ORIGINAL ARTICLE

AHI EVRAN MEDICAL JOURNAL
E-ISSN: 2619 - 9203

Importance of Tracking COVID-19 Data from Official Sources for Short-Term Forecasting of Cases and Deaths

Vaka ve Ölüm Sayılarının Kısa Dönem Tahmini için Resmi Kaynaklardan COVID-19 Veri Takibinin Önemi

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ÖZ

Amaç: COVID-19 salgını sırasında hükümetler, bilim adamları, sağlık çalışanları ve çok sayıda insan, hastalığın yayılmasını durdurmak için stratejiler veya çözümler üzerinde çalışmıştır. Ne yazık ki artık vakaların izleme ihtiyacı hızla artmakta ve gerekli veya kısıtlayıcı önlemlerin alınması kaçınılmaz hale gelmektedir. Epidemiyolojik verilerin eksikliği ve sürekli değişen sayılar nedeniyle, daha az hataya açık tahmin modelleri ve yakın gelecek için güvenilir matematiksel modeller oluşturmak, daha iyi yasal eylemler ve önleme stratejilerinin harekete geçirilmesine yardımcı olacaktır.
Araçlar ve Yöntem: Bu çalışmada, farklı tahmin modelleri kullanılarak gelecekteki COVID-19 olaylarının sayısını tahmin etmek için 01/21/2020-02/05/2020 ve 21/01/2020-17/06/2020 tarihleri arasında on bir ülkenin günlük vaka sayılarının verileri kullanılmıştır. MAPE değerlerine dayalı olarak Auto-Regressive Integrated Moving Average (ARIMA), Brown's linear exponential smoothing (LES) ve Holt's LES modelleri ile mevcut sayıların analizinden sonra en uygun modeller seçilerek analizler yapılmıştır.
Bulgular: Çalışmamız, iki veri setini analiz ederek kısa vadeli gelecek tahminleri için en az hataya en uygun modelleri ortaya çıkararak bu modellerin seçilen ülkeler arasında veri güncellemelerinden sonra değiştiğini göstermiştir. Verilerin analiz edilmesiyle onbir ülkenin içinde Amerika, Türkiye, Brezilya, Rusya'nın verilerinin güncellenmesinin tahmin sonuçlarında değişikliklere neden olduğunu göstermiştir.
Sonuç: Bu çalışmanın sonuçları, mevcut yaklaşımlarda birden fazla istatistiksel model kullanmanın üstünlüğü olduğunu ve halihazırda karmaşık ve yorucu olan COVID-19'un yönetimi için matematiksel modeller oluşturmak ve geleceğe yönelik tahminler oluşturmak için verileri kullanırken sayılardaki dalgalanmaların dikkate alınması gerektiğini göstermektedir. Bu sayede, COVID-19 yayılımına karşı uygulanacak olan politikalar ve kısıtlamalar, daha doğru sonuçlar sağlamak için düzeltilmiş tahminler göz önüne alındığında daha başarılı olabilir.

Anahtar Kelimeler: ARIMA; brown's LES; COVID-19; holt's LES; tahmin

ABSTRACT

Purpose: During the COVID-19 outbreak, governments, scientists, health workers, and numerous people worked on strategies or solutions for halting disease propagation. Unfortunately, the need for monitoring is steeply increasing, and restrictive actions are currently unavoidable. Due to the lack of epidemiological data and constantly changing numbers, constructing less error-prone predictive models and reliable mathematical models for the near future will help make better legal actions and prevention strategies.
Materials and Methods: In this study, daily data from eleven countries between 21/01/2020-02/05/2020 and 21/01/2020-17/06/2020 were used to forecast the number of future COVID-19 events by using different forecasting models. Best fit models were chosen after analysis with ARIMA, Brown's LES, and Holt's LES models based on MAPE values.
Results: The study showed the least error-prone best-fit models for short-term future predictions by analyzing two datasets and demonstrated that models changed after data updates among the selected countries. Investigation of the data from eleven countries, USA, Turkey, Brazil, and Russia analysis showed that updating data alters the model selection resulting in changes in the predictions.
Conclusion: The results of this study indicate that using more than one statistical model has superiority over the current approaches, and fluctuations in the numbers should be considered when using the data to construct mathematical models and create future predictions for the management of the already complicated and exhausting COVID-19 pandemic. Thus, policies and restrictions against COVID-19 spread might be more successful after considering that adjusted predictions for providing more accurate results.

