Original article:

Modeling and Short-Term Forecasts of Indicators for COVID-19 Outbreak in 25 Countries at the end of March

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Abstract

Objective: The coronavirus, which originated in Wuhan, causing the disease called COVID-19, spread more than 200 countries and continents end of the March. In this study, it was aimed to model the outbreak with different time series models and also predict the indicators. ***Materials and Methods:*** The data was collected from 25 countries which have different process at least 20 days. ARIMA(p,d,q), Simple Exponential Smoothing, Holt's Two Parameter, Brown's Double Exponential Smoothing Models were used. The prediction and forecasting values were obtained for the countries. Trends and seasonal effects were also evaluated. ***Results and Discussion:*** China has almost under control according to forecasting. The cumulative death prevalence in Italy and Spain will be the highest, followed by the Netherlands, France, England, China, Denmark, Belgium, Brazil and Sweden respectively as of the first week of April. The highest daily case prevalence was observed in Belgium, America, Canada, Poland, Ireland, Netherlands, France and Israel between 10% and 12%.The lowest rate was observed in China and South Korea. Turkey was one of the leading countries in terms of ranking these criteria. The prevalence of the new case and the recovered were higher in Spain than Italy. ***Conclusion:*** More accurate predictions for the future can be obtained using time series models with a wide range of data from different countries by modelling real time and retrospective data.

Keywords: coronavirus disease 2019; modelling; time series models; exponential smoothing

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INTRODUCTION

Coronavirus disease (COVID-19, SARS-CoV-2), which started in Wuhan, China in December 2019, has been recognized as a global threat and it turned into a pandemic that threatened two hundred countries at the end of March. Although there are differences in various indicators such as cumulative case and cumulative death among countries, the outbreak can be estimated with various mathematical models. For this purpose, various models such as logistics model, Bertalanffy model, Gompertz model, Cubic Curve, Exponential Curve, ARIMA models, phenomenological models, optimization algorithms have been examined before. But the estimates have been made for several countries such as China, Japan and USA, whose data are relatively much more. In many countries, the total number of cases reached very high at the end of March, and the outbreak period has exceeded one month. Under these conditions, modeling the data collected from many countries to define the outbreak process and the characteristics of the outbreak, to take precautions and to create projection for the countries where the outbreak has begun or will began is of great importance[1-9].

In this study, it was aimed to model the outbreak for six indicators from twenty five countries with different starting dates and processing at least twenty days of data using the end of March data. For this purpose, ARIMA (p, d, q), Simple Exponential Smoothing Model, Holt's Two Parameter Model, Brown's Double Exponential Smoothing Models

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were used. Then prediction and forecasting values were presented for the countries.

MATERIALS AND METHODS

Data - Indicators and Models

In the study, twenty five countries were selected which cumulative cases exceeding 1000 among the 160 countries have exposed to the COVID-19 outbreak before March 15 and data for six indicators were modeled. The countries selected for modeling were divided into periods at certain intervals according to the start Time of the outbreak and was presented in Table 1 as a summary. The number of countries struggling with the outbreak increased to 200 at the end of March but data from 40 countries that did not contain sufficient data for modeling and started to struggle the outbreak after March 15 were excluded from the study. Since at least one of the countries which was announcing the first case at different periods, was selected for modeling, the results to be obtained from these countries will create a prediction for other countries under similar conditions and for countries that have just started the outbreak.

Table 1.The starting periods of the outbreak in the selected countries for modelling

The Reported First Case(s)	Total Countries	Selected Countries	Number of selected Countries
Dec 31 - Jan 15	3	China	1
Jan 16 - Jan 31	24	Italy, Spain, South Korea, Germany, France, USA, UK, Canada, Sweeden, Australia, Malaysia	11
Feb 1 - Feb 15	2	Belgium	1
Feb 16 - Feb 20	3	Iran, Israel	2
Feb 21 – Feb 29	37	Switzerland, Netherlands, Austria, Norway, Brazil, Denmark, Ireland	7
March 1 - March 7	39	Portugal, Poland	2
March 8 - March 15	52	Turkey	1

The data were obtained from the internet sources (WHO, Worldometers and Wikipedia). The data of the indicators described below were modeled.

- Cumulative Cases
- Cumulative Deaths
- Daily Cases
- Daily Deaths
- Cumulative Recovered
- Active Cases

Time Series Models used in the Study

ARIMA (p,d,q):ARIMA time series are non-stationary time series, AR, MA and ARMA processes are stationary series. Generally, non-stationary processes are encountered in applications. Because, in practice, data generally varies due to seasonal, irregular movements or incidental reasons. The process becomes stationary when the non-stationary ARIMA time series is taken from the appropriate degree. ARIMA processes are expressed in ARIMA (p, d, q) notation. Here, p indicates the degree of autoregressive process, d is the difference of degrees, and q is the degree of the moving averages process. The ARIMA (p, d, q) process includes both AR (p), MA (q) and ARIMA (p, q) processes. The ARIMA process is an integrated autoregressive moving average process. In the ARIMA models, where d = 1, p and q is 0, then the ARIMA (0,1,0) process is obtained, which is defined as the random walk process[10-12].

When the first difference of the non-stationary Y_t series is taken (d=1), the $\Delta Y_t = Y_t - Y_{t-1} = Y_t'$ equation is obtained. If the series is not still stationary, a second difference is taken. $\Delta^2 Y_t = \Delta(Y_t^!) = Y_t^! - Y_{t-1}^! = Y_t - 2Y_{t-1} + Y_{t-2}$ is obtained. In this case, d = 2. Therefore, the non-stationary series is made stationary and shows the ARMA process. The model takes the form of ARIMA (p, d, q). In the method, trial method is used to determine the appropriate p, d and q values. Therefore, this method has the disadvantage, but it gives very good results in short term estimations. While d value is determined as the number of differences in the series, p and q values are obtained by examining partial autocorrelation and autocorrelation functions, respectively. The least squares method or nonlinear methods are used in parameter estimates. Assessment of goodness of fit is investigated by AIC and BIC criteria. In addition, compliance with the white noise process is checked for model suitability. The model must comply with the white noise process[10-12].

Simple Exponential Smoothing Model: The advantage of the model is that it can be applied in series with stochastic trends and the estimates can be updated by evaluating the latest changes in the data. The updating is done by giving different weights to the historical data. In cases where periodic and irregular fluctuations are very large, when there is no trend and seasonality, the use of exponential smoothing methods enables more accurate estimations. In the exponential smoothing method, a

smoothing coefficient is used and it gives decreasing values according to the distances from today's period 13.

According to the seasonal component, the model is $S_t = S_{t-1} + a(Y_{t-1} - S_{t-1})$. In the model Y_t is the observation value at time t and the S_t is the smoothed observation value at time t. The forecast error is equal to $Y_{t-1} - S_{t-1}$. The smoothing parameter a takes values between 0 and 1. Generally $0.05 \leq a \leq 0.3$ range is used. For optimal selecting smoothing parameters, researchers can perform different range of a values. The a, which gives the lowest average standard error value, will be the best choice13.

The simple exponential smoothing method is only suitable for time series that move around an average. In the moving averages method, equal weight is given to the period values by experiment while different weights are given in the simple exponential smoothing method and these values are becoming exponential shape. In the simple exponential smoothing method, higher values are given to recently obtained values in weighting. The simple exponential smoothing method is often used to estimate short-term predictions13.

Holt's Two Parameter Model: The Holt's two parameter model is used when there is a trend in the data. But in the data there is no seasonality. In the method, while each forecast is obtained, the previous forecast is updated and new forecast values are obtained. Since the method also takes into account the trend in the data, it is slightly more complicated than moving averages and simple exponential smoothing methods14.

Holt's two parameter model is created with the help of the following equations.

$$L_t = \alpha Y_t + (1-\alpha)(L_{t-1} + T_{t-1})$$
$$T_t = \beta(L_t - L_{t-1}) + (1-\beta)T_{t-1}$$
$$\bar{y}_{t+p} = L_t + pT_t$$

In the above functions, p is the number of periods predicted, while the value of L_t is the new smoothed value, while T_t is the trend estimate value and Y_t is the actual value in period t. The $\bar{y}_{t+p}$ is the post period prediction value14.

Method uses trend estimates, so in the model there is two coefficients. α is the smoothing coefficient and the β is the coefficient used for trend estimation. These coefficients ranges between 0 and 1. The alpha and beta coefficients that make the total error square minimum are chosen as the most appropriate parameter value.

Brown's Double Exponential Smoothing Model: This model was obtained as a result of the development of the simple exponential smoothing method. While the series contains trends, it does not include seasonality. Equations of the method is given in the below 15.

$$S'_0 = x_0$$
$$S''_0 = x_0$$
$$S'_t = \alpha Y_t + (1-\alpha)S'_{t-1}$$
$$S''_t = \alpha S'_t + (1-\alpha)S''_{t-1}$$

S' is the smoothed series and S'' is the double smoothed series. They obtained by simple exponential smoothing model. For Y_{t+k} forecasting, the equation is $F_{t+k} = L_t + kT_t$.

$$L_t = 2S'_t - S''_t$$
$$T_t = \frac{\alpha}{1-\alpha}(S'_t - S''_t)$$

Here L_t is the predicted level in time t, while T_t is the predicted trend in time. If there is an increase and decrease in the series in the data set, Brown's model gives better results. In the method, two different smoothed series are used, which are located in two different centers. Brown's method tries to create a linear equation. Estimates include single and double smoothed constants. Therefore, the method takes its name from this feature [15].

Statistical Analysis

In modeling, cumulative cases, cumulative deaths, daily cases, daily deaths, cumulative recovered and active cases, which are indicators of the COVID-19 outbreak, were used. The models with the most successful results were selected and 10-day forecasts after the modelling were calculated. In the modelling process, autocorrelation values were calculated in the data and seasonality and trend of the data were examined. The largest R-square value and the smallest RMSE and Normalized BIC values were used for the model performance.

