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COVID-19 and Non-Pharmaceutical Interventions: The Greek Paradigm

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Abstract

Due to the COVID-19 pandemic originating in China in December 2019, apart from the grave concerns on the exponentially increasing casualties, the affected countries are called to deal with severe repercussions in all aspects of everyday life; from economic recession to national and international movement restrictions. Several regions managed to handle the pandemic more successfully than others in terms of life loss, while ongoing heated debates as to the right course of action for battling COVID-19 have divided the academic community as well as public opinion. To this direction, in this paper, an autoregressive COVID-19 prediction model with heterogeneous explanatory variables is proposed for Greece, taking past COVID-19 data, non-pharmaceutical interventions (NPIs), and Google query data as independent variables, from the day of the first confirmed case -February 26th- to the day before the announcement for the quarantine measures' softening -April 24th. The analysis indicates that the early measures taken by the Greek officials positively affected the flattening of the curve, with Greece having recorded significantly decreased COVID-19 casualties compared to other countries. In specific, the prediction model identifies not only the seven-day lag that is needed in order for the measures' results to actually show, that is, in sense, the optimal time-intervention framework for managing the disease's spread, but the appropriate point during the disease spread where restrictive measures should be applied. Present results have significant implications for effective policy making and in the designing of the NPIs, as the second wave of COVID-19 is expected in fall 2020, and such multidisciplinary analyses are crucial in order to understand the evolution of the Daily Deaths to Daily Cases ratio along with its determinants as soon as possible, for the assessment of the respective domestic health authorities' policy interventions as well as for the timely health resources allocation.

Keywords: coronavirus; COVID-19; disease surveillance; internet behavior; non-pharmaceutical interventions; predictability analysis

Introduction

In December 2019, a novel coronavirus that causes severe acute respiratory syndrome (SARS) is detected in Wuhan, China.¹⁻² The coronavirus is of unknown origin, though there are suggestions pointing to a wet market in said region as per the virus' emergence.³ With WHO declaring the new coronavirus disease -officially COVID-19 as of February 11th-⁴ a pandemic on March 11th, 2020,⁵ and after most countries having been affected, the importance of taking immediate action becomes evident.

To this direction, flattening the curve and exploring novel approaches in dealing with COVID-19 spreading is what has been the first priority over the past two months. Italy, being the first negative example of the impact of said disease in Europe, alarmed the rest of the countries to adopt certain non-pharmaceutical interventions (NPIs), including a chain of preventive and movement restrictive measures in order to avoid the spreading of the virus. However, certain regions decided on alternative routes (e.g. Sweden⁶), possibly aiming at herd immunity and in minimizing the COVID-19's social and economic impact.

Heated ongoing discussions and debates are dividing the scientific community and the public, as to which approach should be followed in order to combat COVID-19⁷⁻⁸. Following Italy's disaster, where daily deaths first surpass 300 mid-March and keep these levels for all but two days until the end of April and with a record of 919 on March 27th,⁹ it is evident that COVID-19 is not that easy to handle as seemed at first.

Several approaches are identified, mainly those of mass population testing, like South Korea¹⁰ and Germany¹¹, early closing of borders and movement restrictions like in Slovakia¹²⁻¹³, and few light measures, like Sweden⁶. Figure 1 depicts the cumulative cases and deaths, and Figure 2 depicts the total cases and total deaths per million in Europe up to May 3rd, 2020.

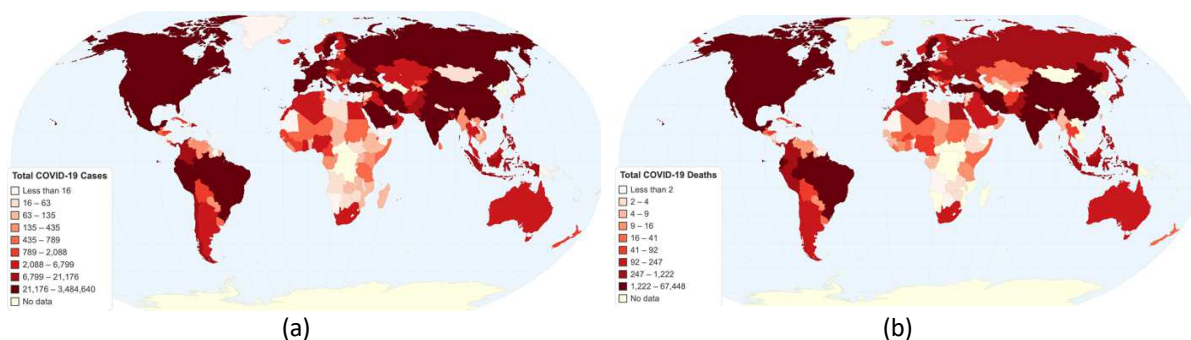


Figure 1. Cumulative worldwide COVID-19 (a) cases and (b) deaths.

As countries have different populations and different approaches to testing in order to identify cases, the best available measure for comparison is deaths per million. This redaction is done only for the purposes of the comparison in this case, as several other factors can affect the number of deaths, as, for example, the population density in certain regions, the weather, the population age, geographical location, open borders, flights per day, or diversity in terms of socioeconomic conditions.

Table 1 consists of the days between the first confirmed case and the first confirmed death, as well as deaths per million as of May 3rd, 2020, for the EU countries UK, Norway, and Switzerland. Malta is not included in the list, as it has reported no deaths.

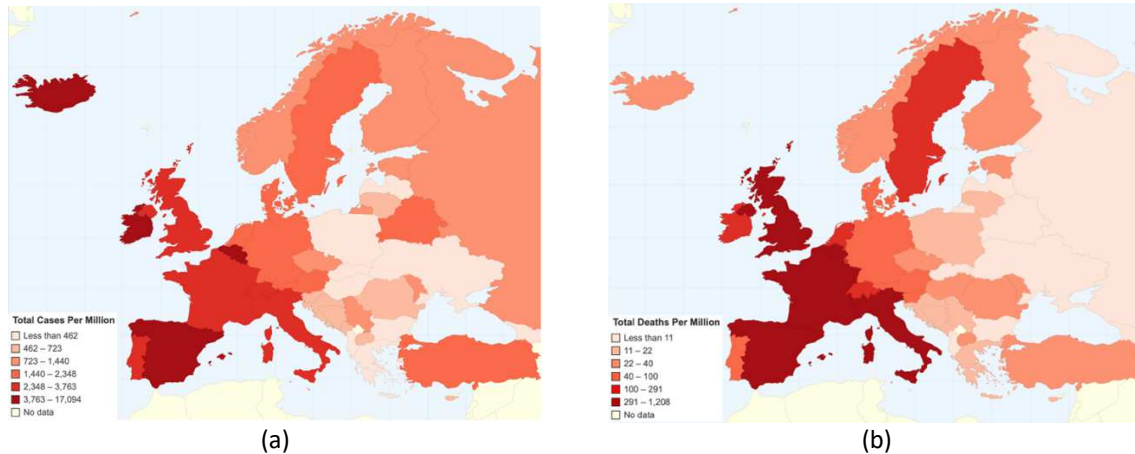


Figure 2. Total COVID-19 (a) cases and (b) deaths per 1 million in Europe.