Keywords: ARIMA; brown's LES; COVID-19; holt's LES; forecasting

Received: 06.12.2021; Accepted: 10.07.2022

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How to cite: Murat N. Importance of tracking COVID-19 data from official sources for short-term forecasting of cases and deaths. Ahi Evran Med J. 2023;7(1):41-48. DOI: 10.46332/aemj.1033009

INTRODUCTION

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is an emerging viral pathogen from the zoonotic coronavirus family first identified in Wuhan province, China, in late 2019 and started to spread throughout the world and has already taken a thousand lives to date.[1] Due to the unpreparedness for such transmission and fatal results, COVID-19 destroyed the livelihoods of millions and cost enormous amounts of money, and directly caused a national economic crisis in several countries. Therefore, nations urgently need new aspects to expand their mindset by creating long-term strategies for the coming waves of COVID-19 or possible different viral pandemics.

While the number of infected people and deaths due to the COVID-19 is increasing, nearly all governments enacted a range of behavioral restrictions, such as frequent handwashing, sneeze etiquette, and social distancing. However, due to the high transmissive ability, non-symptomatic patients, and non-sensitive tests, current interventions have difficulty in preventing transmission to people in high-risk groups and lowering the risk of mortality. Additionally, the trend of spreading the disease and the number of confirmed cases is not unpredictable because of the diagnosis capacity, which differs between countries. Although close monitoring of daily cases and deaths gives directions to the nations for the enactment of preventive and restrictive actions, the use of powerful mathematical and statistical modeling tools is promptly needed to decide further prevention strategies and plan nationwide interventions.[2] Several statistical methods used in the past, such as phenomenological growth models, for predicting epidemic cases and were shown to be useful to generate short-term forecasts of epidemic trajectory incidence and prevalence were studied.[3,4] Therefore, constructing such models based on the short-term data forecasting epidemic trajectory with different or more than one statistical method will provide a valuable path for handling the COVID-19 epidemic.

Several models were used to estimate COVID-19 incidence and mortality rates in the most affected countries, such as China, Italy, and France. For example, Roosa et al. (2020) used a generalized logistic growth model (GLGM), and the Richards model extends the simple logistic growth model with an additional scaling parameter to predict possible numbers of reported cases in China.[5] Also, Li and Feng proposed a function to estimate the outbreak size of COVID-19 in China.[6] Besides, Fanelli and Piazza (2020) investigated the temporal dynamics of the COVID-19 pandemic in the most affected countries which are China, Italy and France.[7] Although Al-qaness et al. (2020), Wu et al. (2020), and Wang et al. (2020) predicted the COVID-19 spread on a national scale and proposed several models for the effects of the quarantine protocols in Wuhan and its neighbors, information about other severely affected countries and models for evaluating possible short-term outcomes of restrictions is still missing.[8-10]

Based on the current knowledge about epidemiological data and statistical methods, in this study, the cumulative number of cases and deaths in 11 countries from the 18/06/2020-27/06/2020 within 95% confidence intervals were estimated. Auto-Regressive Integrated Moving Average (ARIMA), Brown's Linear Exponential Smoothing, and Holt's Linear Exponential Smoothing methods were used for the short-term forecast to give a clue about guiding the future allocation of resources to bring more useful tools for epidemic control.

MATERIALS and METHODS

Data

All data were obtained from the official website of the World Health Organization (WHO). Data from the first eleven most affected countries from the WHO's statistical records were used for investigation. 01.21.2020-05.02.2020 and 01.21. 2020-06.17.2020 time periods were selected in order to investigate possible alterations. Obtained data were analyzed by Statgraphics 18 (Demo Version). At least 50 observations from the 11 countries were analyzed, and models were created for 10-day forecasting of total death and cases with a 95% confidence interval.

Models and Selection

In the current study, three different phenomenological models that have been previously used to investigate infectious disease outbreaks, including similar respiratory illnesses as well as in the current COVID-19 pandemic, were used. ARIMA models, Brown's Double Exponential Smoothing model, and Holt-Winter's model were used in the investigated periods. These three models were selected because of the studies that were recently used to predict short-term forecasts on COVID-19 pandemics in different countries.[11-13] Detailed information about the models and their parameters is represented in Appendix A. According to the current knowledge about time series analysis to develop the best-fit model, at least 50 observational analyses must be included.[14] Additionally, in order to get an accurate estimation, 12 data points must not be exceeded.[15,16] However, current approaches seem to be unreliable after daily number updates, and we use two pieces of the data set in the indicated periods. This study was designed on the hypothesis that daily number updates might change cases and death number trends, which might cause false decisions in the context of COVID-19. Therefore, in the current study, analyses were made based on the two different periods (01.21.2020-05.02.2020 and 01.21.2020-06.17.2020) for the same countries, where 50 observations were present. Where y_t is the observed value at time point t, et is the difference between the observed and estimated values. Also, n is the number of time points. Lower Root Mean Square Error (RMSE), mean absolute error (MAE), and Mean Absolute Percentage Error (MAPE) values indicate a better fit of the data. P values of less than 0.05 were considered statistically significant. All data were analyzed and reported according to the transparent reporting of a multivariable prediction model for individual prognosis or diagnosis (TRIPOD) guidline.[17]