RESULTS

The results of the China is very important for many countries because the COVID-19 outbreak first began in China. In addition, China has caused the outbreak to spread to many countries and has been fighting this epidemic for 3 months. Also, as of the end of March, it is the fifth country with the highest number of cases and total deaths in the world When the modeling results of China data were investigated considering six different indicators, It was seen that the first four indicators were modeled with high success, and sufficient success was reached in the modeling of cumulative recovered (Table 2). However, there was no suitable time series model that successfully models active cases. (R-squared < 0,50). The 10-day forecast results after the model

building date for the indicators modeled with high success were given in Table 3.

When the table was evaluated, it was observed that the number of cases did not change much except recovered cases in the first half of April in China.

Table 2. Time series models for China

Country		Model	R^2	RMSE	BIC
China	Cumulative Cases	ARIMA(0,2,1)	1,00	253,05	11,130
	Cumulative Deaths	Brown	1,00	16,03	5,612
	Daily Cases	Simple	,997	1660,29	14,894
	Daily Deaths	Simple	,992	1681,08	14,919
	Cumulative Recovered	Brown	,865	16,09	5,619

Table 3. Forecasting for 10 days in China

Date	Cum. Cases	Cum. Deaths	Daily Cases	Daily Deaths	Cum. Rec.
29.03.20	81491	3305	52	5	75910
30.03.20	81542	3309	52	5	76372
31.03.20	81594	3314	52	5	76834
01.04.20	81645	3318	52	5	77297
02.04.20	81697	3323	52	5	77759
03.04.20	81749	3327	52	5	78221
04.04.20	81800	3332	52	5	78684
05.04.20	81852	3336	52	5	79146
06.04.20	81903	3341	52	5	79609
07.04.20	81955	3345	52	5	80071

Estimates of different indicator data obtained from China are shown in Figure 1. From the graphs, it was seen that there was no significant change in the number of cumulative cases and the number of cumulative deaths as of the end of March. But the number of cumulative recovered was seen to increase. Daily cases and daily death were close to the minimum level.

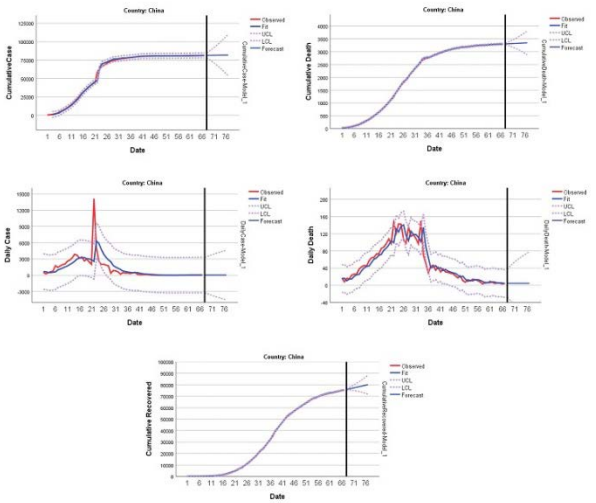

Figure 1. Predicting and forecasting of indicators for China

In 11 out of 24 countries that detected the first Coronavirus cases in the period of 16-31 January, the total number of cases was over 1000. So the data of the indicators used in the prediction of the outbreak process were modeled and the results are presented in Table 4 and Table 5.

Table 4. Time series models for the countries that announced the first case in the period of 16-31 Jan

Country		Model Type	R^2	RMSE	BIC
Italy	Cum. Case	Brown	1,000	480,0	12,4
	Cum. Death	ARIMA(0,2,1)	0,999	498,3	12,5
	Daily Case	ARIMA(0,1,0)	0,999	71,0	8,7
	Daily Death	Brown	0,998	154,3	10,4
	Cum. Rec.	ARIMA(4,2,0)	0,959	463,9	12,4
	Active Cases	Brown	0,951	65,5	8,5
Spain	Cum. Case	Brown	0,999	45,9	7,7
	Cum. Death	ARIMA(0,3,1)	0,999	623,8	13,0
	Daily Case	Brown	0,998	656,9	13,1
	Daily Death	Brown	0,990	277,5	11,3
	Cum. Rec.	ARIMA(0,2,0)	0,972	41,6	7,5
	Active Cases	Brown	0,949	592,0	12,9
South Korea	Cum. Case	Holt	0,999	119,0	9,7
	Cum. Death	Brown	0,998	2,2	1,6
	Daily Case	ARIMA(1,1,0)	0,998	71,6	8,6
	Daily Death	Holt	0,997	142,2	10,1
	Cum. Rec.	Brown	0,714	119,8	9,7
Germany	Cum. Case	Brown	0,998	622,0	13,0
	Cum. Death	ARIMA(0,2,0)	0,997	752,6	13,3
	Daily Case	Brown	0,996	6,2	3,8
	Daily Death	Brown	0,947	446,9	12,3
	Cum. Rec.	ARIMA(1,2,0)	0,926	5,8	3,6
	Active Cases	Brown	0,919	581,2	12,8
France	Cum. Case	Holt	0,998	412,8	12,2
	Cum. Death	Brown	0,997	29,8	6,9
	Daily Case	Holt	0,996	513,1	12,7
	Daily Death	Brown	0,977	241,1	11,1
	Cum. Rec.	Brown	0,936	325,3	11,7
	Active Cases	Holt	0,925	26,7	6,7
USA	Cum. Case	Brown	0,999	1024,8	14,0
	Cum. Death	ARIMA(0,3,1)	0,999	1110,5	14,1
	Daily Case	Holt	0,998	23,8	6,4
	Daily Death	Brown	0,982	731,8	13,4
	Active Cases	Brown	0,959	23,0	6,4
UK	Cum. Case	ARIMA(0,2,1)	0,998	194,7	10,6
	Cum. Death	ARIMA(0,3,1)	0,998	194,6	10,6
	Daily Case	Brown	0,992	20,3	6,1
	Daily Death	Brown	0,960	9,2	4,5
	Cum. Rec.	ARIMA(0,1,0)	0,924	195,3	10,6
	Active Cases	ARIMA(0,2,1)	0,861	19,2	6,0
Canada	Cum. Case	Brown	0,996	85,3	9,0
	Cum. Death	ARIMA(1,2,0)	0,992	115,1	9,6
	Daily Case	Brown	0,985	1,9	1,3
	Daily Death	ARIMA(1,1,0)	0,891	79,8	8,8
	Cum. Rec.	Holt	0,757	49,1	8,0
Sweden	Cum. Case	ARIMA(0,2,3)	0,998	40,8	7,5
	Cum. Death	Brown	0,998	43,8	7,6
	Daily Case	ARIMA(1,1,1)	0,969	4,7	3,2
	Daily Death	Brown	0,894	2,2	1,6
	Cum.Rec	ARIMA(0,1,0)	0,883	33,5	7,2
Australia	Cum. Case	Holt	0,996	57,1	8,3
	Cum. Death	ARIMA(0,1,0)	0,996	62,9	8,5
	Daily Case	ARIMA(1,1,0)	0,970	0,7	-0,7
	Daily Death	Holt	0,946	10,6	4,8
	Cum. Rec.	Brown	0,790	64,0	8,4
Malaysia	Cum. Case	Brown	0,997	34,7	7,2
	Cum. Death	Brown	0,996	39,6	7,4
	Daily Case	Brown	0,986	0,9	-0,1
	Daily Death	ARIMA(1,1,0)	0,952	16,4	5,7
	Cum. Rec.	Brown	0,768	34,3	7,2

It was seen that the activated cases can be

modeled successfully in 6 out of 11 countries, and there was no time series model that produces a successful forecast for other countries (Table 4, R-squared < 0,50). In addition, success in modeling the number of cumulative recovered numbers in several countries was between 70% and 85%, while the prediction success of models for other indicators was calculated around 99%.

Italy was the second country with the highest number of cases in the world and the country with the highest number of deaths as of the end of March. In general, it was observed that the increase in indicator results continues, but the prevalence in the daily cases and daily death was slower than other indicators when Table 5 and Figure 2, which include the results of the forecast for the next 10 days, were examined.

Table 5. Forecasting for 10 days in Italy

Date	Cum. Cases	Cum. Deaths	Daily Cases	Daily Deaths	Cum. Rec.	Cum. Active Cases
29.03.20	98446	10930	6116	928	13419	73894
30.03.20	104420	11858	6258	970	14385	77712
31.03.20	110394	12808	6401	1012	15349	81530
01.04.20	116368	13781	6543	1054	16803	85348
02.04.20	122342	14775	6685	1097	17665	89166
03.04.20	128316	15791	6827	1139	18738	92984
04.04.20	134290	16829	6970	1181	19896	96802
05.04.20	140264	17888	7112	1223	21167	100620
06.04.20	146238	18970	7254	1266	21993	104438
07.04.20	152212	20073	7396	1308	23228	108256

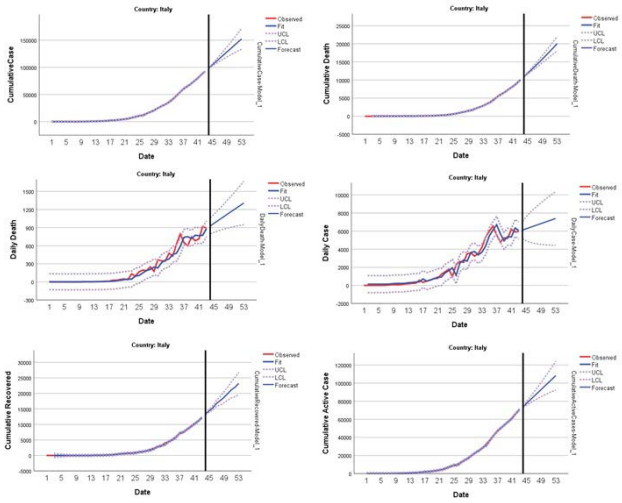

Figure 2. Predicting and forecasting of indicators for Italy

Spain was the 2nd country with the highest total number of deaths and the 4th country with the total number of cases. The forecast values for 10 days after modeling were presented in Table 6 and Figure 3. It can be seen from the graphs that the number of cases and deaths continues to increase.

