

Comparison of Estimated and Real COVID-19 Cases and Deaths for 45 Days

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ABSTRACT

The Coronavirus Disease 2019 (COVID-19) is caused by the new type of coronavirus, severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), emerged in China at the end of 2019, and spread all over the world in a very short time. The World Health Organization (WHO) declared COVID-19 a global pandemic due to its rapid spread and lack of effective vaccination, immunization and treatment. In this study, we aimed to make a retrospective evaluation of forty-five days of COVID-19 cases and deaths simulated by the modified mathematical model which was previously established and published by us. 30 days and 45 days of COVID-19 cases and deaths which were estimated by our modified mathematical model were compared to the real cases and deaths in Turkey since 15.03.2020. The COVID-19 cases increased to a significant level on 20.03.2020 in Turkey. The modified mathematical modeling results' estimation accuracy remained above 90% until 13.04.2020. This rate was 78.40% on 28.04.2020. The modified mathematical modeling estimation for the COVID-19 deaths started on 20.03.2020 because the number of deaths were then significant enough for estimation with the modified mathematical model. The estimation accuracy for the number of deaths was 100% with a value of 37 on 23 March 2020, and after that, it had always remained above 90% until 13.04.2020. Finally, it was 66.08% on 28.04.2020. The estimation accuracies of the modified mathematical model about the COVID-19 cases in Turkey for 30 days and 45 days were above 90% and 78% respectively. The estimation accuracies of the modified mathematical model about the COVID-19 deaths in Turkey for the 30-day and 45-day periods were above 90% and 66%, respectively. This result suggests that the modified mathematical model is available for estimating the course of disease outbreaks and pandemics. The model should be developed through future studies, which will improve its estimation accuracy.

Keywords: COVID-19, coronavirus, mathematical modeling, error evaluation, pandemic

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Received: 06.08.2020,

Accepted: 15.10.2020

<https://doi.org/10.29333/jcei/9565>

INTRODUCTION

The Coronavirus Disease 2019 (COVID-19) is caused by the new type of coronavirus, severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), emerged in China at the end of 2019 and spread all over the world in a very short time. The WHO declared COVID-19 a global pandemic due to its rapid spread and lack of effective vaccination, immunization and treatment [1]. The symptoms of COVID-19 are variable. Some patients are asymptomatic, and some patients have severe respiratory failure. The main symptoms are fever, cough, headache and fatigue. In addition to clinical symptoms, the main method for the disease's diagnosis is Real-time PCR.

Typical-ground glass opacity in CT especially on the lower and peripheral lobes and viral infection findings in laboratory test results are also helpful for the diagnosis of COVID-19 [2]. Precautions are very effective in determining the velocity of the course of the COVID-19 pandemic. Routinely exercising [3], eating healthy foods [4], general hygiene, hand hygiene and using personal protective equipment like masks to prevent contamination [5], maintaining physical distance measures [6] and stopping tobacco consumption are effective precautions [7].

The first COVID-19 cases in Turkey were reported in March 2020. After that, deaths caused by COVID-19 began to occur.

Comparison of Estimated and Real COVID-19 Cases and Deaths

Table 1. Values of estimated and real COVID-19 cases and deviation for 45 days in Turkey

Date	Real Number of Cases	Estimated Number of Cases	% Deviation
15.03.2020	18	18	0.00
16.03.2020	47	90	91.49
17.03.2020	98	175	78.57
18.03.2020	191	292	52.88
19.03.2020	359	449	25.07
20.03.2020	670	656	-2.09
21.03.2020	947	923	-2.53
22.03.2020	1236	1262	2.10
23.03.2020	1529	1686	10.27
24.03.2020	1872	2211	18.11
25.03.2020	2433	2853	17.26
26.03.2020	3629	3629	0.00 *
27.03.2020	5698	5678	-0.35
28.03.2020	7402	6949	-6.12
29.03.2020	9217	8448	-8.34
30.03.2020	10827	10171	-6.06
31.03.2020	13531	12132	-10.34
1.04.2020	15679	14339	-8.55
2.04.2020	18135	16796	-7.38
3.04.2020	20921	19502	-6.78
4.04.2020	23934	22447	-6.21
5.04.2020	27069	25615	-5.37
6.04.2020	30217	28983	-4.08

Table 1 (continued). Values of estimated and real COVID-19 cases and deviation for 45 days in Turkey

Date	Real Number of Cases	Estimated Number of Cases	% Deviation
7.04.2020	34109	32518	-4.66
8.04.2020	38226	36186	-5.34
9.04.2020	42282	39944	-5.53
10.04.2020	47029	43750	-6.97
11.04.2020	52167	47560	-8.83
12.04.2020	56956	51330	-9.88
13.04.2020	61049	55021	-9.87
14.04.2020	65111	58598	-10.00
15.04.2020	69392	62032	-10.61
16.04.2020	74193	65299	-11.99
17.04.2020	78546	68382	-12.94
18.04.2020	82329	71296	-13.40
19.04.2020	86306	73956	-14.31
20.04.2020	90980	76441	-15.98
21.04.2020	95591	78727	-17.64
22.04.2020	98674	80821	-18.09
23.04.2020	101790	82729	-18.73
24.04.2020	104912	84464	-19.49
25.04.2020	107773	86035	-20.17
26.04.2020	110130	87454	-20.59
27.04.2020	112261	88734	-20.96
28.04.2020	114653	89886	-21.60