RESULTS

Updating the Data of the Confirmed Cases and Death Numbers Caused Alterations in the Model Selection

The best-fit model with the lowest error chance (MAPE) was selected for every country, and descriptive statistics are given in supplementary material 1A. This study presented the results of the analysis of predicted cases in the indicated periods with the best-fit model (Table 1). Plots of the predicted and fitted values of total cases and deaths between 21.01.2020-17.06.2020 are demonstrated in Figures 1 and 2.

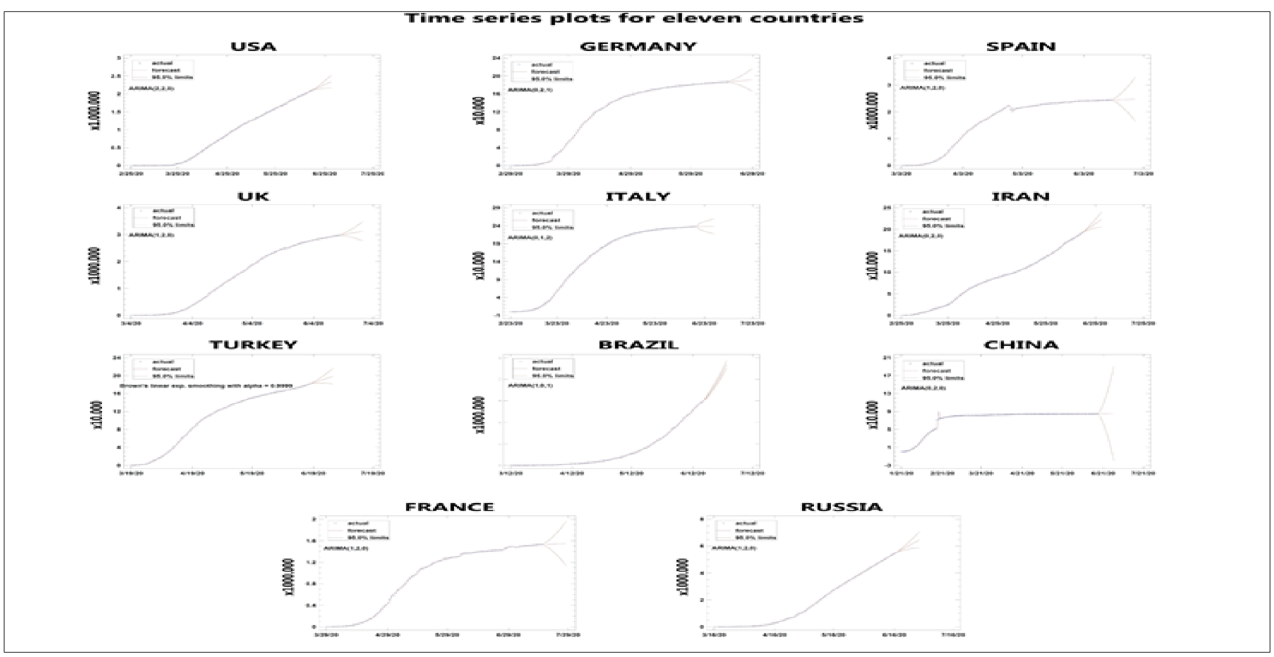

Figure 1. Time series plot of the forecasting of total case numbers for the eleven countries with updated data. Y-axis indicates the number of people. Future predictions were shown with red lines without squares.

