The impact of the *social distancing policy* on COVID-19 new cases in Iran: insights from an interrupted time series analysis

Mahboubeh Khaton Ghanbari
Health Management and Economics Research Center, Iran University of Medical Sciences, Tehran, Iran

Meysam Behzadifar
Department of Epidemiology and Biostatistics, School of Public Health and Nutrition, Lorestan University of Medical Sciences, Khorramabad, Iran

Mohammad Hasan Imani-Nasab
Social Determinants of Health Research Center, Lorestan University of Medical Sciences, Khorramabad, Iran

Masoud Behzadifar
Social Determinants of Health Research Center, Lorestan University of Medical Sciences, Khorramabad, Iran

masoudbehzadifar@gmail.com*Corresponding Author*

Ahad Bakhtiari
Department of Health Management and Economics, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran

Iman Mir
Social Determinants of Health Research Center, Lorestan University of Medical Sciences, Khorramabad, Iran

Jianhong Wu
Laboratory for Industrial and Applied Mathematics (LIAM), Department of Mathematics and Statistics, York University, Toronto, ON, Canada

Nicola Luigi Bragazzi
Department of Health Sciences (DISSAL), Postgraduate School of Public Health, University of Genoa, Genoa, Italy

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Abstract

Background In late December 2019, a viral outbreak occurred in Wuhan, province of Hubei, People's Republic of China, and rapidly spread out worldwide. The infectious agent was identified and termed as SARS-CoV-2, responsible of the "coronavirus disease 19" (COVID-19). Due to the lack of vaccines and effective drugs for this disease, many policy- and decision-makers have focused on non-pharmacological methods to prevent and control this disease. Social distancing can be effective in reducing the spread of the outbreak. This study was aimed at assessing the effects of the implementation of the social distancing policy in Iran, one of the countries most affected by the COVID-19.

Methods This study was designed as a quasi-experimental study, and was conducted utilizing the interrupted time series analysis (ITSA) approach. Daily data was collected between February 20th 2020 and April 16th 2020. The social distancing policy was launched on March 27th 2020.

Results A significant decrease of -288.57 (95% CI: 269.08 (95% CI: -83.37 to -621.55, P-value=0.04) new confirmed cases following the implementation of the social distancing policy was found, corresponding to a daily decrease in the trend of -8.10 (95% CI: -10.02 to -6.19, P-value=0.001). A significant decrease of -24.78 (95% CI: -42.97 to -6.58, P-value=0.01) new deaths following the implementation of the social distancing policy could be found, corresponding to a daily decrease in the trend of -8.10 (95% CI: -10.02 to -6.19, P-value=0.001).

Conclusion The growth rate of new cases and deaths from the COVID-19 in Iran has significantly decreased after the implementation of social distancing. By monitoring and implementing this policy in all countries, the burden of COVID-19 can be mitigated.

Background

In late December 2019, a viral outbreak occurred in Wuhan, province of Hubei, People's Republic of China, and rapidly spread out worldwide (1). The infectious agent was identified and termed as SARS-CoV-2, responsible of the "coronavirus disease 19" (COVID-19). As of April 16th 2020, the virus has infected more than 2 million people and killed about 150,000 people (2). The World Health

Organization (WHO) has declared COVID-19 a pandemic, and the health systems of all countries are making their best efforts to prevent the spread of COVID-19, to control and counteract/mitigate its burden and effectively treat patients. In recent decades, many researchers have issued serious warnings about the problems and dangers that emerging infections can pose to human health (3). Due to the unknown nature of many aspects of COVID-19, this pandemic has caused a serious crisis affecting the public health systems, with many negative effects on the countries' economies (4, 5). Due to the lack of effective vaccines or drugs that can be used to prevent and treat COVID-19, respectively, public health policy- and decision-makers in many countries have implemented various policies – some of which totally unprecedented – to reduce the effects of the disease, such as quarantine, self-restriction, social distancing, use of face masks, school and university closures, and travel restrictions (6, 7).

COVID-19 in Iran

With the global spread of COVID-19, on February 19th 2020, the Ministry of Health and Medical Education (MOHME) has announced the first cases in the city of Qom near the Iranian capital (8). Following this announcement, by the order of the President of Iran, the anti-Coronavirus headquarters were established under the leadership of the Minister of MOHME, in order to handle all COVID-19 related activities and policies (7).