There has been a great effort to control the COVID-19 pandemic both in Turkey and across the world. One of the most important stages in the fight against a pandemic is to simulate the course of the pandemic. The course of the COVID-19 pandemic in Turkey was previously estimated by us by using a mathematical model [8]. This study aimed to make a retrospective evaluation of forty-five days of COVID-19 cases and deaths simulated by the modified mathematical model which was previously established and published by us.

MATERIALS AND METHODS

The modified mathematical modeling estimations which were performed by us were compared to the real numbers of the COVID-19 cases and deaths in Turkey for 30-day and 45-day periods since 15.03.2020, and the estimation accuracy was calculated. [8,10].

RESULTS

The results of the modified mathematical modeling estimations and real COVID19 cases were compared, and the estimation accuracy was around 100% with a value of 3,629 on March 26, 2020. According to the modified mathematical modeling results on the COVID-19 cases after March 20, 2020, when the number of cases increased to a significant level, the estimation accuracy always remained above 90% until April 13, 2020. This rate was 78.40% on

April 28, 2020. The estimation accuracy values for the estimated and real 45-day COVID-19 cases that started from March 15, 2020 in Turkey are presented in **Table 1** and **Figure 1**.

The modified mathematical modeling estimation for the COVID-19 deaths started on 20.03.2020 because the number of deaths were then significant enough for estimation with the modified mathematical model. The estimation accuracy was 100% with a value of 37 on March 23, 2020. The estimation accuracy always remained above 90% until April 13, 2020, and it was 66.08% on April 28, 2020. The estimation accuracy values for the estimated and real 45 days of COVID-19 deaths that started from March 15, 2020 in Turkey are presented in **Table 2** and **Figure 2**.

Comparison of Estimated and Real COVID-19 Cases and Deaths

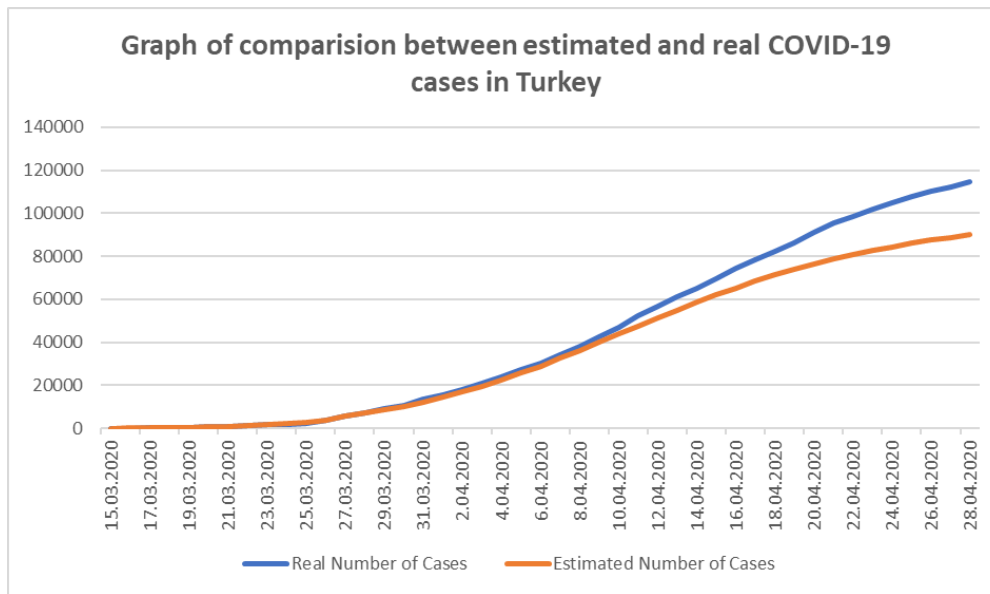


Figure 1. Graph of comparison between estimated and real COVID-19 cases for 45 days in Turkey

Table 2. Values of estimated and real COVID-19 deaths and deviation for 45 days in Turkey

Date	Real Number of Cases	Estimated Number of Cases	% Deviation
15.03.2020	0	0	0
16.03.2020	1	0	-100.00
17.03.2020	2	0	-100.00
18.03.2020	3	0	-100.00
19.03.2020	4	0	-100.00
20.03.2020	9	14	55.56
21.03.2020	21	20	-4.76
22.03.2020	30	27	-10.00
23.03.2020	37	37	0.00
24.03.2020	44	48	9.09
25.03.2020	59	62	5.08
26.03.2020	75	79	5.33
27.03.2020	92	124	34.78
28.03.2020	108	152	40.74
29.03.2020	131	185	41.22
30.03.2020	168	223	32.74
31.03.2020	214	266	24.30
1.04.2020	277	315	13.72
2.04.2020	356	369	3.65
3.04.2020	425	429	0.94
4.04.2020	501	493	-1.60
5.04.2020	574	563	-1.92
6.04.2020	649	637	-1.85