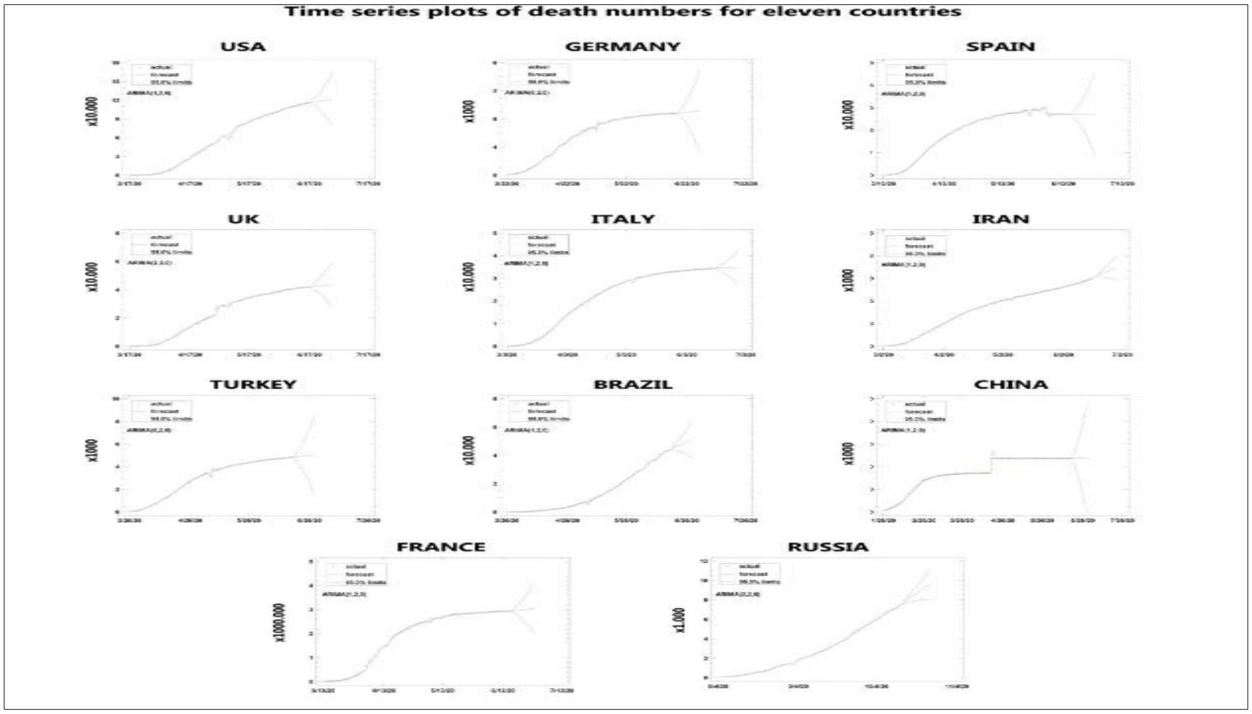

Figure 2. Times series plot of the forecasting of total death numbers for eleven countries with updated data. Y-axis indicates the number of people. Future predictions were shown with the red lines without squares.

As seen from Table 1, although the best model for predicting the number of cases remained constant for Germany, Spain, the UK, China, France, and Russia, it was changed for the remaining countries. Additionally, in line with the case numbers of results, the construction of a model with up-to-date data on death numbers caused changes in the model selection for the USA, Turkey, Brazil, and Russia (Table 2). Additionally, from the table 1 and 2, even though the same models were best fit for two data, MAPE values were decreased for nearly all analyzed countries, which means more accurate prediction (Tables 1 and 2).

Table 1. Mean Square Error (RMSE), mean absolute error (MAE), mean absolute percentage error (MAPE), mean error (ME), and mean percentage error (MPE) values of total case numbers for selected eleven countries' best-fit models in former and updated data.

	Time: 01.21.2020-05.02.2020						Time: 01.21.2020-06.17.2020					
Country	**Model**	**RMSE**	**MAE**	**MAPE**	**ME**	**MPE**	**Model**	**RMSE**	**MAE**	**MAPE**	**ME**	**MPE**
USA	Holt's (a=0.9999; b=0.4585)	3976.9	2625.9	7.7	944.3	3.5	ARIMA(2.2.0)	6322.0	4105.6	4.8	345.8	2.1
GERMANY	ARIMA(0.2.1)	1110.2	700.6	5.1	49.4	2.7	ARIMA(0.2.1)	854.9	483.4	2.9	5.5	1.6
SPAIN	ARIMA(1.2.0)	2666.1	1265.9	3.7	31.7	2.2	ARIMA(1.2.0)	2031.3	874.2	2.1	2.1	1.2
UK	ARIMA(1.2.0)	920.2	569.1	8.9	-0.3	-7.0	ARIMA(1.2.0)	911.2	578.3	1.9	14.6	0.9
ITALY	ARIMA(2.0.0)	543.6	409.1	2.4	63.9	1.3	ARIMA(0.1.2)	795.2	638.5	15.2	11.4	-14.1
IRAN	ARIMA(0.2.0)	388.1	216.5	2.7	14.7	1.5	ARIMA(0.2.0)	351.5	224.3	1.7	22.6	0.9
TURKEY	ARIMA(2.0.0)	480.8	248.3	4.0	68.9	2.1	Brown's LES (alpha=0.999)	361.9	244.7	2.0	16.1	1.1
BRAZIL	Holt's (a=0.9909; b=0.5503)	660.7	432.2	6.2	228.7	2.2	ARIMA(1.0.1)	3746.1	2330.2	36.4	843.5	12.5
CHINA	ARIMA(0.2.0)	2541.0	498.1	1.8	-0.3	1.0	ARIMA(0.2.0)	2106.3	344.2	1.2	0.1	0.7
FRANCE	ARIMA(1.2.0)	1364.9	875.2	4.5	17.3	1.6	ARIMA(1.2.0)	1181.0	707.5	2.7	1.8	0.9
RUSSIA	ARIMA(1.2.0)	2366.8	1209.2	6.8	289.1	2.3	ARIMA(1.2.0)	1703.7	797.9	3.5	125.5	1.2