With the spread of the disease in different cities of Iran, the educational activities of schools and universities were closed (9). Then, a strict monitoring of the entry of passengers in domestic and foreign travels was implemented. Various awareness campaigns have been launched to reduce hours of social activity, encouraging people to stay home (7). Also, to prevent the disease, the activities of specific manufacturers producing disinfectant liquids and gels, masks and personal protective equipment for the general public and service providers in health centers and hospitals were increased up to 8 times (7).

Social distancing policy

Due to the transmission dynamics of COVID-19 through social interactions, reducing contact rates can play a very important role in disease prevention (10). Countries such as People's Republic of China,

South Korea, Indonesia, and Hong Kong have pursued this policy and have been able to achieve positive results in preventing the transmission of the disease (11, 12). Due to the high prevalence and mortality of COVID-19, health policy-makers have decided to implement this policy to control the disease also in Iran (10).

More specifically, on March 27th 2020, Iran implemented a social distancing policy in all Iranian cities to further prevent and control the disease. The implementation of this policy was advocated by all political groups, organizations, society elites, celebrities, non-governmental organizations (NGOs) and militaries. Social networks have endorsed this policy and are supporting it by means of several campaigns (7).

The aim of this study was to investigate the effects of the social distancing policy on the confirmed new cases and deaths of COVID-19 by applying the interrupted time series analysis method.

Methods

Ethical statement

Data to this study is publicly available online and does not need ethical approval.

Design of study

This study was designed as a quasi-experimental study, and was interpreted utilizing the interrupted time series analysis (ITSA) approach.

Interrupted time series analysis (ITSA)

Evaluating the impact of different health policies can be very important and helpful to advise policy- and decision-makers whether to continue or not the implementation of a given policy or make some changes (13). Health decision-makers try to implement policies that are highly effective (14). ITSA is a valuable analysis to evaluate the impact of the implementation of various policies in the health sector (15). ITSA can be used both for clinical and non-clinical interventions. Time series examine the relationship between data and a topic over time. In ITSA, the impact of a policy at a given point of time is compared to before and after the implementation (16). ITSAs can provide a strong assessment of the long-term impact of policy implementation, and can often be highly generalizable because they are performed in real-world contexts (17). ITSA can play a very important role in health-related crises,

as it is able to assess the consequences of implementing a policy in a crisis situation (18). In addition to health consequences, this assessment can also investigate its impact on the economic, social, political and cultural sectors (16, 19, 20).

Data sources

We used daily data related COVID-19 on confirmed new cases and deaths, which were collected through the Websites of MOHME and the WHO. The MOHME daily announces as a resume the statistics of all the provinces of Iran. Daily data was collected between February 20th 2020 and April 16th 2020. The social distancing policy was launched on March 27th 2020. ITSA is an ideal, robust method for analyzing the effects of a given health policy (21).

Statistical analysis

ITSA models were fit using segmented regression models (SRMs) and longitudinal data. For estimating the best analytical approach, we used the Newey-West method (18). Also, to assess the robustness of our findings, we conducted several diagnostic and sensitivity assessments. An ordinary least squares (OLS) regression model with a time series specification (an intercept and a trend term, a level and a trend change) was utilized in order to check for serially correlated errors using the Durbin-Watson test and by visualizing the residuals from the OLS regression and plotting the autocorrelation and partial autocorrelation (ACF/PACF) graphs (13).

All synthesized estimates were reported with their computed 95% confidence interval (CI). p-value < 0.05 was considered significant. All analyses were carried out with R software Version 3.6.1.

Results

New confirmed cases

A significant decrease of -269.08 (95% CI: -83.37 to -621.55, P-value=0.04, see Figure 1) new confirmed cases following the implementation of the social distancing policy was found.

This corresponds to a daily decrease in the trend of -86.82 (95% CI: -139.53 to -34.11, P-value=0.02).

New deaths

A significant decrease of -24.78 (95% CI: -42.97 to -6.58, P-value=0.01, see Figure 2) new deaths following the implementation of the social distancing policy could be found.