Table 6. Forecasting for 10 days in Spain

Date	Cum. Cases	Cum. Deaths	Daily Cases	Daily Deaths	Cum. Rec.	Cum. Active Cases
29.03.20	80763	6887	8542	907	15284	58975
30.03.20	88290	7852	8973	970	18359	62966
31.03.20	95818	8878	9403	1033	21506	66956
01.04.20	103345	9965	9834	1096	24727	70947
02.04.20	110873	11112	10265	1159	28021	74938
03.04.20	118400	12320	10695	1222	31388	78928
04.04.20	125928	13589	11126	1285	34829	82919
05.04.20	133455	14918	11557	1348	38342	86909
06.04.20	140983	16309	11987	1411	41929	90900
07.04.20	148510	17759	12418	1474	45589	94891

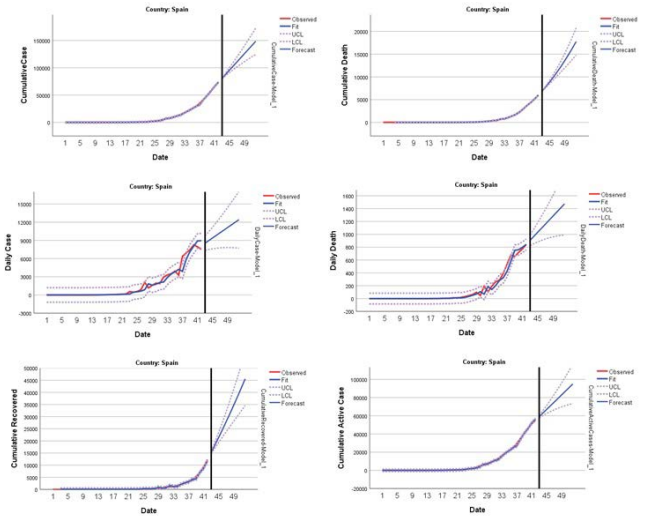

Figure 3. Predicting and forecasting of indicators for Spain

South Korea was a country that has controlled the number of cumulative cases and cumulative deaths since the outbreak. The number of new deaths per day has never exceeded 10. After modeling the obtained data, the 10-day predicted results were given in Table 7 and Figure 4. It was predicted that the changes in the indicators will not change in the first half of April when the table is evaluated.

Table 7. Forecasting for 10 days in South Korea

Date	Cum Cases	Cum Deaths	Daily Cases	Daily Deaths	Cum Rec.
29.03.20	9603	151	119	6	5142
30.03.20	9737	157	132	7	5474
31.03.20	9871	163	126	7	5805
01.04.20	10005	169	129	7	6137
02.04.20	10139	175	127	7	6468
03.04.20	10273	182	128	7	6800
04.04.20	10408	188	128	7	7131
05.04.20	10542	194	128	7	7463
06.04.20	10676	200	128	8	7794
07.04.20	10810	207	128	8	8126

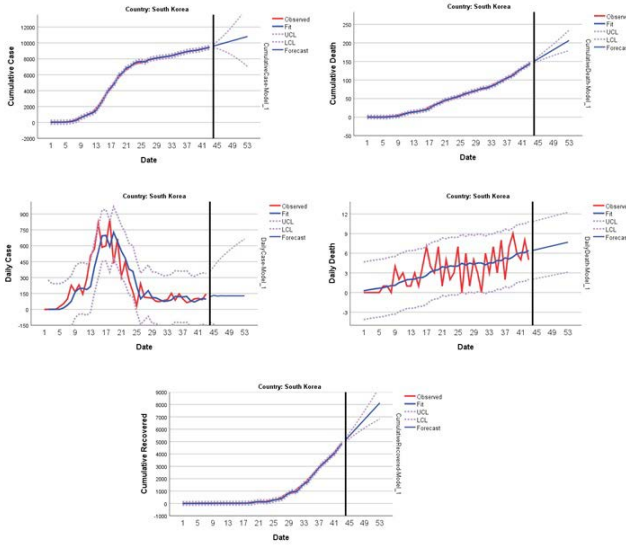

Figure 4. Predicting and forecasting of indicators for South Korea

Germany has been the most successful European country that managed the outbreak for a long time. When the 10-day forecast values given in Table 8 and Figure 5 were examined, it was seen that there will be an increase in the indicators similar to the current days and the cumulative death in the cumulative case is very low (1%).

Table 8. Forecasting for 10 days in Germany

Date	Cum. Cases	Cum. Deaths	Daily Cases	Daily Deaths	Cum. Rec.	Cum. Active Cases
29.03.20	64525	517	7476	95	9664	53860
30.03.20	71356	603	8000	106	11334	58929
31.03.20	78186	691	8524	116	12637	63999
01.04.20	85016	781	9047	127	14219	69068
02.04.20	91847	873	9571	137	15588	74137
03.04.20	98677	967	10094	148	17119	79207
04.04.20	105507	1063	10618	158	18527	84276
05.04.20	112338	1161	11141	169	20029	89346
06.04.20	119168	1261	11665	179	21459	94415
07.04.20	125998	1363	12188	190	22944	99485

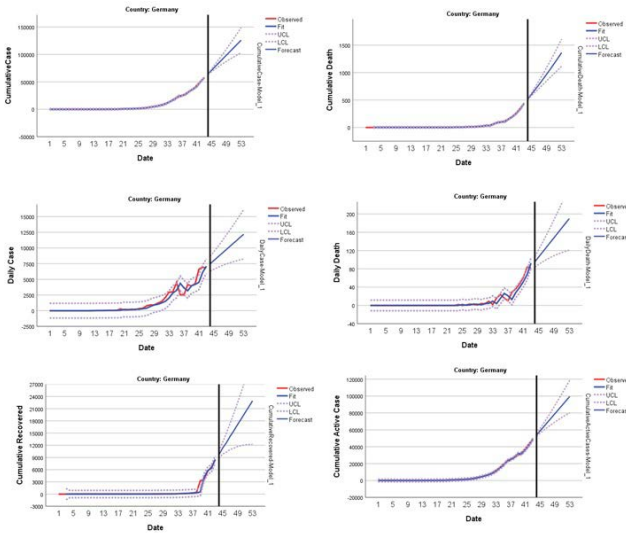

Figure 5. Predicting and forecasting of indicators for Germany

The results for France were summarized in Table 9 and Figure 6. The increase rate in the analyzed indicators continues. In the first half of April, the cumulative recovered prevalence in the cumulative case were expected to be around 14%. The mortality rate in positive cases is expected around 6%.

Table 9. Forecasting for 10 days in France

Date	Cum. Cases	Cum. Deaths	Daily Cases	Daily Deaths	Cum. Rec.	Cum. Active Cases
29.03.20	41837	2631	4773	360	6390	32115
30.03.20	46346	2948	5245	386	6935	35693
31.03.20	50855	3265	5717	412	7479	39271
01.04.20	55364	3581	6189	438	8024	42848
02.04.20	59873	3898	6661	464	8569	46426
03.04.20	64382	4215	7133	490	9113	50004
04.04.20	68891	4532	7605	516	9658	53581
05.04.20	73400	4849	8077	542	10202	57159
06.04.20	77909	5166	8549	568	10747	60737
07.04.20	82418	5483	9021	594	11292	64314

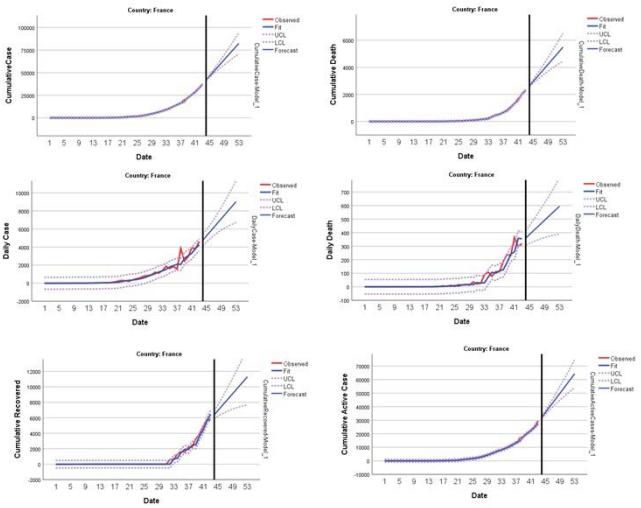

Figure 6. Predicting and forecasting of indicators for France

USA data results were given in Table 10 and Figure 7. The increase rate in the analyzed indicators continues. In the first half of April, the daily case prevalence in cumulative case was expected to be 12% and the cumulative deaths prevalence is around 2%.