Table 1. First case & death, and deaths per million for the examined Europe countries.

Country	1 st case	1 st death	Deaths per million*	Country	1 st case	1 st death	Deaths per million*
Belgium**	D1	D11	670	Slovenia	D1	D11	45
Spain***	D1	D25	537	Romania	D1	D26	40
Italy	D1	D23	475	Finland*****	D1	D25	40
UK	D1	D7	414	Estonia	D1	D28	40
France	D1	D22	379	Norway	D1	D16	39
Netherlands	D1	D9	291	Hungary	D1	D12	35
Sweden****	D1	D15	264	Czech Rep.	D1	D22	23
Ireland	D1	D12	260	Croatia	D1	D24	19
Switzerland	D1	D10	204	Poland	D1	D9	18
Luxembourg	D1	D12	147	Lithuania	D1	D24	17
Portugal	D1	D15	100	Greece	D1	D16	14
Denmark	D1	D17	82	Cyprus	D1	D13	12
Germany	D1	D42	81	Bulgaria	D1	D5	10
Austria	D1	D17	66	Latvia	D1	D33	8
Slovenia	D1	D27	45	Slovakia	D1	D27	4

*As of May 3rd, 2020.

** For Belgium. The second confirmed case is taken into consideration, as the previous was a repatriated man

*** For Spain, the first death was a traveler from Nepal and was diagnosed post-mortem, so the 2nd death is taken into consideration.

****For Sweden, the second case is counted, as the first was an individually identified case on January 31st about an isolated case of a traveler returning from Wuhan.

*****For Finland, the second case is considered, as the first was a Wuhan traveler one month before.

A very important question that should be addressed soon in order for the world to be ready for the second COVID-19 wave next fall¹⁴⁻¹⁵, is that of identifying the appropriate course of action in battling COVID-19. To this end, we investigate one of the most internationally discussed EU cases, that of Greece¹⁶⁻¹⁹; a country that managed to successfully deal with the first COVID-19 wave, as shown in Figure 2 and Table 1.

What made the Greek case successful in dealing with the pandemic in terms of casualties and in maintaining the state of its national health care system during the pandemic, was that the Greek officials adopted NPIs at a very early stage; schools closed just one day after WHO declared COVID-19 a pandemic on March 11th and while the country had recorded less than 100 confirmed cases and no casualty -the first death was recorded the next day.

While most approaches on exploring COVID-19 predictability focus on previously confirmed COVID-19 case data, this approach also investigates the role of non-pharmaceutical interventions (NPIs) along with query data from Google, in order to elaborate on the

multidisciplinarity of combining various surveillance variables and methods. The rest of the paper is structured as follows: Section 2 consists of the detailed description of the data collection procedure and predictive analysis for the COVID-19 prediction model, while in Sections 3 and 4, the results are presented and discussed, respectively.

Methods

COVID-19

Worldwide and Europe data on COVID-19 cases and deaths are retrieved from the Worldometers platform²⁰. Greek cases, deaths, and active data are retrieved from the same platform, while data for the geographical distribution of cases and deaths in Greece are retrieved from COVID-19's page on the official governmental platform²¹. Maps were created with Chartsbin and Mapcharts²²⁻²³. The selected timeframe is from February 26th to April 24th, as these two dates mark important milestones; first confirmed case and end-of-quarantine announcement, respectively.

Non-Pharmaceutical Interventions (NPIs)

Since no official COVID-19 cure exists, and as the vaccine is not yet available and could be more than a year before it is ready for public distribution, NPIs, as, for example, house quarantine or international flights restrictions are required in order to monitor and minimize disease spreading. The timely adoption of such measures is what made the Greek case that successful, and the statistical significance of the days of adoption are explored order to elaborate on the importance of NPIs.

Greek officials immediately acted on adopting preventive measures for the spread of the disease, with the first NPI being announced along with WHO declaring COVID-19 a pandemic on March 11th, and, effective as of March 12th, ordered the closing of all schools and universities²⁴. Retail shops, gyms, cafes, restaurants, etc., followed over the next days²⁵⁻²⁶, while less than two weeks later, on March 23rd, strict movement measures took place, including house quarantine, and special forms and SMS for all forms of movement²⁷. On March 12th and March 25th, two villages in the Kozani and one in the Xanthi Prefectures were put under complete lockdown, respectively²⁸⁻²⁹, while the two major cities close by were also put in special quarantine measures -but not complete lockdown- on March 31st.³⁰⁻³¹ Said cities exhibit increases COVID-19 cases and deaths compared to other Prefectures.

Google Trends

Several approaches in monitoring and analysis several epidemiological characteristics of the virus have been recorded up to this point using Google Trends data.³²⁻³⁵ Google Trends is an open online tool that provides information on the behavior towards selected topics and keywords. Such infodemiology variables can accurately measure the users' online search patterns, and, in this case, assist with exploring the public's perception and interest towards COVID-19 over the examined period.

In this paper and in line with the Google Trends Methodology Framework in Infodemiology and Infoveillance³⁶, normalized Google Trends data were retrieved on a sequence of Google queries from February 26th, which is the date for recording of the first confirmed COVID-19 case in the country, up to April 24th, which is the day before the announcement of the softening of the quarantine measures.

Google Trends is not case sensitive, but it does take into account accents, special characters, and misspellings. Greek is a rather complicated language in terms of accents and spelling, and the spelling of the word of coronavirus had not been definite. To that end, and to ensure that the majority of coronavirus searches were included in the analysis, the following procedure for the selection of the examined keywords was followed.

