,2.3,2.3,2.3,2.9 respectively. Till 22nd April the Doubling rate decreases suggesting a much faster rate of spread than initially measured. After 23rd April the doubling time kept on increasing and on 30th April it was 14.6 (Table 1, Figure 1)

Table 1: Details of Cases and it`s doubling rate (based on prior 7 days) of COVID19 from 17th March 2020 to 30th April 2020[3]

Date	Cases	Doubling Rate (based on prior 7 days)	Date	Cases	Doubling Rate (based on prior 7 days)	Date	Cases	Doubling Rate (based on prior 7 days)
17-Mar-20	1	-	1-Apr-20	10	9.5	16-Apr-20	128	2.8
18-Mar-20	1	-	2-Apr-20	10	9.5	17-Apr-20	161	2.6
19-Mar-20	1	-	3-Apr-20	10	9.5	18-Apr-20	226	2.2
20-Mar-20	3	-	4-Apr-20	11	8.0	19-Apr-20	260	2.3
21-Mar-20	3	-	5-Apr-20	15	6.4	20-Apr-20	320	2.3
22-Mar-20	5	-	6-Apr-20	17	6.4	21-Apr-20	362	2.3
23-Mar-20	5	-	7-Apr-20	20	6.1	22-Apr-20	437	2.9
24-Mar-20	5	3.0	8-Apr-20	22	6.2	23-Apr-20	445	3.9
25-Mar-20	6	2.7	9-Apr-20	22	6.2	24-Apr-20	461	4.6
26-Mar-20	6	2.7	10-Apr-20	25	5.3	25-Apr-20	506	6.0
27-Mar-20	6	7.0	11-Apr-20	26	5.6	26-Apr-20	520	7.0
28-Mar-20	6	7.0	12-Apr-20	31	6.7	27-Apr-20	552	8.9
29-Mar-20	7	14.4	13-Apr-20	40	5.7	28-Apr-20	577	10.4
30-Mar-20	8	10.3	14-Apr-20	45	6.0	29-Apr-20	579	17.2
31-Mar-20	9	8.3	15-Apr-20	83	3.7	30-Apr-20	620	14.6

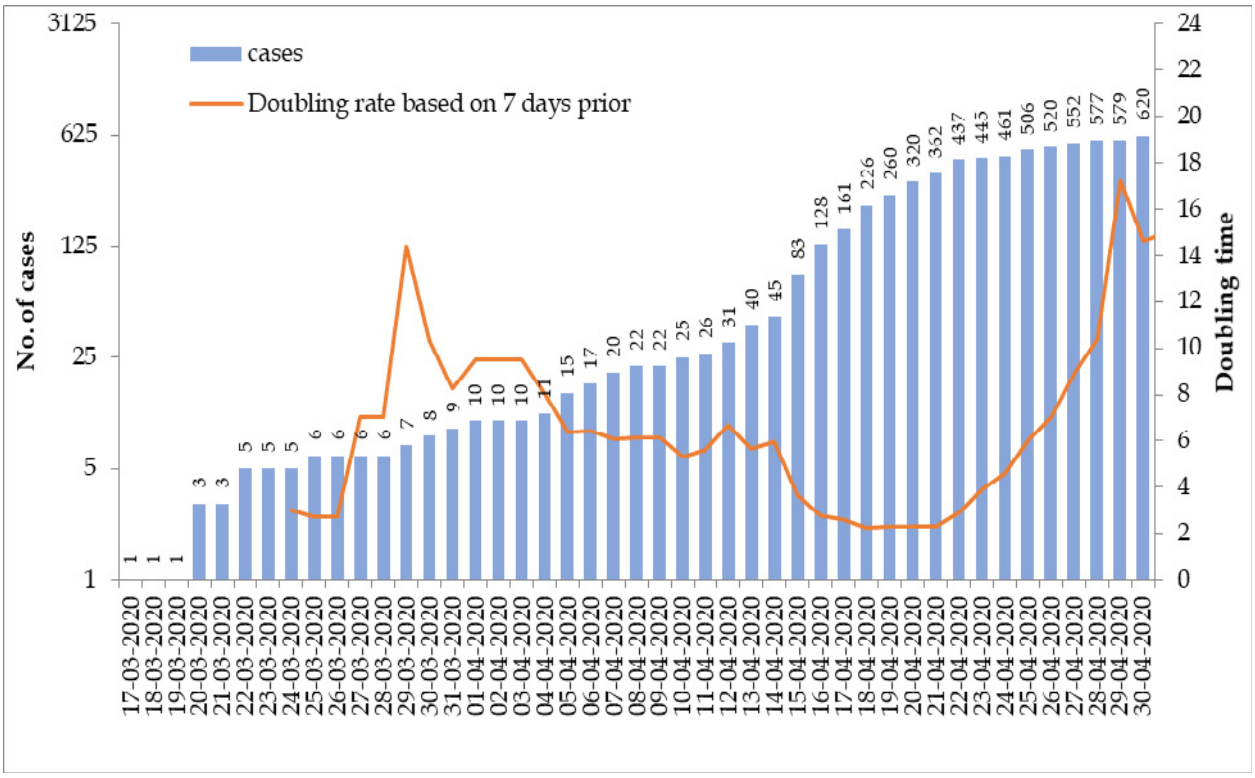

Figure.1 Details of cumulative COVID19 cases and Doubling rate/time in Surat city