Table 10. Forecasting for 10 days in USA

Date	Cum Cases	Cum Deaths	Daily Cases	Daily Deaths	Cum Active Cases.
29.03.20	143030	2849	22619	630	136344
30.03.20	162482	3579	24761	739	154562
31.03.20	181934	4411	26903	848	172780
01.04.20	201386	5346	29045	956	190998
02.04.20	220838	6384	31187	1065	209216
03.04.20	240290	7524	33329	1174	227434
04.04.20	259741	8767	35471	1282	245652
05.04.20	279193	10112	37612	1391	263870
06.04.20	298645	11560	39754	1500	282088
07.04.20	318097	13111	41896	1609	300306

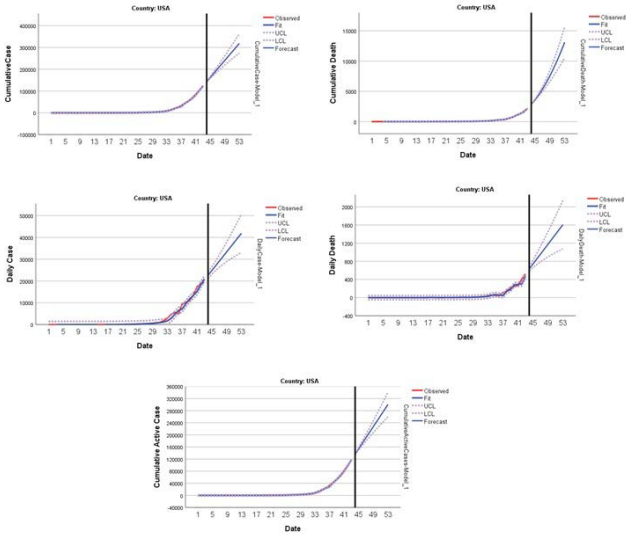

Figure 7. Predicting and forecasting of indicators for USA

The results of UK data were given in Table 11 and Figure 8. The rate of increase in the indicator values examined was similar in the first week of April. In this period, the cumulative recovered prevalence was quite low. The cumulative active case prevalence was found to be quite high (90%).

Table 11. Forecasting for 10 days in UK

Date	Cum. Cases	Cum. Deaths	Daily Cases	Daily Deaths	Cum. Rec.	Cum. Active Cases
29.03.20	20728	1332	2984	317	130	19333
30.03.20	25264	1698	3265	378	133	23551
31.03.20	30982	2117	3546	440	136	28853
01.04.20	38277	2589	3827	502	139	35590
02.04.20	47704	3114	4109	564	142	44250
03.04.20	60049	3691	4390	626	145	55517
04.04.20	76446	4322	4671	687	148	70365
05.04.20	98553	5006	4952	749	151	90196
06.04.20	128826	5743	5233	811	154	117059
07.04.20	170970	6532	5515	873	157	153989

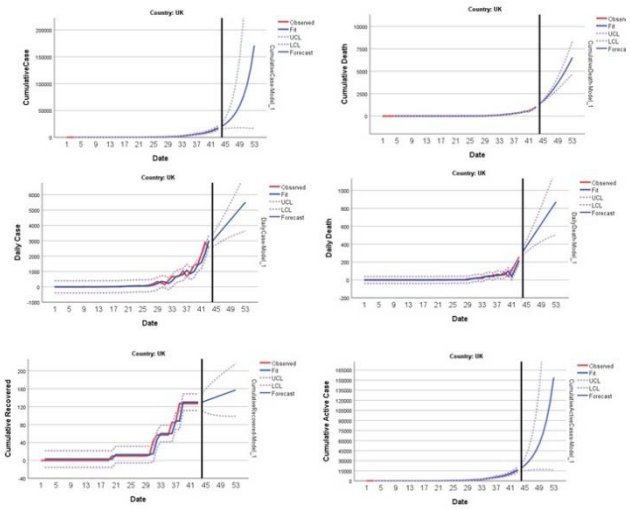

Figure 8. Predicting and forecasting of indicators for UK

When Canada data was evaluated, it is seen that the number of daily deaths is estimated to be quite low (Table 12 and Figure 9). The cumulative recovered prevalence was expected to be around 7% and the cumulative active case prevalence was around 87% in the first week of April.

Table 12. Forecasting for 10 days in Canada

Date	Cum. Cases	Cum. Deaths	Daily Cases	Daily Deaths	Cum. Rec.	Cum. Active Cases
29.03.20	6551	75	920	15	442	5939
30.03.20	7448	81	993	6	512	6688
31.03.20	8344	95	1066	14	582	7437
01.04.20	9241	102	1139	6	652	8185
02.04.20	10137	116	1212	14	722	8934
03.04.20	11034	123	1285	7	792	9683
04.04.20	11930	136	1358	13	862	10432
05.04.20	12827	144	1431	7	932	11180
06.04.20	13723	157	1504	13	1002	11929
07.04.20	14619	164	1577	8	1072	12678

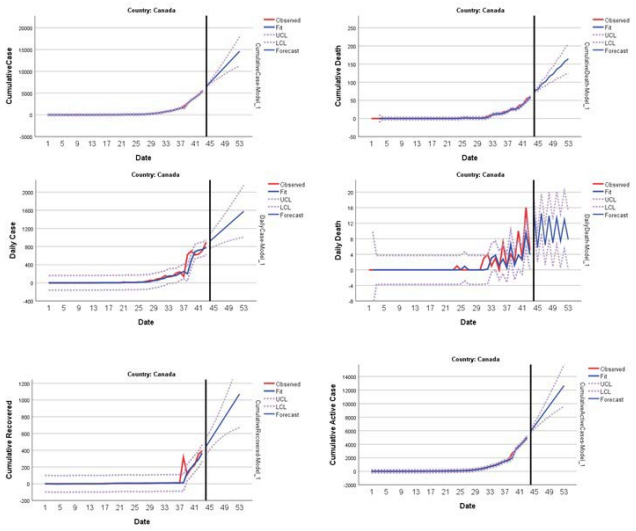

Figure 9. Predicting and forecasting of indicators for Canada

When Sweden's data was evaluated, it was predicted that the new daily case prevalence will be around 5% in the first week of April, and the daily mortality and recovered prevalence will still be at a very low level. In addition, cumulative death prevalence in cumulative case was estimated at 4% levels (Table 13 and Figure 10).

Table 13. Forecasting for 10 days in Sweden

Date	Cum Cases	Cum Deaths	Daily Cases	Daily Deaths	Cum Rec
29.03.20	3822	120	288	14	15
30.03.20	4242	132	377	15	16
31.03.20	4633	144	289	16	16
01.04.20	5042	157	375	17	16
02.04.20	5469	169	290	17	17
03.04.20	5916	182	374	18	17
04.04.20	6383	194	292	19	17
05.04.20	6870	206	373	20	18
06.04.20	7376	219	293	20	18
07.04.20	7904	231	371	21	19

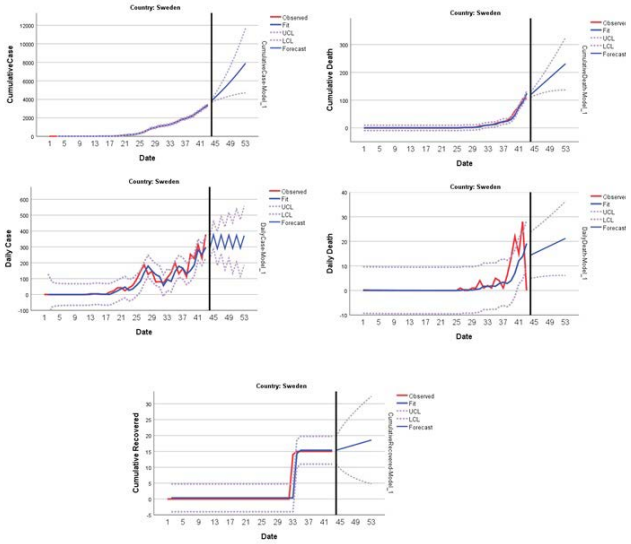

Figure 10. Predicting and forecasting of indicators for Sweden

At the end of the modeling for Australia data, it was predicted that the number of daily deaths will be very low in the first week of April, and the cumulative death prevalence will be observed at a very low level in the cumulative case. In addition, daily new cases and cumulative recovered prevalence were estimated to be around 4% (Table 14 and Figure 11).

Table 14. Forecasting for 10 days in Australia

Date	Cum Cases	Cum Deaths	Daily Cases	Daily Deaths	Cum Rec
29.03.20	3934	14	300	1	180
30.03.20	4205	15	274	1	193
31.03.20	4476	15	290	1	207
01.04.20	4747	15	280	1	220
02.04.20	5019	16	286	1	234
03.04.20	5290	16	283	1	247
04.04.20	5561	16	285	1	261
05.04.20	5832	17	283	1	274
06.04.20	6103	17	284	1	288
29.03.20	3934	14	300	1	180

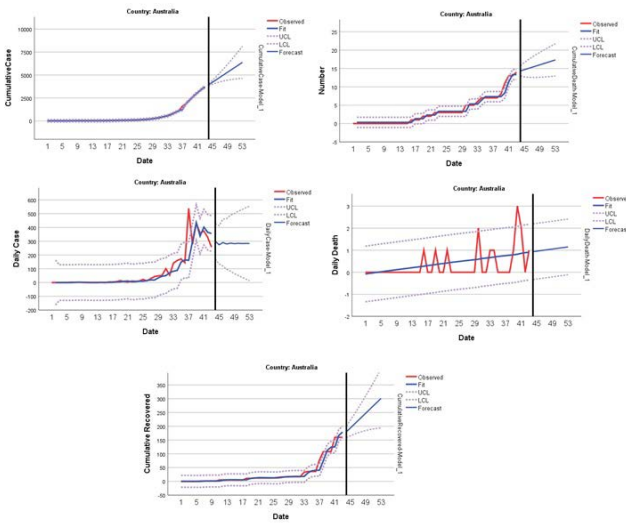

Figure 11. Predicting and forecasting of indicators for Australia

When Malaysia results were analyzed, it was predicted that the number of daily deaths will be very low and the cumulative death prevalence in the cumulative case will be 1% in the first week of April. In addition, the daily case prevalence was estimated to be around 6% and the cumulative recovered prevalence around 15% (Table 15 and Figure 12). These results emphasized that Malaysia has shown successful results in struggle with the outbreak.