At first, there existed four differently spelled terms to express coronavirus, i.e., “Κορωνοϊός”, “Κορωναιός”, “Κορονοϊός”, and “Κοροναϊός”, with all terms including accents. Each term was compared to itself without the accent in Google, and all cases exhibited non-significant results for the terms with the accents. As the terms “Κορωναιός” and “Κοροναϊός”, though used during the first days of the epidemic, were quickly “abandoned” by the experts, media, and public, they exhibit significantly less interest, and thus not included in further analysis. Therefore, the Greek terms “Κορωνοιος” and “Κορονοιος” were selected at this stage and, in order to also include searches conducted in English, “Coronavirus (search term)” was also added in the analysis, i.e., data for the “κορωνοιος+κορονοιος+coronavirus” sequence of search terms were retrieved for the Google query data variable.

Predictability analysis

In this paper, a predictability analysis for COVID-19 Daily Deaths and Daily Cases ratio in Greece is performed; the prediction model is based on an autoregressive model with heterogeneous explanatory variables ($AR - HX$). This proposed model is constructed in order to incorporate and study short-term and long-term effects of predictors that are crucial for the assessment of the duration and the effectiveness of an intervention policy. In spite of the simplicity of the model, we find that it successfully achieves to predict the COVID-19 Daily Deaths and Daily Cases ratio.

In particular, let $y_t^{(d)}$ be the dependent variable constructed as the between Daily Deaths and Daily Cases, $x_{i,t}$, with $i = 1, 2, 3$ denoting the explanatory variables and $t = 1, \dots, T$, with T being the respective number of observations. The dependent variable exhibits a series of statistical properties that pose serious challenges to standard statistical models (e.g. autoregressive fractionally integrated moving average models). For example, the autocorrelations of the square and absolute values of Daily Deaths and Daily Cases ratio display large-memory that last for long periods of time (e.g. weeks), while it is expected that its determinants will influence it after a long period of a random time.

Despite that the widely used models in the existing literature use infinite-dimension restrictions to infinite variable lags in order to be able to obtain long memory, many observations are lost because of the not time-effective build-up period for the fractional difference operator.³⁷ However, for cases as the one explored in our study, there is a limited number of observations, as the statistical understanding is crucial to be developed over a restricted short-term period. In sense, delays could be measured in number of casualties. What is more, such models capture the so-called unifractal scaling behavior and not the multiscaling behavior (i.e., when the data exhibits patterns which are repeated at different time scales or scaling laws). Such scaling-type regularities can provide useful information for modeling and forecasting a phenomenon.

The model developed during the implementation of this study has a simple autoregressive structure, yet with the feature of considering explanatory variables over different interval sizes. The $AR(k) - HX$ model heterogeneous is given by:

$$y_{t+1}^{(d)} = c + \sum_{i=1}^3 \delta_i^{(d)} x_{i,t} + \delta_1^{(w)} \left(w^{-1} \sum_{h=0}^w x_{1,(t-h)-w}^{(d)} \right) + \delta_2^{(w)} \left(w^{-1} \sum_{h=0}^w x_{2,(t-h)-w}^{(d)} \right) + \delta_3^{(w)} \left(w^{-1} \sum_{h=0}^w x_{3,(t-h)-w}^{(d)} \right) + \sum_{j=1}^k \varphi_j y_{(t+1)-j}^{(d)} + \psi D_{t-w}^{(d)} + \omega_{t+1}^{(d)}$$

where c is the constant term, (d) denotes the data frequency (i.e., daily data frequency) and D is the dummy variable that is equal to one (1) for the day that an event occurs (e.g. a restriction imposed), and zero otherwise, while (w) denotes longer aggregation periods. The selection of (w) is data driven. In this predictability analysis, we make use of longer aggregation periods than one day, as we allow the (w) to varies over a fixed number of lags.

This data driven method allows us to find the optimal number of days passed for assessing past events that may influence the dependent variable in the future. It allows us to examine not only the effectiveness of the imposed measures via a strict statistical analysis, but the optimal intervention framework so that such situations are predicted as well.

In sense, explanatory variables viewed over different time horizons are considered, which, in turn, permit for direct comparison among quantities defined over various time horizons. This is of high significance, as it indicates how much time -in which case, days- policy makers have at their disposal in order to determine the last time-point which will allow them to act, how long such imposed measures should be in place, how the latter will be evaluated, etc. In fact, the explanatory variables are multiperiod quantities that are normalized sums of the one-period quantities (i.e., a simple average of the daily quantities).

Table 2 consists of the description of the dependent and explanatory (independent) variables used in this study.

Table 2. Descriptions of the dependent and independent variables.

Variable	Description
y	Ratio between Daily Deaths and Daily Cases
x_1	Ratio between Deaths and Cases*
x_2	Ratio between Recovered and Active**
x_3	Google Trends
D	Dummy for Restrictive measures

* Refers to total deaths and total cases

** Refers to total active and total recovered

Notes. In order to explore the relationship between the dependent and the independent variables and to avoid spurious regression results with non-stationary times series, the Augmented Dickey-Fuller (ADF) test³⁸⁻³⁹ and the Phillips-Perron (PP) test⁴⁰ were used. In the case where the null hypothesis of non-stationarity (i.e., the series has a unit root) cannot be rejected, the first differences of the series is constructed.

Studying the interrelations of the dependent variables measured over different time horizons, the dynamics of the different components of a system can be revealed. It is expected that innervations or infections over longer time intervals have a stronger influence on the Daily Deaths and Daily Cases ratio over shorter time intervals. Furthermore, the interpretation of the proposed model is must simpler than an autoregressive model with non-heterogenous explanatory variables taking a very large number of lags. As already mentioned, standard models employed in the literature, while possibly effective in modelling the evolution of a phenomenon that develops in an endogenous system, are not able to capture exogenous effects that have took place a long time ago (e.g. weeks or months).

Results

Greece records its first confirmed case on February 26th, its first death on March 12th, and imposes strict quarantine as of March 23rd. On April 25th, the Prime Minister, Kyriakos Mitsotakis, in a public address to the Greek citizens, announces the softening of the quarantine measures as of May 4th, with some retail shops restarting operation and schools opening within the week. Special commuting forms and SMS are no longer required, and citizens are allowed to freely move within their Prefecture.

The geographical distribution of the COVID-19 (a) cases and (b) deaths is depicted in Figure 3. Up to May 3rd (4pm) the country has recorded 2,620 cases, 143 deaths, while 1374 COVID-19 patients are recovered. Note that some COVID-19 cases are not included Fig4a, as they do not have a geographical location (e.g., ship personnel or passengers). As is evident, Greece, with approximately a population of 10.7 million (approx. 3.8 of which in Attica), managed to well contain the disease spread.