Table 2. Mean Square Error (RMSE), mean absolute error (MAE), mean absolute percentage error (MAPE), mean error (ME), and mean percentage error (MPE) values of total deaths for selected eleven countries with best-fit models in former and updated data.

	Time: 05.02.2020						Time: 06.17.2020					
Country	**Model**	**RMSE**	**MAE**	**MAPE**	**ME**	**MPE**	**Model**	**RMSE**	**MAE**	**MAPE**	**ME**	**MPE**
USA	ARIMA(2.0.0)	348.9	227.7	5.7	55.0	2.6	ARIMA(1.2.0)	1361.3	661.2	3.4	8.0	1.5
GERMANY	ARIMA(0.2.0)	72.5	49.5	2.5	6.5	0.9	ARIMA(0.2.0)	120.6	54.6	1.6	0.0	0.4
SPAIN	ARIMA(1.2.0)	145.6	104.2	3.1	-0.1	1.5	ARIMA(1.2.0)	536.5	226.1	2.3	-0.5	0.8
UK	ARIMA(2.2.0)	634.2	218.7	4.3	105.4	3.3	ARIMA(2.2.0)	612.6	262.8	2.6	2.7	1.4
ITALY	ARIMA(1.2.0)	131.3	85.0	2.7	6.2	1.3	ARIMA(1.2.0)	231.4	99.6	1.7	0.1	0.8
IRAN	ARIMA(1.2.0)	33.8	17.4	1.9	1.5	0.9	ARIMA(1.2.0)	52.6	22.0	1.3	1.6	0.5
TURKEY	ARIMA(2.1.1)	6.1	4.2	0.9	0.1	0.0	ARIMA(0.2.0)	72.1	17.4	0.9	0.0	0.3
BRAZIL	Brown's (a=0.9377)	65.0	36.2	3.2	13.1	2.0	ARIMA(1.2.0)	389.2	189.0	2.8	11.5	1.0
CHINA	ARIMA(1.2.0)	164.3	37.1	1.4	-0.4	0.3	ARIMA(1.2.0)	134.8	25.1	0.9	-0.3	0.2
FRANCE	ARIMA(1.2.0)	347.4	188.6	3.8	6.3	1.7	ARIMA(1.2.0)	69.4	38.0	2.8	5.7	0.6
RUSSIA	ARIMA(1.1.1)	27.1	17.0	3.7	2.7	0.7	ARIMA(2.2.0)	1703.7	797.9	3.5	125.5	1.2

Prediction of Total Cases and Total Death Numbers in the Ten Days

Our results suggest that all countries show a similar increasing pattern for the number of cases (Tables 3 and 4). However, total death numbers followed the same pattern in selected countries, and only China showed stable numbers in the predicted period. Additionally, even though patterns have similarities between countries in both cases and death numbers, deviations and rates of increase were found as different (Tables 3 and 4).

Table 3. Prediction of total case numbers of COVID-19 for the next ten days according to Brown's linear exp. Smoothing and ARIMA models with 95% confidence interval