Table 15. Forecasting for 10 days in Malaysia

Date	Cum. Cases	Cum. Deaths	Daily Cases	Daily Deaths	Cum. Rec.	Cum. Active Cases
29.03.20	2482	29	183	2	333	2105
30.03.20	2642	32	189	1	365	2223
31.03.20	2803	34	195	2	398	2342
01.04.20	2963	36	201	2	430	2460
02.04.20	3124	38	207	2	463	2578
03.04.20	3284	40	213	2	495	2697
04.04.20	3444	42	219	2	528	2815
05.04.20	3605	45	225	2	560	2934
06.04.20	3765	47	231	2	593	3052
07.04.20	3926	49	237	2	625	3170

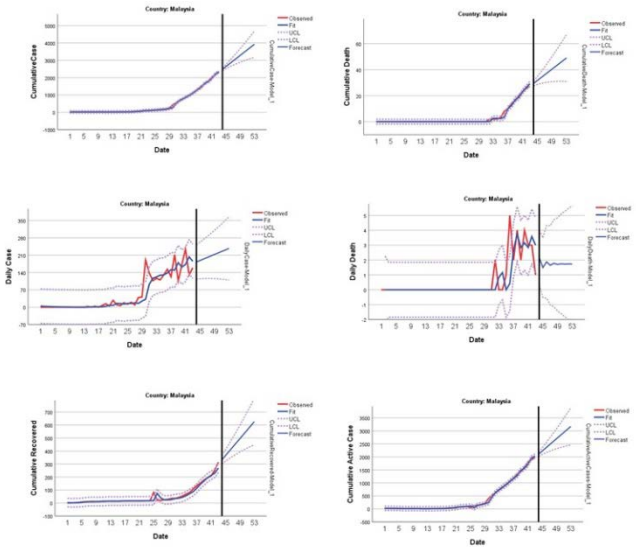

Figure 12. Predicting and forecasting of indicators for Malaysia

Model performance criteria obtained when Belgium data exposed to the outbreak between February 1-15 were modeled (Table 16).

Table 16. Time series models for Belgium that announced the first case in the period of 1-15 Feb

Country		Model	R^2	RMSE	BIC
Belgium	Cumulative Case	Brown	,994	170,678	10,367
	Cumulative Death	Brown	,992	164,562	10,382
	Daily Case	Brown	,990	7,946	4,233
	Daily Death	Holt	,983	32,323	7,039
	Cumulative Recovered	Brown	,860	6,791	4,006

For Belgium, it was predicted that the daily mortality prevalence would be low in the cumulative case, the daily case prevalence would be around 15% and the cumulative recovered prevalence would be around 10% in the first week of April (Table 17 and Figure 13).

Table 17. Forecasting for 10 days in Belgium

Date	Cum. Cases	Cum. Deaths	Daily Cases	Daily Deaths	Cum. Rec.	Cum. Active Cases
29.03.20	10842	417	1879	79	1241	9035
30.03.20	12556	481	2113	90	1425	10474
31.03.20	14270	546	2346	101	1608	11912
01.04.20	15984	610	2579	112	1791	13351
02.04.20	17698	674	2812	123	1975	14789
03.04.20	19412	738	3045	135	2158	16227
04.04.20	21126	802	3279	146	2341	17666
05.04.20	22840	867	3512	157	2525	19104
06.04.20	24555	931	3745	168	2708	20542
07.04.20	26269	995	3978	179	2891	21981

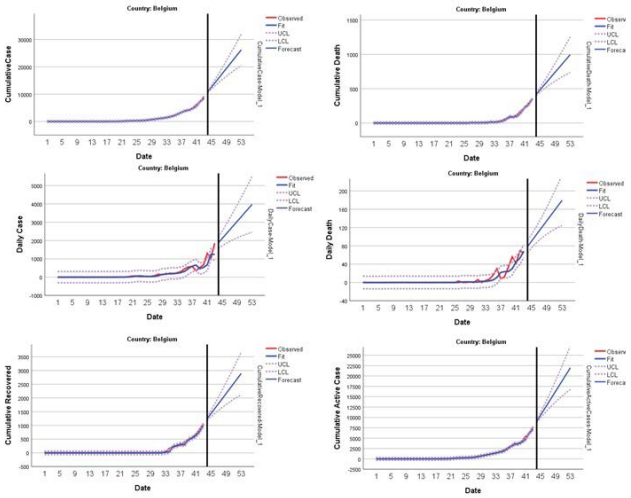

Figure 13. Predicting and forecasting of indicators for Belgium

Iran and Israel, which were exposed to the outbreak between 16-20 February, model performance criteria obtained and the model results were given in Table 18.

Table 18. Time series models for Iran and Israel that announced the first case in the period of 16-20 Feb

Country		Model	R^2	RMSE	BIC
Iran	Cum Case	Brown	1,000	9,938	4,687
	Cum Death	Brown	1,000	231,627	10,984
	Daily Case	ARIMA(0,1,0)	,998	294,052	11,461
	Daily Death	ARIMA(0,1,0)	,997	195,074	10,641
	Cum Rec	Brown	,975	9,364	4,570
	Active Cases	Brown	,921	219,931	10,882
Israel	Cum Case	Brown	,994	77,028	8,786
	Cum Death	Brown	,993	76,848	8,781
	Daily Case	Brown	,981	3,401	2,643
	Daily Death	ARIMA(1,0,0)	,937	,770	-,426
	Cum Rec	Holt	,797	72,314	8,660

When Iran data is modeled, it was predicted that the daily mortality prevalence in the cumulative case will be low in the first week of April, the daily case prevalence would be around 6% and the cumulative recovered prevalence will be around 30% (Table 19 and Figure 14).

Table 19. Forecasting for 10 days in Iran

Date	Cum. Cases	Cum. Deaths	Daily Cases	Daily Deaths	Cum. Rec.	Cum. Active Cases
29.03.20	38484	2656	3157	143	12346	23540
30.03.20	41560	2795	3238	146	12990	25870
31.03.20	44636	2934	3319	150	13634	28200
01.04.20	47712	3073	3400	154	14278	30531
02.04.20	50788	3212	3481	157	14923	32861
03.04.20	53864	3351	3562	161	15567	35192
04.04.20	56940	3490	3643	165	16211	37522
05.04.20	60016	3629	3724	168	16855	39853
06.04.20	63092	3768	3805	172	17499	42183
07.04.20	66168	3907	3885	176	18143	44514

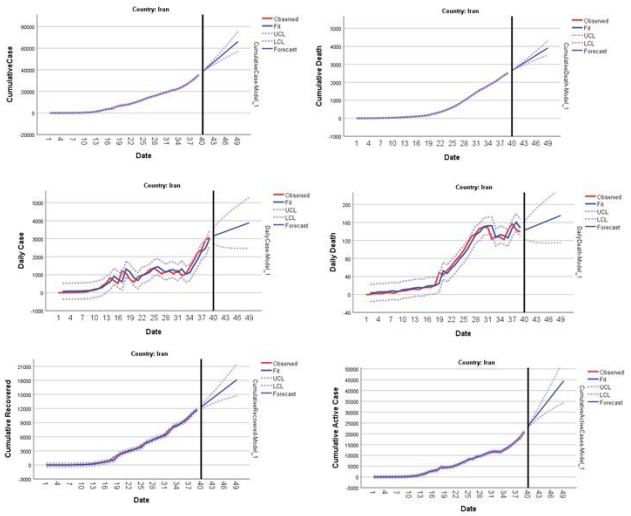

Figure 14. Predicting and forecasting of indicators for Iran

When Israel data was modeled, it is predicted that there would be no new daily deaths in the first week of April, the daily case prevalence in the cumulative case would be around 10% and the cumulative recovered prevalence would be around 2% (Table 20 and Figure 15).

Table 20. Forecasting for 10 days in Israel

Date	Cum Cases	Cum Deaths	Daily Cases	Daily Deaths	Cum Rec
29.03.20	4130	14	527	0	96
30.03.20	4647	16	562	0	106
31.03.20	5163	17	598	0	116
01.04.20	5680	19	633	0	126
02.04.20	6197	21	668	0	136
03.04.20	6713	22	704	0	147
04.04.20	7230	24	739	0	157
05.04.20	7747	26	775	0	167
06.04.20	8263	27	810	0	177
07.04.20	8780	29	845	0	187

The model performance criteria obtained when the data of 7 countries selected among the countries exposed to the outbreak between 21-29 February were modeled are given in Table 21.