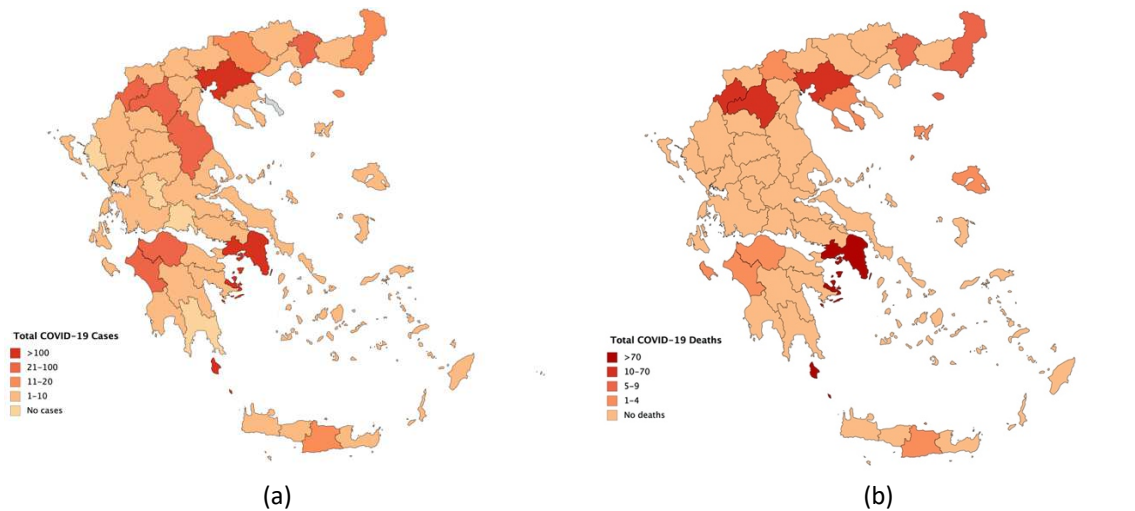


Figure 3. Cumulative COVID-19 (a) cases and (b) deaths in Greece as of May 3rd.

Figure 3b shows that most of the Greek Prefectures have recorded no deaths, while even the most affected regions (apart from Attica) only have very few casualties. This is also evident by several mainland Prefectures having recorded no COVID-19 case, while most have recorded fewer than a total of ten confirmed COVID-19 cases.

Figure 4 depicts the cumulative and daily COVID-19 cases, deaths, active, and recovered in Greece from February 26th and April 24th, 2020, as well as the change in the (Deaths)/(Cases) and (Active/Recovered) ratios, i.e., the times series used for the independent variables x_1 and x_2 , respectively.

Note that on April 21st, a spike of 156 is observed in the daily cases (Fig4c); this is an outlier to the sample, as 150 of those cases were identified in a closed refugee and immigrant structure (hotel), located in a non-urban environment. As this spike was observed in a closed structure, it is not indicative of the spread in the community. Another spike in daily cases is observed on April 23rd, referring to a private health structure in the Attica Prefecture.

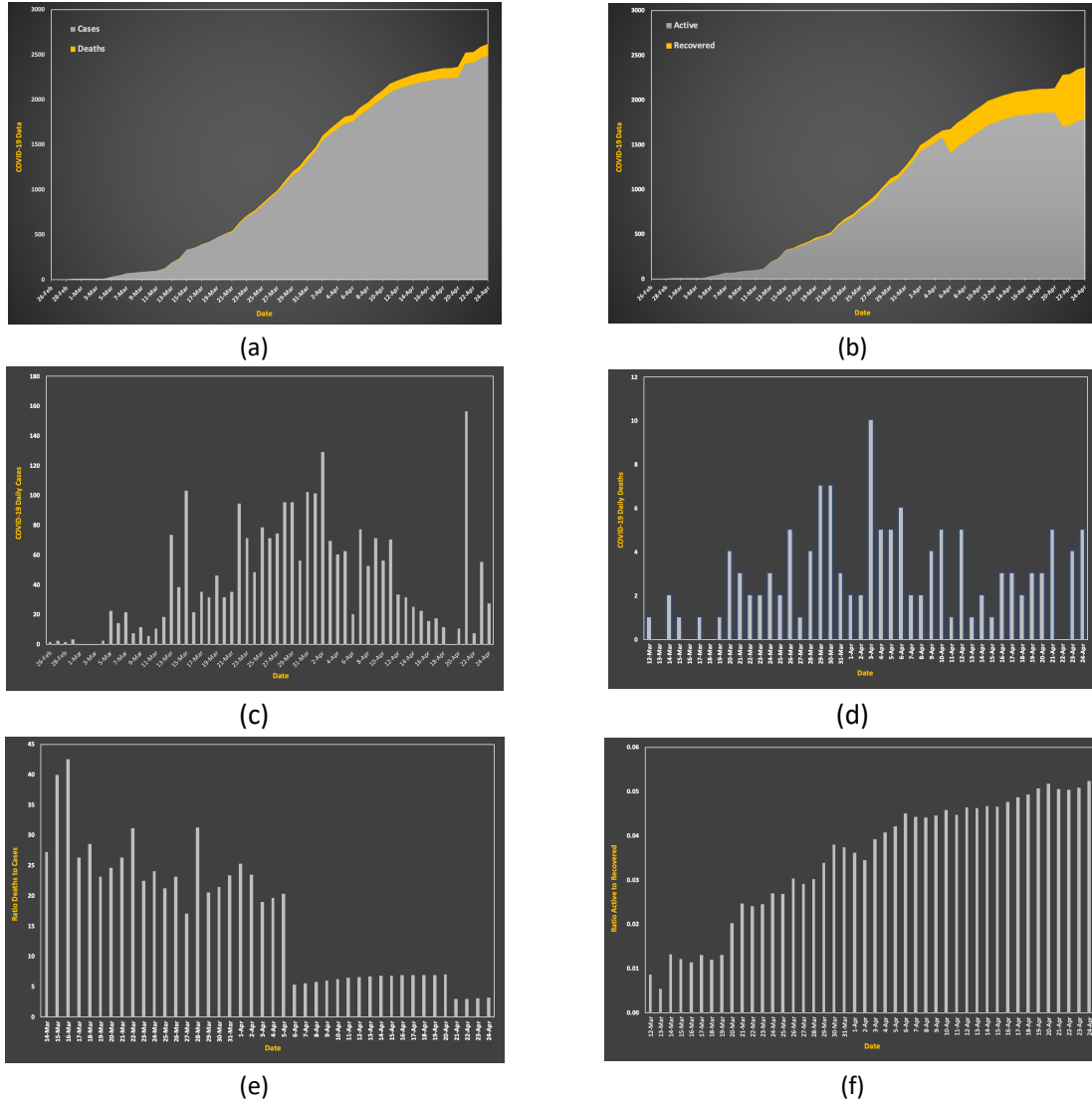


Figure 4. Cumulative (a) cases and deaths; (b) active cases and recovered; (c) daily cases; (d) daily deaths; (e) deaths to cases ratio; (f) active to recovered ratio.