			Lower 95% CI					**Lower 95% CI**	
	Period	Forecast	Lower	Upper		Period	Forecast	Lower	Upper
USA	06.18.2020	2.119.590	2.107.060	2.132.120	**ITALY**	06.18.2020	238.331	236.745	239.916
	06.19.2020	2.139.740	2.119.000	2.160.490		06.19.2020	240.015	236.413	243.617
	06.20.2020	2.160.160	2.128.700	2.191.630		06.20.2020	242.048	236.324	247.773
	06.21.2020	2.180.690	2.136.880	2.224.500		06.21.2020	244.082	236.831	251.332
	06.22.2020	2.201.090	2.143.850	2.258.330		06.22.2020	246.115	237.608	254.622
	06.23.2020	2.221.550	2.149.610	2.293.490		06.23.2020	248.148	238.548	257.749
	06.24.2020	2.242.000	2.154.290	2.329.700		06.24.2020	250.181	239.600	260.763
	06.25.2020	2.262.440	2.157.970	2.366.910		06.25.2020	252.215	240.736	263.694
	06.26.2020	2.282.890	2.160.680	2.405.090		06.26.2020	254.248	241.937	266.559
	06.27.2020	2.303.330	2.162.500	2.444.160		06.27.2020	256.281	243.191	269.372
SPAIN	06.18.2020	244.536	240.508	248.564	**UK**	06.18.2020	908.265	900.785	915.744
	06.19.2020	244.748	236.729	252.766		06.19.2020	927.650	911.381	943.919
	06.20.2020	244.958	232.022	257.895		06.20.2020	946.468	919.952	972.984
	06.21.2020	245.169	226.628	263.710		06.21.2020	964.758	926.925	1.002.590
	06.22.2020	245.380	220.602	270.158		06.22.2020	982.556	932.602	1.032.510
	06.23.2020	245.590	214.006	277.175		06.23.2020	999.896	937.211	1.062.580
	06.24.2020	245.801	206.885	284.718		06.24.2020	1.016.810	940.930	1.092.690
	06.25.2020	246.012	199.272	292.752		06.25.2020	1.033.320	943.904	1.122.740
	06.26.2020	246.223	191.198	301.247		06.26.2020	1.049.470	946.251	1.152.680
	06.27.2020	246.433	182.687	310.180		06.27.2020	1.065.270	948.071	1.182.460
UK	06.18.2020	299.327	297.520	301.134	**RUSSIA**	06.18.2020	153.183	150.842	155.525
	06.19.2020	300.542	296.970	304.114		06.19.2020	153.366	149.153	157.579
	06.20.2020	301.748	295.993	307.503		06.20.2020	153.526	146.788	160.264
	06.21.2020	302.957	294.716	311.197		06.21.2020	153.698	144.184	163.211
	06.22.2020	304.165	293.159	315.170		06.22.2020	153.863	141.223	166.503
	06.23.2020	305.373	291.349	319.396		06.23.2020	154.032	138.005	170.059
	06.24.2020	306.581	289.307	323.855		06.24.2020	154.199	134.517	173.881
	06.25.2020	307.789	287.048	328.531		06.25.2020	154.367	130.794	177.941
	06.26.2020	308.997	284.584	333.411		06.26.2020	154.535	126.841	182.229
	06.27.2020	310.205	281.926	338.485		06.27.2020	154.703	122.674	186.731

Table 3. Prediction of total case numbers of COVID-19 for the next ten days according to Brown's linear exp. Smoothing and ARIMA models with 95% confidence interval (continue)

			Lower 95% CI					Lower 95% CI	
	Period	Forecast	Lower	Upper		Period	Forecast	Lower	Upper
GERMANY	06.18.2020	187.514	185.819	189.209	IRAN	06.18.2020	195.002	194.306	195.698
	06.19.2020	187.845	184.741	190.949		06.19.2020	197.565	196.008	199.122
	06.20.2020	188.175	183.492	192.858		06.20.2020	200.128	197.522	202.734
	06.21.2020	188.505	182.071	194.939		06.21.2020	202.691	198.876	206.506
	06.22.2020	188.835	180.488	197.182		06.22.2020	205.254	200.089	210.419
	06.23.2020	189.166	178.754	199.577		06.23.2020	207.817	201.173	214.461
	06.24.2020	189.496	176.878	202.114		06.24.2020	210.380	202.140	218.620
	06.25.2020	189.826	174.867	204.785		06.25.2020	212.943	202.996	222.890
	06.26.2020	190.156	172.729	207.584		06.26.2020	215.506	203.749	227.263
	06.27.2020	190.487	170.470	210.503		06.27.2020	218.069	204.404	231.734
TURKEY	06.18.2020	182.765	182.060	183.470	BRAZIL	06.18.2020	561.328	557.943	564.712
	06.19.2020	184.232	182.655	185.809		06.19.2020	569.271	563.038	575.504
	06.20.2020	185.699	183.060	188.338		06.20.2020	577.252	567.284	587.220
	06.21.2020	187.166	183.303	191.029		06.21.2020	585.216	571.090	599.342
	06.22.2020	188.633	183.403	193.864		06.22.2020	593.188	574.403	611.973
	06.23.2020	190.100	183.372	196.828		06.23.2020	601.156	577.310	625.003
	06.24.2020	191.567	183.222	199.912		06.24.2020	609.126	579.824	638.428
	06.25.2020	193.034	182.961	203.108		06.25.2020	617.095	581.980	652.211
	06.26.2020	194.501	182.595	206.408		06.26.2020	625.065	583.795	666.335
	06.27.2020	195.968	182.130	209.807		06.27.2020	633.034	585.288	680.780
CHINA	06.18.2020	84.911	80.749	89.074					
	06.19.2020	84.955	75.647	94.263					
	06.20.2020	84.999	69.424	100.574					
	06.21.2020	85.043	62.244	107.842					
	06.22.2020	85.087	54.217	115.957					
	06.23.2020	85.131	45.424	124.838					
	06.24.2020	85.175	35.924	134.426					
	06.25.2020	85.219	25.767	144.671					
	06.26.2020	85.263	14.992	155.534					
	06.27.2020	85.307	3.633	166.981					