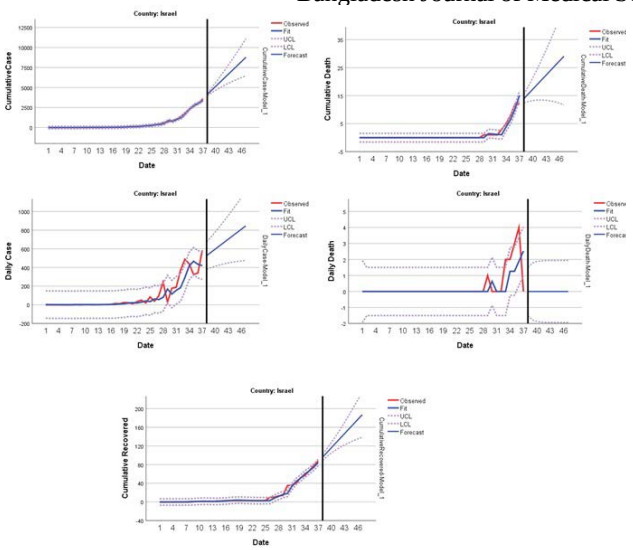

Figure 15. Predicting and forecasting of indicators for Israel

Table 21. Time series models for Iran and Israel that announced the first case in the period of 21-29 February

Country		Model Type	R^2	RMSE	BIC
Switzerland	Cum Case	Brown	,997	259,03	11,220
	Cum Death	Brown	,992	359,20	11,874
	Daily Case	Brown	,992	6,64	3,894
	Daily Death	Holt	,782	5,80	3,728
	Cum Rec	Brown	,730	254,9	11,188
Netherlands	Cum Case	Brown	,999	73,19	8,697
	Cum Death	Brown	,999	78,75	8,843
	Daily Case	Brown	,996	10,42	4,799
	Daily Death	Holt	,968	65,37	8,471
	Cum Rec	ARIMA(0,1,0)	,935	8,224	4,436
	Active Cases	Brown	,882	0,403	-1,706
Austria	Cum Case	Holt	,996	157,0	10,325
	Cum Death	Holt	,995	169,5	10,477
	Daily Case	Holt	,980	2,59	2,115
	Daily Death	Holt	,888	19,25	6,026
	Cum Rec	ARIMA(0,2,2)	,715	178,46	10,581
Norway	Cum Case	Brown	,998	51,37	7,987
	Cum Death	Brown	,998	51,13	7,977
	Daily Case	Simple	,963	1,192	,460
	Daily Death	Brown	,860	0,956	,021
	Cum Rec	ARIMA(0,1,0)	,766	51,34	7,985
Brazil	Cum Case	Holt	,998	55,99	8,263
	Cum Death	ARIMA(0,2,0)	,998	55,18	8,233
	Daily Case	Brown	,997	1,792	1,278
	Daily Death	Holt	,963	1,172	,529
	Cum Rec	ARIMA(0,1,0)	,894	52,84	8,041
	Active Cases	Holt	,829	0,738	-,500
	Daily Death	ARIMA(1,1,0)	,952	16,36	5,678
	Cum Rec	Brown	,768	34,33	7,160
Denmark	Cum Case	Brown	,997	40,38	7,507
	Cum Death	Brown	,997	40,64	7,521
	Daily Case	Simple	,978	2,581	2,007
	Daily Death	Holt	,815	0,183	-3,290
Ireland	Cum Case	Brown	,998	34,26	7,184
	Cum Death	ARIMA(1,2,0)	,998	34,17	7,179
	Daily Case	Holt	,938	2,071	1,578
	Daily Death	ARIMA(1,1,0)	,925	28,02	6,899
	Cum Rec	ARIMA(0,1,0)	,905	0,772	-,398

It was predicted that the number of new daily deaths will be low in the first week of April, the daily case prevalence in the cumulative case would be around 6-10% and the cumulative recovered prevalence would be around 75% when Switzerland data was modeled (Table 22 and Figure 16).

Table 22. Forecasting for 10 days in Switzerland

Date	Cum. Cases	Cum. Deaths	Daily Cases	Daily Deaths	Cum. Rec.	Cum. Active Cases
29.03.20	15177	299	1213	40	1861	12858
30.03.20	16284	334	1256	44	2202	13499
31.03.20	17392	368	1299	48	2543	14141
01.04.20	18500	403	1342	53	2884	14783
02.04.20	19608	438	1384	57	3225	15425
03.04.20	20716	473	1427	61	3566	16067
04.04.20	21824	507	1470	65	3907	16709
05.04.20	22932	542	1513	69	4248	17351
06.04.20	24039	577	1556	73	4589	17993
07.04.20	25147	612	1599	77	4930	18635

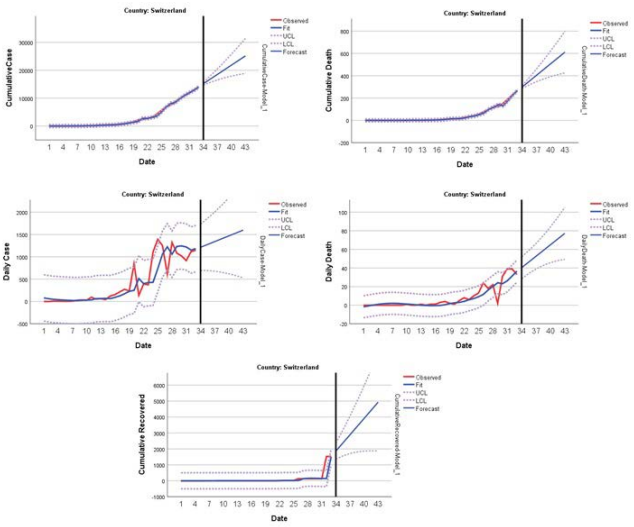

Figure 16. Predicting and forecasting of indicators for Switzerland

When the Netherlands results were analyzed, it was predicted that cumulative recovered and daily new deaths are very low in the first week of April, the daily case prevalence in the cumulative case would be around 8-10% and the cumulative active case prevalence would be reach around 92% (Table 23 and Figure 17).

Table 23. Forecasting for 10 days in Netherlands

Date	Cum. Cases	Cum. Deaths	Daily Cases	Daily Deaths	Cum. Rec.	Cum. Active Cases
29.03.20	10921	734	1282	121	3	10189
30.03.20	12080	830	1375	135	3	11255
31.03.20	13239	925	1468	149	3	12321
01.04.20	14398	1020	1561	163	3	13387
02.04.20	15557	1116	1654	177	4	14453
03.04.20	16716	1211	1747	190	4	15519
04.04.20	17875	1306	1840	204	4	16585
05.04.20	19034	1402	1933	218	4	17651
06.04.20	20193	1497	2026	232	4	18717
07.04.20	21352	1592	2119	245	4	19783

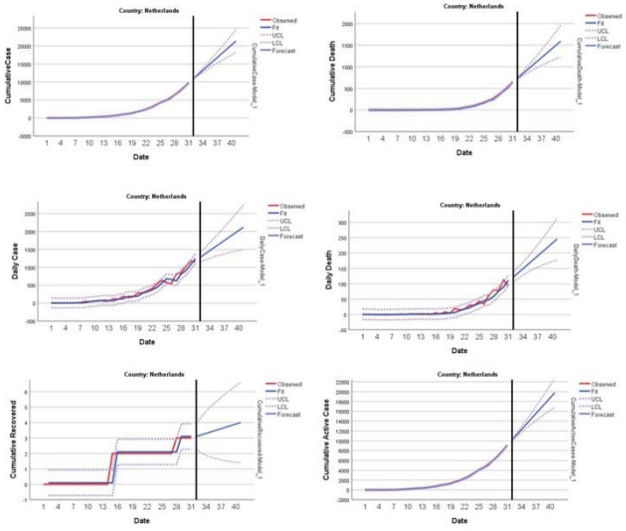

Figure 17. Predicting and forecasting of indicators for Netherlands

When the results of Austria data were evaluated, it was predicted that cumulative death, daily new death and cumulative recovered prevalence would be quite low in the first week of April. In addition, the cumulative recovered prevalence in the cumulative case was estimated to be around 2% (Table 24 and Figure 18).

Table 24. Forecasting for 10 days in Austria

Date	Cum. Cases	Cum. Deaths	Daily Cases	Daily Deaths	Cum. Rec.	Cum. Active Cases
29.03.20	9270	81	998	14	216	8867
30.03.20	10106	93	1025	16	226	9601
31.03.20	10941	105	1052	18	236	10336
01.04.20	11777	117	1079	20	246	11070
02.04.20	12613	129	1106	21	256	11804
03.04.20	13448	141	1134	23	266	12539
04.04.20	14284	153	1161	25	275	13273
05.04.20	15120	165	1188	27	285	14007
06.04.20	15955	177	1215	28	295	14742
07.04.20	16791	189	1242	30	305	15476

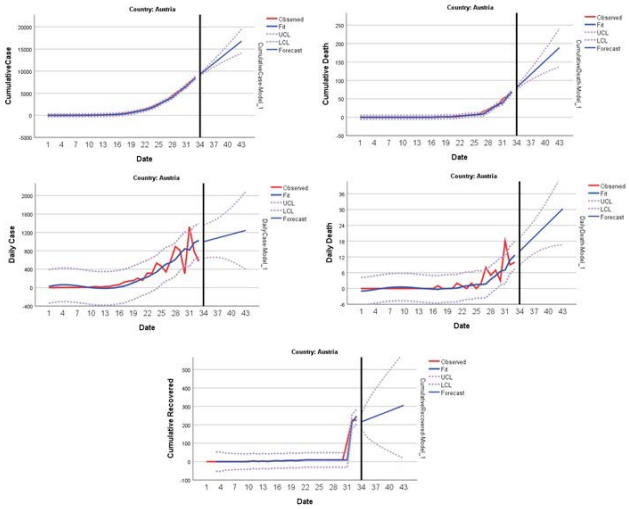

Figure 18. Predicting and forecasting of indicators for Austria

Cumulative death, Daily new death and cumulative recovered prevalence were predicted to be quite low in the first week of April for Norway. In addition, the prevalence of daily new cases in the cumulative case was estimated to be around 6-7% (Table 25 and Figure 19).