Figure 5 depicts the forecasts derived by the application of the $AR(2) - HX$ model, and Table 3 consists of the bootstrapped coefficient estimates and standard errors of the model. The application of bootstrap methods to regression models helps approximate the distribution of the coefficients and the distribution of the prediction errors. In this paper, we apply a bootstrap technique resampling by residuals in order to take into account the presence of influential observations (some x_t very far away from the others); with the bootstrap we use an empirical distribution derived by resampling to approximate an unknown one [41].

The proposed model exhibits remarkably good forecasting performance for the Daily Deaths to Daily Cases ratio, with the latter being well predicted by the selected explanatory variables. In sense, what our prediction model shows is the optimal time intervention framework for the flattening of the curve, in which case it is measured by the COVID-19 Daily Deaths to Daily Cases ratio.

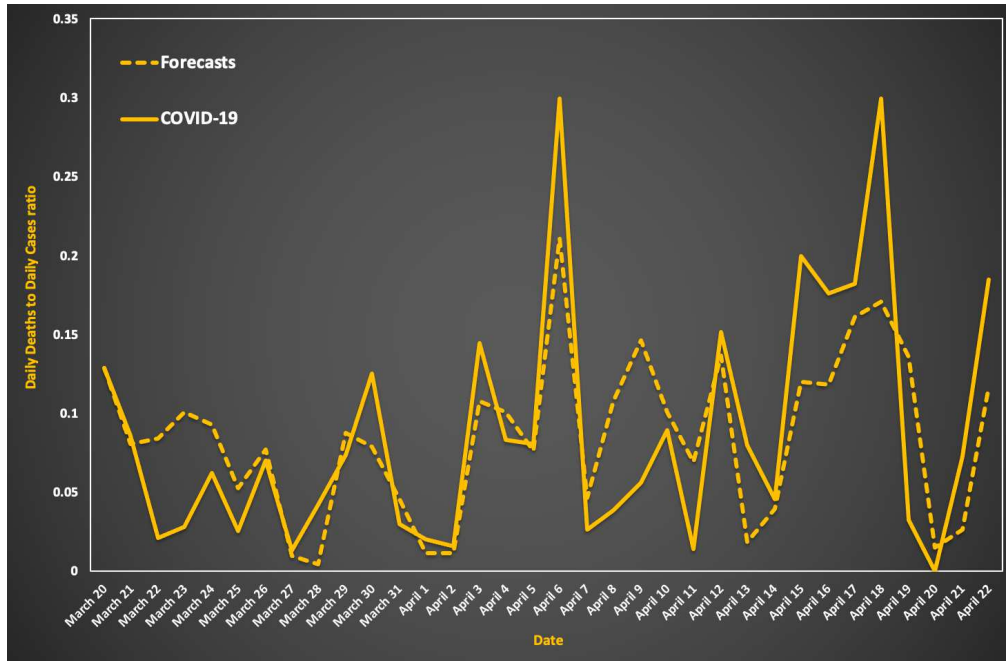


Figure 5. Official COVID-19 data vs. Forecasts

Table 3. Heterogeneous autoregressive model with explanatory variables $AR(2) - HX$.

Panel A. Regression estimates				
Variable	Coefficient	Std. Error	t-statistic	Prob.
c	0.030732***	(0.009801)	3.135473	[0.0033]
$x_{2,t}^{(d)}$	-0.711290***	(0.198599)	-3.581536	[0.0009]
$7^{-1} \sum_{h=0}^7 x_{1,(t-h)-7}^{(d)}$	3.829134***	(0.536053)	7.143197	[0.0000]
$7^{-1} \sum_{h=0}^7 x_{2,(t-h)-7}^{(d)}$	2.509127***	(0.736212)	3.408159	[0.0015]
$7^{-1} \sum_{h=0}^7 x_{3,(t-h)-7}^{(d)}$	-0.003312*	(0.001755)	-1.887019	[0.0666]
$D_{t-7}^{(d)}$	-0.035046**	(0.017100)	-2.049438	[0.0472]
$y_{(t+1)-1}^{(d)}$	0.320404***	(0.101509)	3.156401	[0.0031]
$y_{(t+1)-2}^{(d)}$	0.056718	(0.098270)	0.577167	[0.5671]
Panel B. Model specification				
Adjusted R-squared		0.597701		
Akaike information criterion		-3.329188		

Notes. ***, **, and * denote statistical significance at 1%, 5% and 10%, respectively. Bootstrapped coefficient estimates and standard errors via (2000 repetitions). The final optimal number of (w) and (k) are selected according to the Akaike information criterion. The variance inflation factor (VIF) is used in order to deal with multicollinearity issues among the regressors. Regressors with values of VIF higher than 5 are excluded from the estimation analysis.

Discussion

Battling COVID-19 is the first priority in policy planning in the whole northern hemisphere at the moment. To that end, modeling the predictability of COVID-19 in order to minimize the spread is of great importance, at least until an effective treatment is found or a vaccine is publicly administrated.

In this paper, by using past COVID-19 data, an NPIs variable, and Google query data on the coronavirus, the predictability of the Daily Deaths to Daily Cases ratio in Greece is explored. On investigating the course of action in terms of NPIs of Greek officials in the COVID-19 spreading, a seven-day lag after a set of restrictive measures take place is identified. This study, apart from introducing a novel approach in the prediction of COVID-19, is a significant addition to the literature in terms of providing the direction to the appropriate course of action to minimize COVID-19 impact in terms of casualties and flattening the curve, as well as identifying that point of the regional outbreak that such NPIs should take place, in order to ensure and maximize their effectiveness.

How did the Greek government successfully handle this epidemic? What were the key milestones that they took into account in designing the operation? How were they distributed in time? Figure 6 consists of a timeline with some of the most important COVID-19 points.