Table 4. Prediction of total deaths of COVID-19 for the next ten days according to Brown's linear exp. Smoothing and ARIMA models with 95% confidence interval

			Lower 95% CI					Lower 95% CI	
	Period	Forecast	Lower	Upper		Period	Forecast	Lower	Upper
USA	06.18.2020	116.391	113.686	119.095	ITALY	06.18.2020	34.434	33.975	34.893
	06.19.2020	116.860	112.394	121.327		06.19.2020	34.466	33.687	35.245
	06.20.2020	117.290	110.067	124.512		06.20.2020	34.496	33.243	35.750
	06.21.2020	117.746	107.740	127.753		06.21.2020	34.528	32.779	36.276
	06.22.2020	118.184	104.876	131.492		06.22.2020	34.558	32.235	36.881
	06.23.2020	118.635	101.861	135.409		06.23.2020	34.589	31.655	37.524
	06.24.2020	119.077	98.494	139.660		06.24.2020	34.620	31.019	38.221
	06.25.2020	119.525	94.934	144.116		06.25.2020	34.651	30.345	38.958
	06.26.2020	119.969	91.105	148.833		06.26.2020	34.682	29.627	39.737
	06.27.2020	120.416	87.078	153.753		06.27.2020	34.713	28.871	40.555
SPAIN	06.18.2020	27.136	26.071	28.201	UK	06.18.2020	44.578	43.804	45.353
	06.19.2020	27.136	25.267	29.005		06.19.2020	45.202	43.818	46.585
	06.20.2020	27.136	24.143	30.129		06.20.2020	45.823	43.609	48.036
	06.21.2020	27.136	22.930	31.342		06.21.2020	46.445	43.323	49.566
	06.22.2020	27.136	21.550	32.722		06.22.2020	47.067	42.920	51.213
	06.23.2020	27.136	20.063	34.209		06.23.2020	47.689	42.433	52.945
	06.24.2020	27.136	18.455	35.817		06.24.2020	48.310	41.857	54.764
	06.25.2020	27.136	16.745	37.527		06.25.2020	48.932	41.204	56.660
	06.26.2020	27.136	14.933	39.339		06.26.2020	49.554	40.476	58.632
	06.27.2020	27.136	13.028	41.244		06.27.2020	50.176	39.678	60.674
UK	06.18.2020	42.064	40.847	43.282	RUSSIA	06.18.2020	29.548	28.922	30.174
	06.19.2020	42.195	40.202	44.189		06.19.2020	29.637	28.520	30.753
	06.20.2020	42.344	39.404	45.284		06.20.2020	29.714	27.928	31.500
	06.21.2020	42.470	38.371	46.568		06.21.2020	29.797	27.279	32.315
	06.22.2020	42.606	37.279	47.933		06.22.2020	29.877	26.533	33.222
	06.23.2020	42.742	36.070	49.414		06.23.2020	29.959	25.720	34.198
	06.24.2020	42.875	34.752	50.997		06.24.2020	30.040	24.836	35.244
	06.25.2020	43.010	33.352	52.667		06.25.2020	30.121	23.889	36.353
	06.26.2020	43.144	31.862	54.427		06.26.2020	30.202	22.882	37.522
	06.27.2020	43.278	30.289	56.268		06.27.2020	30.284	21.819	38.748

Table 4. Prediction of total deaths of COVID-19 for the next ten days according to Brown's linear exp. Smoothing and ARIMA models with 95% confidence interval (continue)