Table 25. Forecasting for 10 days in Norway

Date	Cum Cases	Cum Deaths	Daily Cases	Daily Deaths	Cum Rec
29.03.20	4294	26	277	3	7
30.03.20	4571	29	277	3	7
31.03.20	4849	32	277	3	8
01.04.20	5126	35	277	4	8
02.04.20	5403	38	277	4	8
03.04.20	5680	41	277	4	8
04.04.20	5957	44	277	4	9
05.04.20	6234	47	277	4	9
06.04.20	6511	51	277	4	9
07.04.20	6788	54	277	5	9

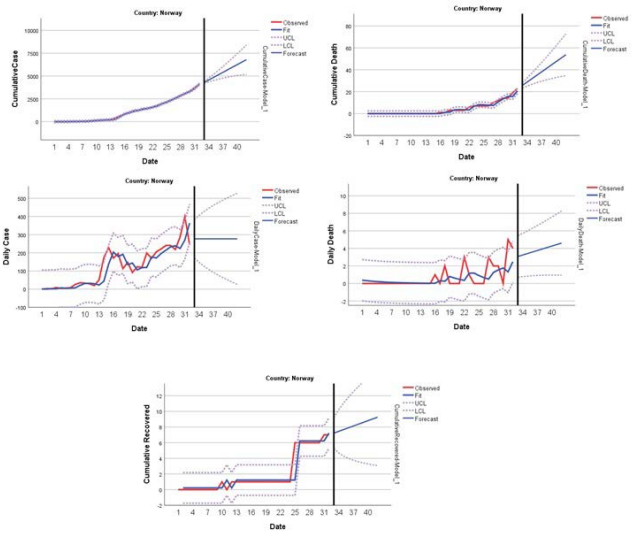

Figure 19. Predicting and forecasting of indicators for Norway

The prevalence of daily new death and cumulative recovered were predicted to be quite low in the first week of April for Brazil. On the other hand, the cumulative active case ratio in cumulative cases was estimated at 95% (Table 26 and Figure 20).

Table 26. Forecasting for 10 days in Brazil

Date	Cum. Cases	Cum. Deaths	Daily Cases	Daily Deaths	Cum. Rec.	Cum. Active Cases
29.03.20	4371	137	502	23	6	4231
30.03.20	4860	160	532	25	6	4700
31.03.20	5349	184	562	28	7	5168
01.04.20	5838	209	592	30	7	5636
02.04.20	6326	235	622	33	7	6105
03.04.20	6815	261	652	35	7	6573
04.04.20	7304	288	682	38	7	7041
05.04.20	7793	316	712	40	8	7510
06.04.20	8282	344	742	43	8	7978
07.04.20	8771	373	772	45	8	8446

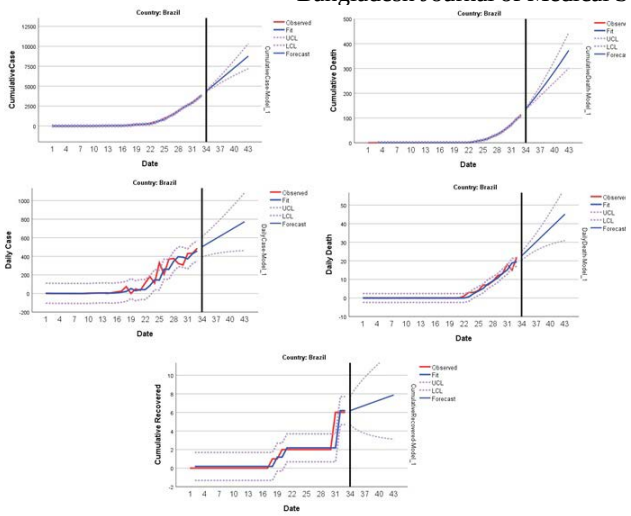

Figure 20. Predicting and forecasting of indicators for Brazil

According to Denmark results, the prevalence of daily new death and cumulative recovered were predicted to be quite low in the first week of April. On the other hand, the cumulative active case ratio in the cumulative case was estimated at 95% (Table 27 and Figure 21).

Table 27. Forecasting for 10 days in Denmark

Date	Cum. Cases	Cum. Deaths	Daily Cases	Daily Deaths	Cum. Rec.	Cum. Active Cases
29.03.20	2356	75	155	12	1	2277
30.03.20	2511	86	155	13	1	2419
31.03.20	2666	97	155	15	1	2561
01.04.20	2821	108	155	16	1	2703
02.04.20	2976	119	155	18	1	2845
03.04.20	3131	130	155	19	1	2987
04.04.20	3286	141	155	21	1	3129
05.04.20	3441	152	155	23	1	3271
06.04.20	3596	163	155	24	1	3413
07.04.20	3751	173	155	26	1	3555

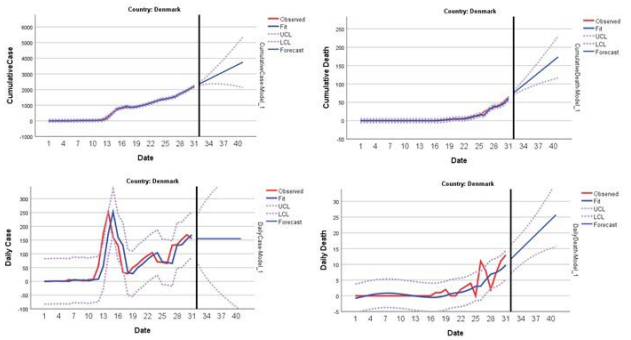

Figure 21. Predicting and forecasting of indicators for Denmark

It was predicted that daily new death and cumulative recovered prevalence will be quite low in the first week of April for Ireland. On the other hand, the cumulative active case prevalence in the cumulative case was estimated at 95% and the daily case prevalence was estimated at 7-10% (Table 28 and Figure 22).

Table 28. Forecasting for 10 days in Ireland

Date	Cum. Cases	Cum. Deaths	Daily Cases	Daily Deaths	Cum. Rec.	Cum. Active Cases
29.03.20	2709	40	328	4	5	2656
30.03.20	3004	53	354	13	5	2938
31.03.20	3298	58	380	5	6	3220
01.04.20	3593	70	405	12	6	3502
02.04.20	3887	76	431	6	6	3784
03.04.20	4181	88	457	12	6	4066
04.04.20	4476	94	483	6	6	4348
05.04.20	4770	105	508	11	6	4630
06.04.20	5064	112	534	7	7	4912
07.04.20	5359	122	560	11	7	5194

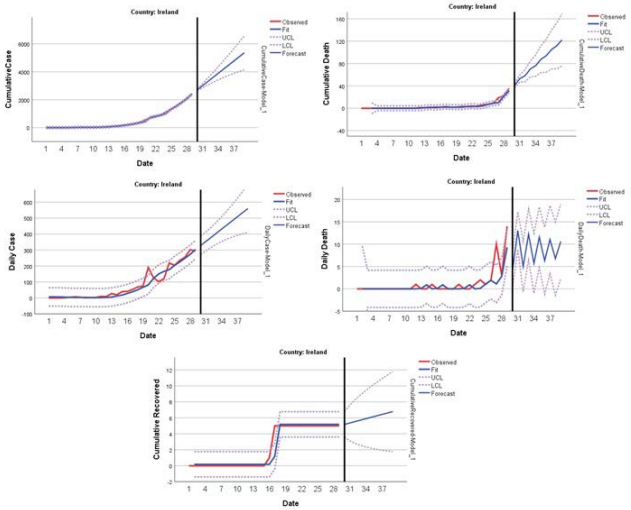

Figure 22. Predicting and forecasting of indicators for Ireland

Table 29 shows the model performance criteria for data from two countries selected from countries exposed to the outbreak between 1-7 March.

Table 29. Time series models for Iran and Israel that announced the first case in the period of 1-7 March

Country		Model Type	R^2	RMSE	BIC
Portugal	Cum Case	ARIMA(1,2,0)	,998	71,667	8,673
	Cum Death	Holt	,997	72,671	8,701
	Daily Case	Holt	,991	2,550	2,117
	Daily Death	Holt	,937	65,057	8,595
	Cum Rec	Brown	,925	1,807	1,427
	Active Cases	ARIMA(1,2,0)	,901	4,364	3,069
Poland	Cum Case	Brown	,998	22,988	6,399
	Cum Death	Brown	,998	23,721	6,461
	Daily Case	Holt	,971	0,957	0,040
	Daily Death	Holt	,950	15,681	5,762
	Cum Rec	Simple	,619	3,727	2,760

When Portugal's results were analyzed, it was predicted that daily new death and cumulative recovered prevalence would be quite low in the first week of April. On the other hand, the prevalence of daily cases in the cumulative cases was at most 15% and it was predicted that this prevalence will decrease gradually, but the cumulative active cases prevalence would be 95% (Table 30 and Figure 23).

Table 30. Forecasting for 10 days in Portugal

Date	Cum. Cases	Cum. Deaths	Daily Cases	Daily Deaths	Cum. Rec.	Cum. Active Cases
29.03.20	6284	121	947	25	50	6114
30.03.20	7709	144	1083	29	55	7503
31.03.20	9619	167	1219	34	60	9364
01.04.20	12249	190	1355	38	65	11923
02.04.20	16036	213	1491	42	70	15602
03.04.20	21677	236	1626	46	76	21071
04.04.20	30450	258	1762	50	81	29556
05.04.20	44673	281	1898	54	86	43272
06.04.20	68855	304	2034	58	91	66512
07.04.20	112099	327	2170	62	96	107899

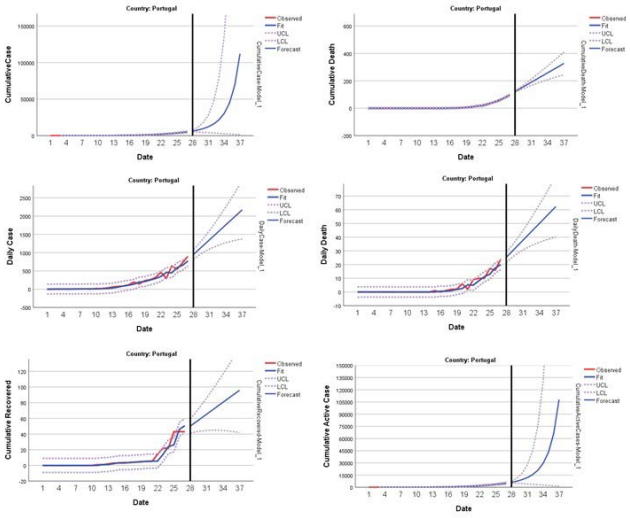

Figure 23. Predicting and forecasting of indicators for Portugal

It was predicted that cumulative death, daily new death and cumulative recovered prevalence would be quite low in the first week of April when Poland results were analyzed. The prevalence of daily new cases in the cumulative case was estimated at around 20% (Table 31 and Figure 24).