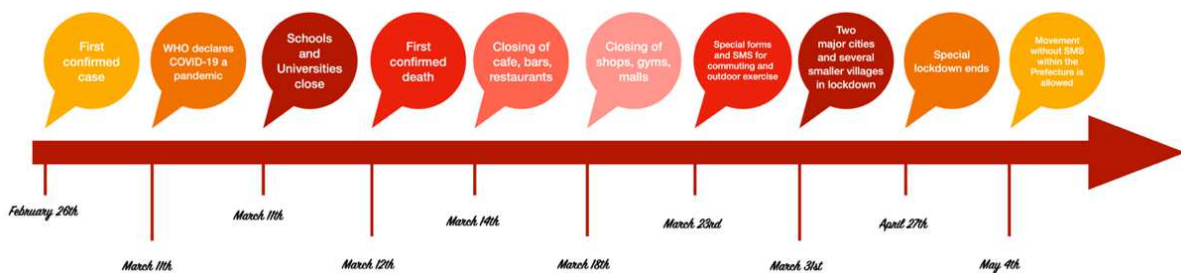


Figure 6. Timeline of COVID-19 in Greece

The Greek officials announced the closing down of all schools and universities with having recorded just short of 100 cases, and only a day before the first official death was recorded on March 12th; the first COVID-19 recovery was on March 13th. The next day all cafes bars and restaurants were not allowed to seat customers, while four days later, all retail and gyms were prohibited from allowing customers to enter their premises; retail switched to online orders and distribution via express mail services.

Ten days after the first death, the Prime Minister in his public address, informed the Greek citizens that any outside activity is not permitted without certain special forms (or SMS), while cities and villages where regional outbreaks were identified, were put under lockdown (partial or complete). The success of the Greek case lies on the early application of any restrictive measures, which were re-evaluated every day in order to adjust them to any condition changes.

Greece is one of the very few examples that can be studied in order to show and validate what the real gain from applying such measures is, as it managed to do so at a very early stage. Countries that did not manage to apply NPIs at their respective appropriate time-point rather than later during the epidemic, did not minimize the spread to the point of not having grave results. Given the easy and quick spread of the virus, it should be noted that even

a 48-hour delay in applying NPIs could be very crucial. In this study, Slovakia is identified as another successful example, and researchers from said region could apply the present analysis, in order to further elaborate on current findings. However, Greece is a unique case, as it is a very popular destination with many international airports that are busy throughout the year, and it also had daily connections by sea with neighboring Italy during the first stage of the epidemic.

This is the first such approach, not only in terms of selection of region, but can also assist with the assessment in policy interventions of the domestic health authorities for regionally containing the disease and minimizing the spread. The prediction model identified the optimal time-intervention framework in order to achieve the latter, with the NPI variable being statistically significant for a seven-day lag. Therefore, countries that choose this course of action, i.e., containing the virus, should approach the subject from a multidisciplinary point of view, in order to manage (a) the softening of the measures during summer, as well as (b) the second COVID-19 wave next fall. It is understandable that an entire country cannot shut down when recording its first confirmed case, but what needs to be identified is this optimal strategy between minimizing deaths and economic and social effects.

This study has limitations. At first, a two-month period was examined with a limited number of (daily) observations, which is, however, the case with all COVID-19 studies at this point of the pandemic. In addition, the NPIs variable was based on observations and recording of the events based on the authors' experience of the events in the examined country during the first wave of the pandemic. Finally, this prediction model takes into account four explanatory variables, and future approaches should aim at including more -exogenous-independent variables.

In conclusion, in this paper a seven-day lag is identified as the optimal intervention framework for the NPIs to come into effect, and this is what should be followed for successful results towards minimizing COVID-19 spreading. In particular, policy makers should take into account that NPIs that do not seem to have a positive effect on battling COVID-19 within a week, should be revised. Predicting COVID-19 is not a one-factor variable model and calls for multidisciplinary action. The present predictive analysis takes into account traditional health data (i.e., COVID-19 reported cases and deaths), specific NPIs (e.g. schools closing, lockdowns), as well as infodemiology metrics (Google query data).

Our main target is to more effectively gain insight on the nature of NPIs and how the latter can assist in halting the spread. This is expected to have various consequences in the COVID-19 prediction modelling. Considering the fact that policy makers are required to make important decisions during periods with chaotic conditions, it is vital to progress with a statistical understanding of the COVID-19 time series behavior in accordance with its real determinants. In sense, the approach should not be strictly medical in order to estimate robust COVID-19 prediction models, rather than a combination of medical and non-medical parameters from several research fields, that also take into account the citizens' response to the measures and the way that the latter are communicated and received by the public.

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Author Contributions

A.M. conceived the idea; A.M. and K.G. designed the methodology; A.M. performed the data collection and analysis; K.G. performed the statistical analysis; A.M. and K.G. interpreted the data; A.M. wrote the paper. Both authors reviewed the manuscript.

Conflict of Interest

The authors declare no conflicts of interest.

Data Availability

All data used in the analysis are open and publicly available in the cited sources.

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Figures

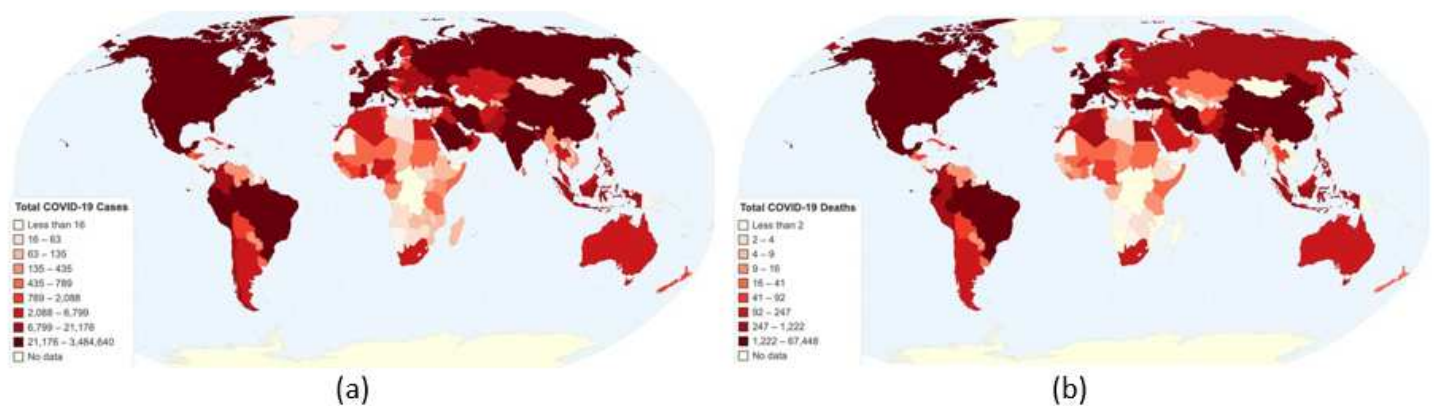


Figure 1

Cumulative worldwide COVID-19 (a) cases and (b) deaths. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