In month of April from 14th to 22nd April 2020 the number of cases increased exponentially. On 14th April 2020 the cases were only 45 which increased to 437 till 22nd April 2020 (i.e 89.70% cases increased)

Short Duration predicting Analysis using doubling time

Exponential statistical model used to calculate the predicted value of COVID19 using doubling time for short duration. We predicted the cases of COVID19 from 1st May 2020 to 16th May 2020 using doubling time and exponential regression method.

$$predicted \;\; cases = \beta \exp(\alpha t)$$

Where β and α is parameters to be estimated by the regression method based on doubling time actual data. (Assuming cases may be double either in 15 or 17 days by last two days doubling rate/time of April (29 and 30), also assuming 30th April as (day one) to calculate predicted cases) (Figure 2).

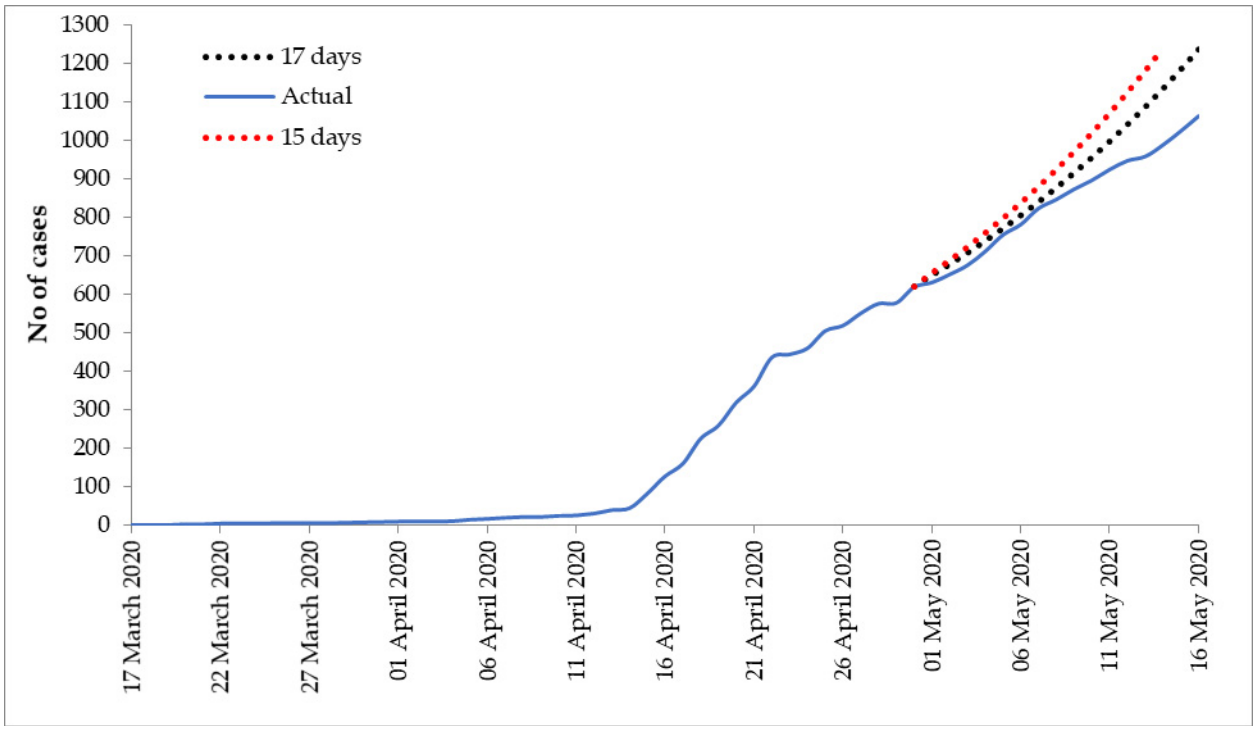

Figure 2: Predicted value for COVID19 in Surat City from 1st May to 16th May -using doubling time exponential method

The increase in the doubling time, manifested by flattening off curve, is an indication that the public health interventions like lockdown, use of mask, social distancing etc are effectively implemented and seems to be working. In typical exponential growth the doubling time remain same. However, in Surat city doubling time in widening which depict that cases are not increasing as they would have in case of exponential growth.

The Doubling time in Surat city increased more than it was expected indicating slow down in exponential growth of cases. It can indirectly indicate effectiveness of the public health strategies being taken in past few days.

In Gujarat the doubling time of COVID19 was 6.4 days on 8th April but it shortened till 25 th of April 2020, but on 26th April it became 7.6 and after that the doubling time kept increasing gradually till 30th April.[4]

In India the doubling time of COVID 19 was 4.6 days on 8th April 2020 which gradually increased and on 30th April, it was 11.7days.[5]

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