			Lower 95% CI					Lower 95% CI	
	Period	Forecast	Lower	Upper		Period	Forecast	Lower	Upper
GERMANY	06.18.2020	8.860	8.620	9.100	**IRAN**	06.18.2020	9.179	9.074	9.283
	06.19.2020	8.890	8.354	9.426		06.19.2020	9.293	9.119	9.468
	06.20.2020	8.920	8.023	9.817		06.20.2020	9.407	9.126	9.688
	06.21.2020	8.950	7.637	10.263		06.21.2020	9.522	9.131	9.912
	06.22.2020	8.980	7.203	10.758		06.22.2020	9.636	9.116	10.155
	06.23.2020	9.010	6.724	11.296		06.23.2020	9.750	9.094	10.406
	06.24.2020	9.040	6.204	11.876		06.24.2020	9.864	9.060	10.668
	06.25.2020	9.070	5.647	12.493		06.25.2020	9.978	9.017	10.940
	06.26.2020	9.100	5.054	13.146		06.26.2020	10.093	8.964	11.221
	06.27.2020	9.130	4.427	13.833		06.27.2020	10.207	8.903	11.510
TURKEY	06.18.2020	4.859	4.716	5.002	**BRAZIL**	06.18.2020	7.649	7.511	7.788
	06.19.2020	4.876	4.555	5.197		06.19.2020	7.841	7.637	8.045
	06.20.2020	4.893	4.356	5.430		06.20.2020	8.024	7.726	8.322
	06.21.2020	4.910	4.124	5.696		06.21.2020	8.206	7.791	8.621
	06.22.2020	4.927	3.863	5.991		06.22.2020	8.393	7.861	8.924
	06.23.2020	4.944	3.576	6.312		06.23.2020	8.575	7.911	9.240
	06.24.2020	4.961	3.264	6.658		06.24.2020	8.760	7.953	9.566
	06.25.2020	4.978	2.929	7.027		06.25.2020	8.944	7.988	9.900
	06.26.2020	4.995	2.573	7.417		06.26.2020	9.128	8.013	10.243
	06.27.2020	5.012	2.197	7.827		06.27.2020	9.312	8.031	10.594
CHINA	06.18.2020	4.645	4.378	4.912					
	06.19.2020	4.645	4.166	5.124					
	06.20.2020	4.645	3.878	5.412					
	06.21.2020	4.645	3.563	5.727					
	06.22.2020	4.645	3.207	6.083					
	06.23.2020	4.645	2.822	6.468					
	06.24.2020	4.645	2.406	6.884					
	06.25.2020	4.645	1.964	7.326					
	06.26.2020	4.645	1.495	7.795					
	06.27.2020	4.645	1.002	8.288					

DISCUSSION

COVID-19 has been declared a pandemic, and currently, no known treatment option is present. Therefore, starting from disease prevention, improving healthcare service, and taking preventive actions against disease propagation is a major global aim. One of the valuable strategies of proper disease management during epidemics is constructing statistical models for deciding strategies to prevent social and economic catastrophes.

This study demonstrated the short-term forecasts for total cases and deaths because of COVID-19 in eleven selected countries. Based on the two different periods, in which the second one extended and updated version of the other one, best-fit models were constructed, and possible numbers were predicted for ten-day. Consequently, our results suggest that forecasting future numbers for restrictions or legal issues should consider dynamic constant data updates to manage COVID-19 better. In the literature, time serial analysis is a prominent method for controlling the dynamics of various diseases.[18] Due to the ARIMA model's systemic and straightforward structure, it is currently used to predict future simulations. Several research groups demonstrated ARIMA models as useful options in the current COVID-19 pandemic for near future forecasting and suggested it is reliable for legal actions, such as restrictions or abolition of restrictions. Nearly all countries implemented precautions, but due to the lack of treatment options and the economic burdens of quarantines, governments were forced to revoke restrictions that are dangerous actions for all nations' health. However, in our study, we demonstrated that using more than one mathematical method is essential for predicting less error-prone models. Thus, decreasing possible data deflections will give a better response to government strategies.

Additionally, in our study, we also demonstrated that after constructing the best-fit model from existing data, results must be cautiously monitored, and models should be rebuilt from up-to-date data for alterations. Due to the nature of the pandemic, inaccuracy in predictions or actions is too risky for people and the nation's health. In addition, the importance of estimating the effect of the implementations on the course of the epidemic should be taken into account in that insufficient measures may require larger and compulsory measures later on. Therefore, decreasing these errors will improve people's health status and have beneficial effects on the life quality of society.

Conflict of Interest

The authors declare that there is not any conflict of interest regarding the publication of this manuscript.

Ethics Committee Permission

Ethical permission is not required for the study.

Authors' Contributions

Concept/Design: NM. Data Collection and/or Processing: NM. Data analysis and interpretation: NM. Literature Search: NM. Drafting manuscript: NM. Critical revision of manuscript: NM. Supervision: NM.

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