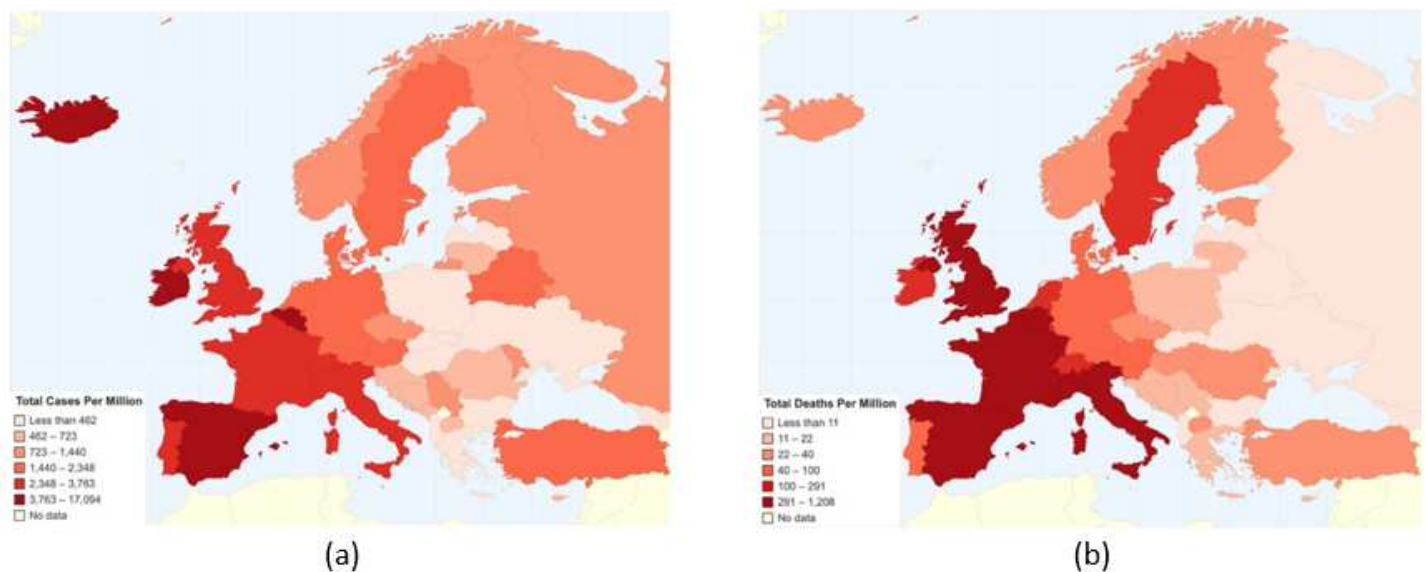


Figure 2

Total COVID-19 (a) cases and (b) deaths per 1 million in Europe. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

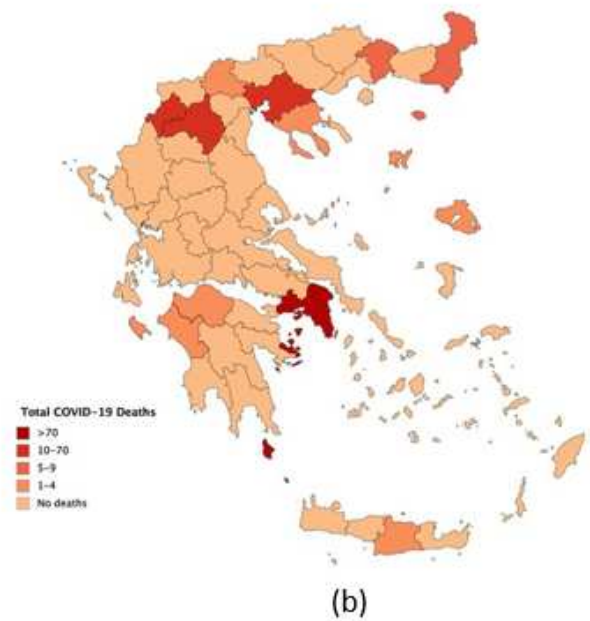
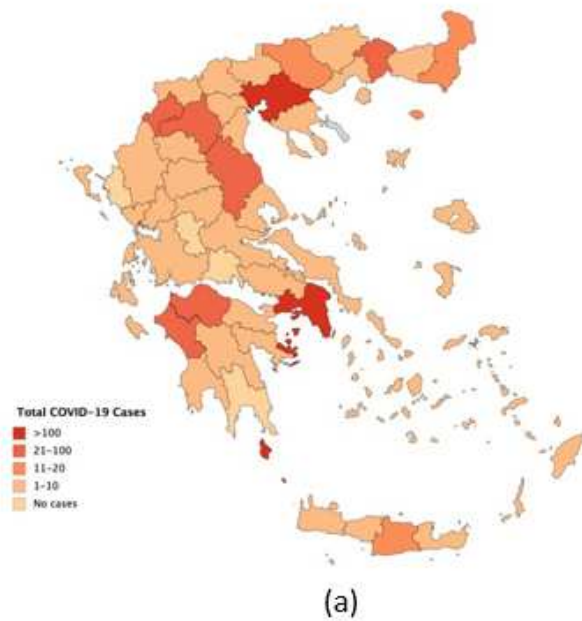


Figure 3

Cumulative COVID-19 (a) cases and (b) deaths in Greece as of May 3rd. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