This corresponds to a daily decrease in the trend of -8.10 (95% CI: -10.02 to -6.19, P-value=0.001). Residuals from the OLS regression for new confirmed cases and new deaths related to COVID-19 are shown in Figure 3.

Autocorrelation and partial autocorrelation functions for new confirmed cases and deaths related to COVID-19 are shown in Figure 4.

Discussion

The findings of the present study showed that the implementation of the social distancing policy in Iran has been effective in controlling the spread of the COVID-19 and has reduced both new cases and deaths. This policy is currently being used as a very effective strategy to control COVID-19 also in other countries.

Prior to the implementation of the social distancing policy, the trend of COVID-19 infection in Iran was increasing. Policy- and decision-makers have launched various programs to control the disease. Due to the fact that the new year holidays in Iran begin in early spring (Nowruz) (22), policy-makers were very concerned about the transmission of the disease through the numerous trips that take place every year during the holidays. Maximum travel restrictions were imposed on passenger transportation by air, train and intercity buses, while fully implementing health protocols (7).

A study by Medeiros de Figueiredo and colleagues, conducted by utilizing ITSA, looked at the impact of the social distancing policy in Chinese cities, and found that the implementation of this policy had significantly reduced the incidence and mortality of COVID-19 (23). In another study employing ITSA, Siedner et al. investigated the effect of social distancing on COVID-19 growth rate in different US states, where, between March 10^{th} and 27^{th} 2020, a policy of self-isolation was implemented and was able to significantly reduce the spread of the COVID-19 (24).

The findings of these two studies in China and the USA are consistent with the results of our study. All of these studies have shown a decrease in the average daily growth rate of cases and deaths, and over time, the social distance policy has been able to greatly help the health system of these countries to reduce the burden of disease, providing better services to hospitalized patients and avoiding overwhelming and straining the healthcare facilities.

At the beginning of COVID-19, some cities in Iran were severely affected by the outbreak and many people became quickly infected. Due to its geographical location, the religious city of Qom and the Northern cities of Iran, tourist destinations for Iranian travelers, were affected the most. Therefore, in the first days, these areas started social distancing earlier, since implementing social distancing can be a great policy option for the most hit settings (6, 7).

The biggest resistance to implementing this policy is due to its economic and social impact. Many people may become unemployed and unable to cover their expenditures. Therefore, a very careful monitoring of it’s the impact of the implementation of this policy should be done. Government should provide financial assistance, such as subsidies and loans, encouraging people to be more compliant with this policy (25).

Given the benefits of social distancing seen in some pandemics, it can also be effective in the COVID-19 outbreak, and policy-makers should try to mitigate the economic and psychological problems that can affect people (26).

After the implementation of social distancing, the trend of new cases and deaths decreased, which was in line with the expected goals of this policy. This enabled to enhance and improve laboratories and diagnostic testing capacity to identify cases as the policy was implemented, and new cases were identified better than in previous days. COVID-19 is spreading rapidly around the world, and implementing social distancing policy is effective (7). A study by Medeiros de Figueiredo et al. showed that delays in implementing policies that can reduce the spread of the disease can have a major impact on its containment (23).

China's experience in reducing the burden of COVID-19 compared to other countries has shown that the implementation of social distancing can be very effective (6). A late implementation of social distancing policy, such as in Italy, can result in a high mortality rate (27, 28).

Limitations of the study

Improving healthcare facilities and diagnostic testing capacity, changing diagnostic criteria, validating new tests and introducing some medications can affect the analyzes performed in this study.

Moreover, we did not have access to time data at the province level. These data could be valuable in

determining the effect of social distancing policy at the province level, because different provinces of Iran can be differently affected by the implementation of this policy due to the different conditions they may experience. The implementation of the social distancing policy may have been carried out more vigorously by some provinces, and this could affect the data. Provinces with larger populations can have a greater impact on the data. Social distancing began during the holidays, with many people staying at home and avoiding or reducing social and working activities.

Conclusions

The growth rate of new cases and deaths from the COVID-19 in Iran has significantly decreased after the implementation of social distancing. Due to the lack of vaccines and effective drugs for this disease, many policy- and decision-makers have focused on non-pharmacological methods to prevent and control this disease. Social distancing has been proven to be effective in reducing the spread of the outbreak. By monitoring and implementing this policy in all countries, the burden of COVID-19 can be mitigated.

