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

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.
simulate the course of the pandemic. The course of the COVID-19 pandemic in Turkey was previously estimated by estimations and real COVID-19 cases were compared, and above 90% until April 13, 2020. This rate was 78.40% on March 23, 2020. The estimation accuracy values for the estimated and real 45 days of 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 was 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-day COVID-19 cases that started from March 15, 2020 in Turkey are presented in Table 1 and Figure 1.

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 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 COVID-19 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.
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].

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       |
| 01.04.2020 | 277                  | 315                       | 13.72       |
| 02.04.2020 | 356                  | 369                       | 3.65        |
| 03.04.2020 | 425                  | 429                       | 0.94        |
| 04.04.2020 | 501                  | 493                       | -1.60       |
| 05.04.2020 | 574                  | 563                       | -1.92       |
| 06.04.2020 | 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 |
|------------|----------------------|---------------------------|-------------|
| 07.04.2020 | 725                  | 715                       | -1.38       |
| 08.04.2020 | 812                  | 796                       | -1.97       |
| 09.04.2020 | 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      |
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.

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