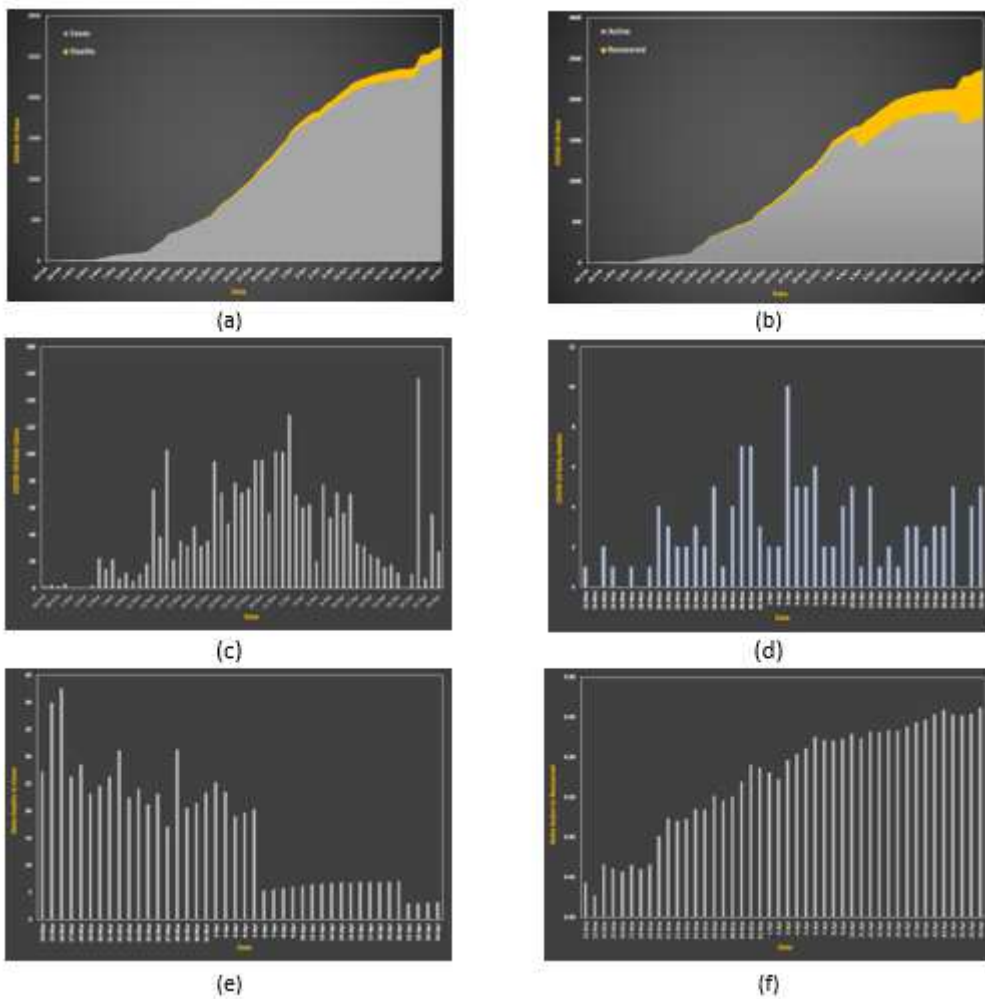


Figure 4

Cumulative (a) cases and deaths; (b) active cases and recovered; (c) daily cases; (d) daily deaths; (e) deaths to cases ratio; (f) active to recovered ratio.

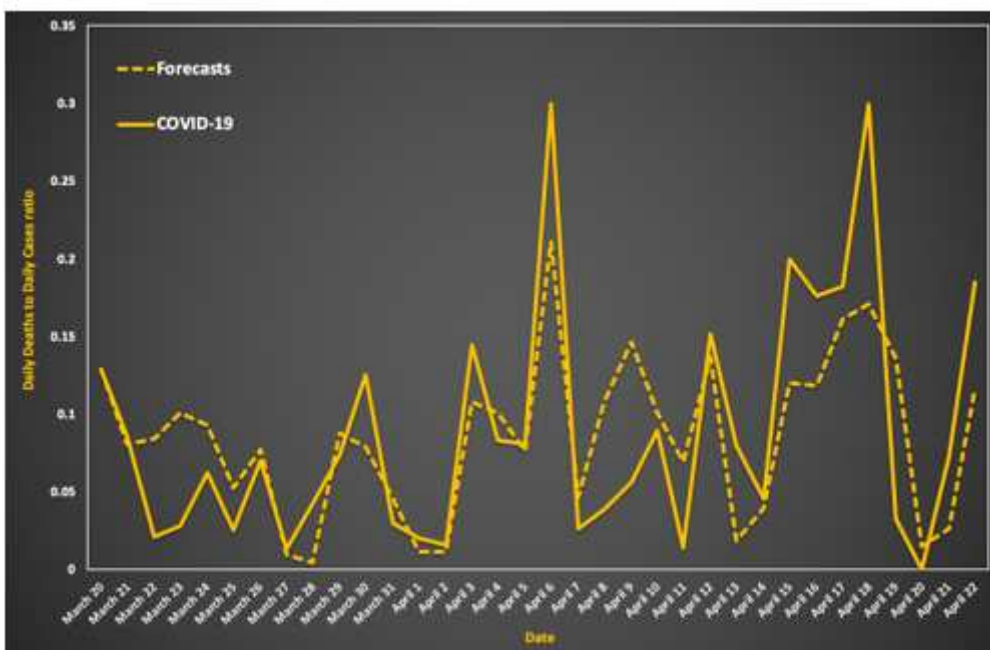


Figure 5

Official COVID-19 data vs. Forecasts

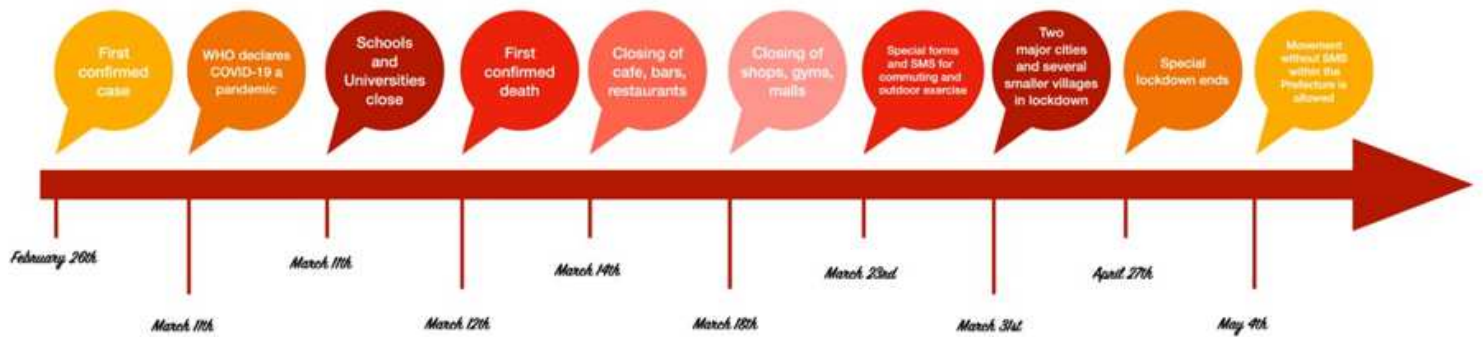


Figure 6

Timeline of COVID-19 in Greece

Supplementary Files

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- [Table3.docx](#)
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