Abbreviations

ITSA: Interrupted time series analysis

WHO: World Health Organization

MOHME: Ministry of Health and Medical Education

NGOs: non-governmental organizations

SRMs: Segmented regression models

OLS: Ordinary least squares

ACF/PACF: Autocorrelation and partial autocorrelation

CI: Confidence interval

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and material

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

MaB, MHI, AB, MeB and IM were the principal investigators who contributed to the conception and design of the study, collected, entered, analyzed, interpreted the data, prepared the manuscript. MaB and acted as a corresponding author. MaB, MeB, NLB, JW, and MKG contributed to data analysis, interpretation and drafted the manuscript. Provided consultancies on the reasons contributing to unfavorable management outcomes and on recommendations forwarded. All authors read and approved the final manuscript.

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Figures

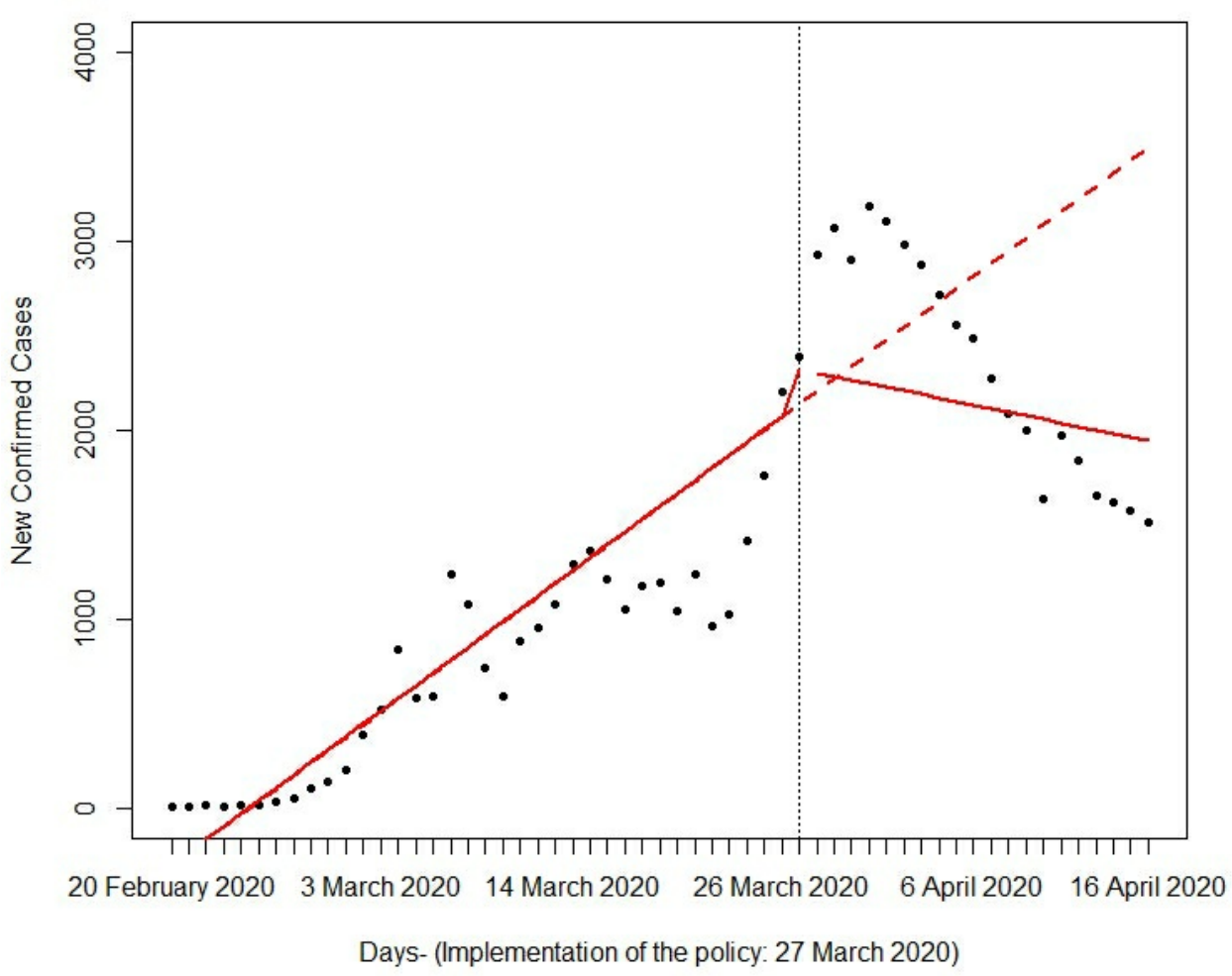


Figure 1

The rate of new confirmed COVID-19 cases prior to and following the implementation of the social distancing policy in Iran.