Table 2 (continued). Values of estimated and real COVID-19 deaths and deviation for 45 days in Turkey

Date	Real Number of Cases	Estimated Number of Cases	% Deviation
7.04.2020	725	715	-1.38
8.04.2020	812	796	-1.97
9.04.2020	908	878	-3.30
10.04.2020	1006	962	-4.37
11.04.2020	1101	1046	-5.00
12.04.2020	1198	1129	-5.76
13.04.2020	1296	1210	-6.64
14.04.2020	1403	1289	-8.13
15.04.2020	1518	1364	-10.14
16.04.2020	1643	1436	-12.60
17.04.2020	1769	1504	-14.98
18.04.2020	1890	1567	-17.09
19.04.2020	2017	1627	-19.34
20.04.2020	2140	1681	-21.45
21.04.2020	2259	1732	-23.33
22.04.2020	2376	1778	-25.17
23.04.2020	2491	1820	-26.94
24.04.2020	2600	1858	-28.54
25.04.2020	2706	1892	-30.08
26.04.2020	2805	1924	-31.41
27.04.2020	2900	1952	-32.69
28.04.2020	2992	1977	-33.92

DISCUSSION

The first COVID-19 cases in Turkey were reported in March 2020 and followed by COVID-19 deaths [10]. After that, serious measures had been taken to control and prevent the spread of the pandemic by the Turkish government. The

intensity of measures had been changed with the number of cases and deaths by the government [11]. Therefore, it is important to estimate the number of the COVID-19 cases and deaths for a successful fight against the pandemic. The modified mathematical model that we established was helpful for simulating the COVID-19 cases and deaths [8].

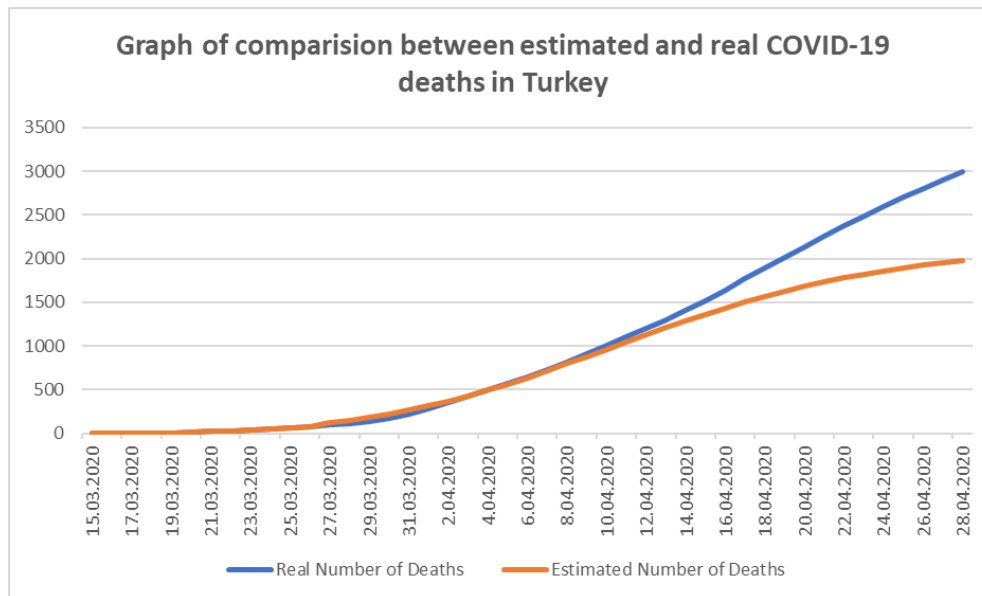


Figure 2. Graph of comparison between estimated and real COVID-19 deaths for 45 days in Turkey

When the number of the COVID-19 cases increased to a significant level on 20 March 2020, our modified mathematical modeling results' estimation accuracy remained above 90% until 13.04.2020. When the 45 days of modified mathematical modeling estimation accuracy were evaluated, it was seen that the estimation accuracy always remained above 78% until 28.04.2020. The modified mathematical modeling estimation accuracy values for 30 days and 45 days of the COVID-19 deaths in Turkey were above 90% and 66%, respectively. This result suggested that the modified mathematical model that we established is a good choice for estimating the course of disease outbreaks and pandemics. The model should be developed further through future studies, which will improve its estimation accuracy [9,10]. The deviation of the modified mathematical modeling estimation accuracy was caused by the strict measures for controlling and preventing COVID-19 for the first 30 days following the first cases, but after the 30-day period, the compliance with these strict measures decreased. Modified mathematical model simulations for the course of epidemic diseases may be helpful for fighting plans against diseases.

Declaration of interest: The authors report no conflicts of interest.

Financial Disclosure: No financial support was received.

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