Table 31. Forecasting for 10 days in Poland

Date	Cum Cases	Cum Deaths	Daily Cases	Daily Deaths	Cum Rec
29.03.20	1879	19	233	2	7
30.03.20	2120	21	258	2	7
31.03.20	2361	22	283	2	7
01.04.20	2603	24	308	2	7
02.04.20	2844	25	333	2	7
03.04.20	3085	27	358	2	7
04.04.20	3326	28	383	2	7
05.04.20	3568	30	408	2	7
06.04.20	3809	32	433	3	7
07.04.20	4050	33	458	3	7

The model performance criteria obtained when the data of one country selected among the countries exposed to the outbreak between 8-15 March are modeled were given in Table 32.

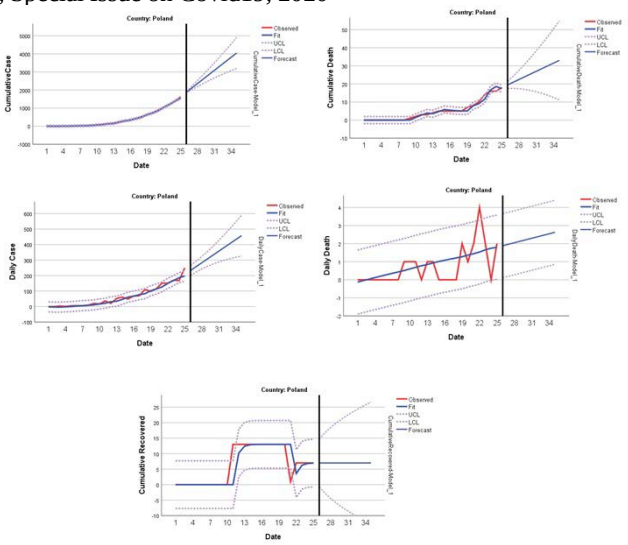

Figure 24. Predicting and forecasting of indicators for Poland

Table 32. Time series models for Turkey that announced the first case in the period of 8-15 March

Country		Model Type	R^2	RMSE	BIC
Turkey	Cum Case	ARIMA(0,1,0)	,995	4,354	3,092
	Cum Death	ARIMA(0,2,0)	,979	602,322	13,092
	Daily Case	ARIMA(0,1,0)	,978	593,394	13,062
	Daily Death	Brown	,969	11,546	5,042
	Cum Rec	ARIMA(0,2,0)	,894	4,092	2,959
	Active Cases	ARIMA(0,1,0)	,836	337,764	11,790

When the results of Turkey were analyzed, it was seen that the cumulative death prevalence in the cumulative case was about 1% in the first week of April, the daily case prevalence showed a decline, the forecast was around 6% on the tenth day and the cumulative recovered prevalence was around 2% (Table 33 and Figure 25).

Table 33. Forecasting for 10 days in Turkey

Date	Cum. Cases	Cum. Deaths	Daily Cases	Daily Deaths	Cum. Rec.	Cum. Active Cases
29.03.20	6284	121	947	25	50	6114
30.03.20	7709	144	1083	29	55	7503
31.03.20	9619	167	1219	34	60	9364
01.04.20	12249	190	1355	38	65	11923
02.04.20	16036	213	1491	42	70	15602
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04.04.20	30450	258	1762	50	81	29556
05.04.20	44673	281	1898	54	86	43272
06.04.20	68855	304	2034	58	91	66512
07.04.20	112099	327	2170	62	96	107899

In the Table 34, on the 5th day after modeling for each country, it was calculated as the prevalence of the indicators in the cumulative cases as %.

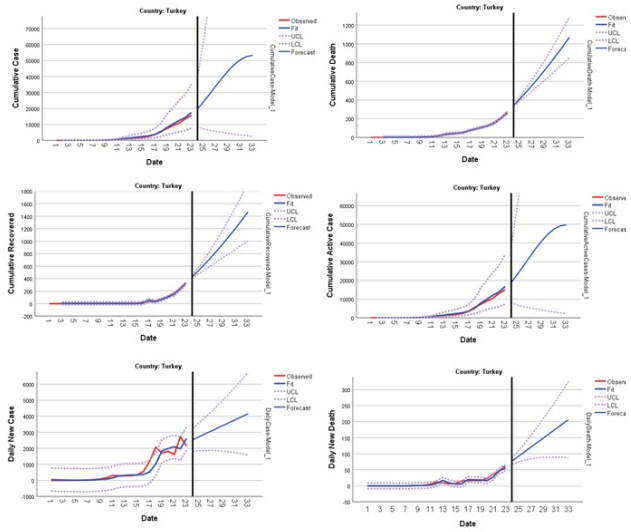

Figure 25. Predicting and forecasting of indicators for Turkey

Table 34. The ratios of the predicted values of the indicators in the cumulative case for the first week of April

Period	Country	Proportions in Cumulative Case				
		Cum Death %	Daily Case %	Daily Death %	Cum. Rec %	Cum. Active Case %
Dec 31 - Jan 15	China	4,07	0,06	0,01	95,18	--
Jan 16 - Jan 31	Italy	12,08	5,46	0,90	14,44	72,88
	Spain	10,02	9,26	1,05	25,27	67,59
	South K	1,73	1,25	0,07	63,79	--
	Germany	0,95	10,42	0,15	16,97	80,72
	France	6,51	11,13	0,77	14,31	77,54
	USA	2,89	14,12	0,48	--	94,74
	UK	6,53	8,61	1,18	0,30	92,76
	Canada	1,14	11,96	0,14	7,12	88,13
	Sweden	3,09	5,30	0,31	0,31	--
	Australia	0,32	5,70	0,02	4,66	--
	Malaysia	1,22	6,63	0,06	14,82	82,52
Feb 1 - Feb 15	Belgium	3,81	15,89	0,69	11,16	83,56
Feb 16 - Feb 20	Iran	6,32	6,85	0,31	29,38	64,70
	Israel	0,34	10,78	0,00	2,19	--
Feb 21– Feb 29	Swtzerland	2,23	7,06	0,29	16,45	78,67
	Netherlands	7,17	10,63	1,14	0,03	92,90
	Austria	1,02	8,77	0,17	2,03	93,59
	Norway	0,70	5,13	0,07	0,15	--
	Brazil	3,71	9,83	0,52	0,11	96,51
	Denmark	4,00	5,21	0,60	0,03	95,60
	Ireland	1,96	11,09	0,15	0,15	97,35
March 1- March 7	Portugal	1,33	9,30	0,26	0,44	97,29
	Poland	0,88	11,71	0,07	0,25	--
March 8- March 15	Turkey	1,18	8,27	0,23	1,75	95,60

*: The calculations were made with on the 5th day after modeling for each country.

According to results, the cumulative death prevalence in Italy and Spain is the highest, followed by the Netherlands, France, UK China, Denmark, Belgium, Brazil and Sweden respectively. The daily new case proportion in cumulative cases can also be considered as an indicator of an increase or decrease in the severity of the outbreak. The highest values was observed in Belgium, USA, Canada, Poland, Ireland, Netherlands, France, and Israel, which vary between 10% and 12% and the lowest proportions was observed in China and South Korea. The daily deaths proportion in the cumulative case was low in many countries and similar. But it is lowest in Netherlands. The cumulative recovered proportion in the cumulative case is the important criteria for outbreak. This proportion was the highest in China, followed by South Korea. However, the highest value was in Switzerland (16.45%) among the ten countries exposed to the outbreak after February 21. The prevalence was found 1.75% for Turkey. Finally, the active case proportion in cumulative case was another criterion that can be used to evaluate the course of the outbreak. The predicted active case proportions are high in most of countries. This result shows that there are many people in the active disease period.

DISCUSSION AND CONCLUSION

The results obtained from the evaluations made with limited epidemiological data at the beginning of March or earlier have transferred some information to the present. As of the end of March, the longest 3.5 months and the shortest 1 month data are available and their evaluation is of great importance. The results of this study gives an important information for the countries struggling with the outbreak in less than one month or who have not yet been exposed to the outbreak. Also future models that can be simulated against similar risks will be obtained.

It was predicted that the outbreak in China was almost under control as a result of the models obtained with this study. The number of cases and deaths has increased rapidly in Italy and the country could not control the outbreak since the outbreak started. However, it was seen that there was a relatively increase in the proportion of the recovered. Both the rapid case increase to date and the increase seen in future forecasts show that Spain has not yet been able to control the outbreak. The new case and recovered case proportions were higher than Italy. It is seen that there has not been a significant decrease in the severity of the outbreak, although it has been 2.5 months since Italy and Spain announced the first case. South Korea, which started to fight the outbreak in the same period, was the most successful country in terms of results, followed by Germany. The results in Iran was better than Israel, which is in the same period, and France that the outbreak started 1 month ago. The results of Turkey was similar to Germany and Ireland.

The differences and advantages of this study from the modelling studies published before can be summarized as follows.

- Modeling and comparative analysis of real-time and retrospective data of 25 countries with a total number of cases exceeding 1000 among infected countries until 10 March,
- The number of data of the most countries has reached sufficient size to develop a good model
- It is also the evaluation of trend and seasonal effect in time series models.

Conflict of interest

The author declares no competing interest

Author's contribution

All authors participated equally in this research and preparation of manuscript.

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