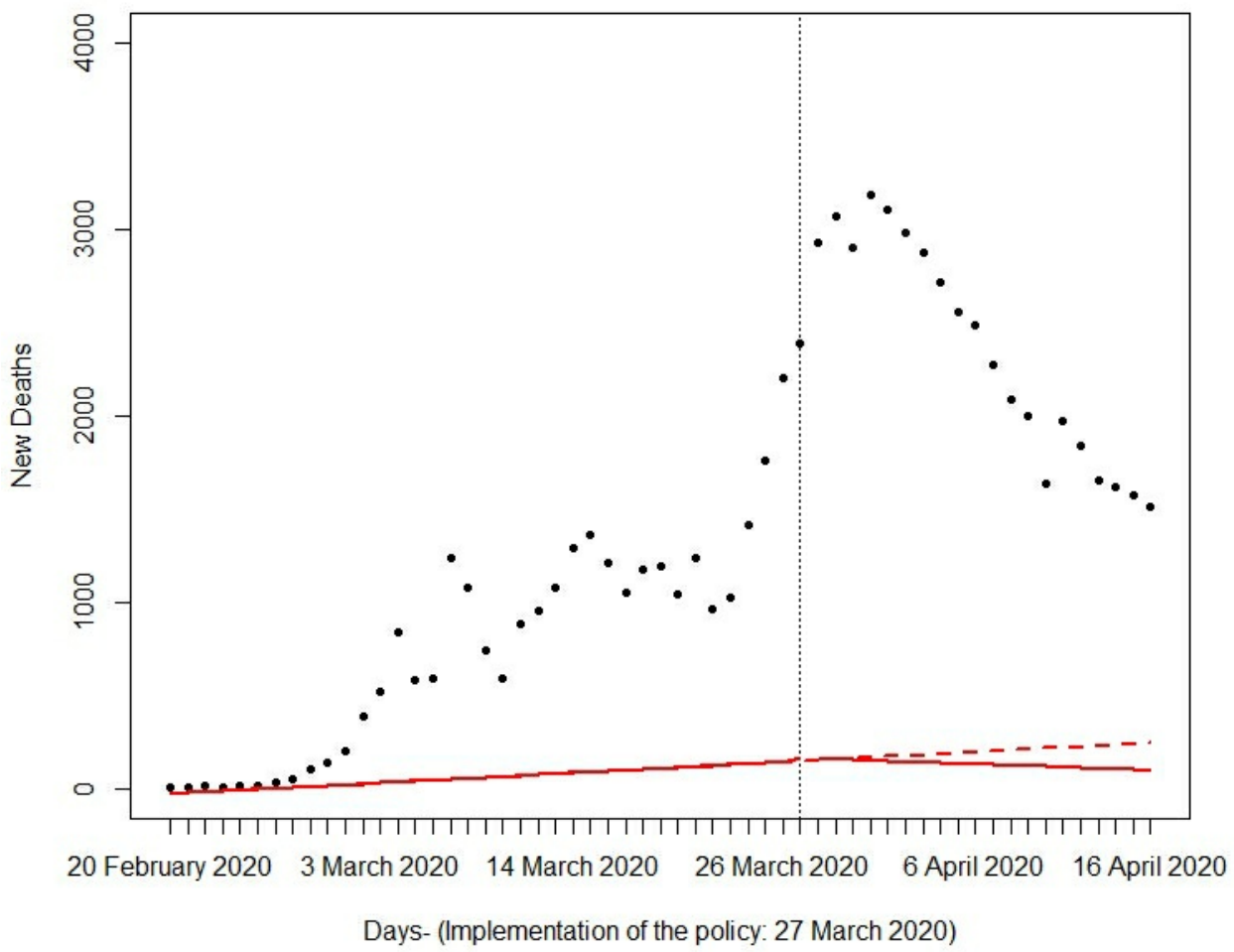


Figure 2

The rate of new deaths related to COVID-19 prior to and following the implementation of the social distancing policy in Iran.

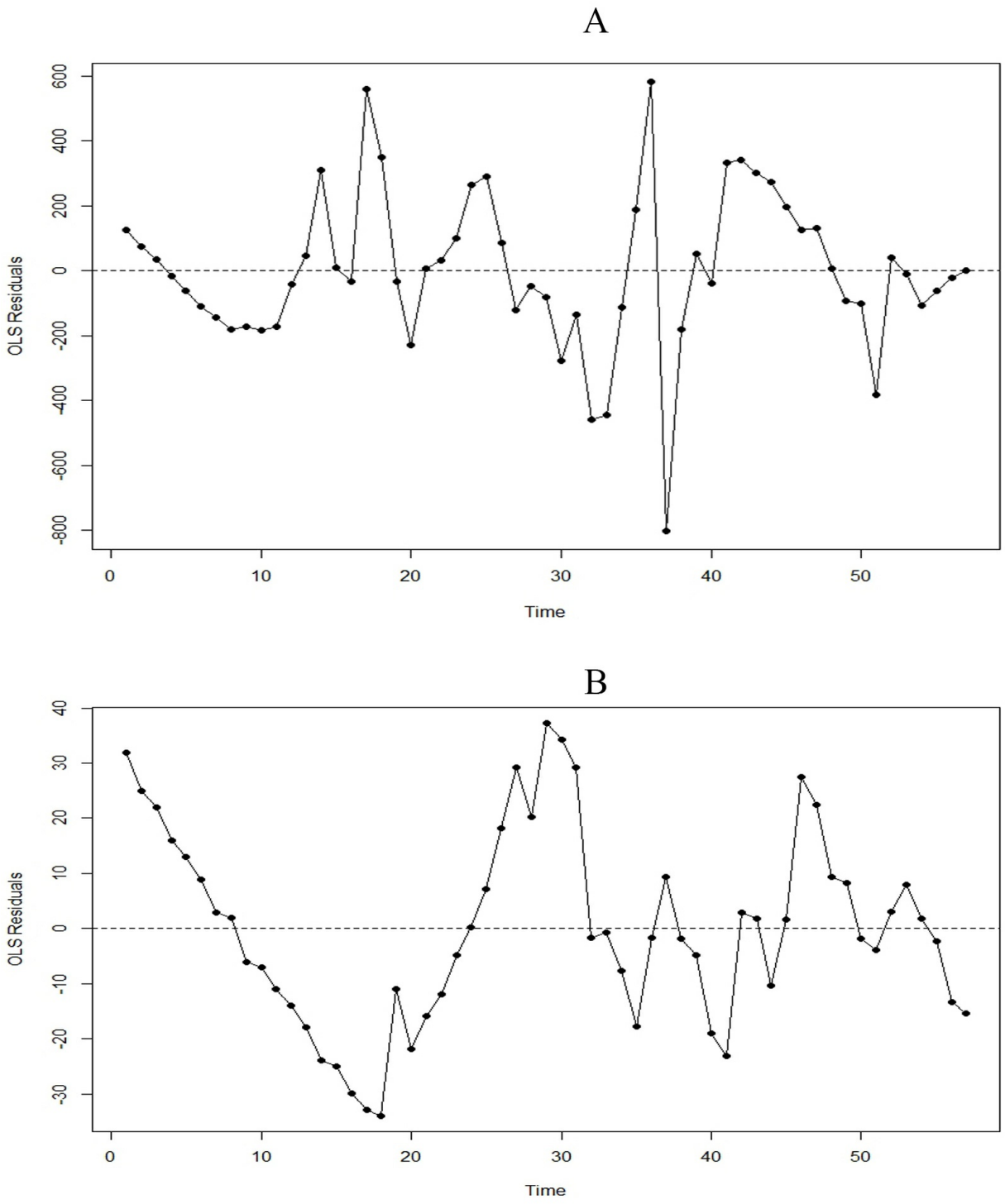
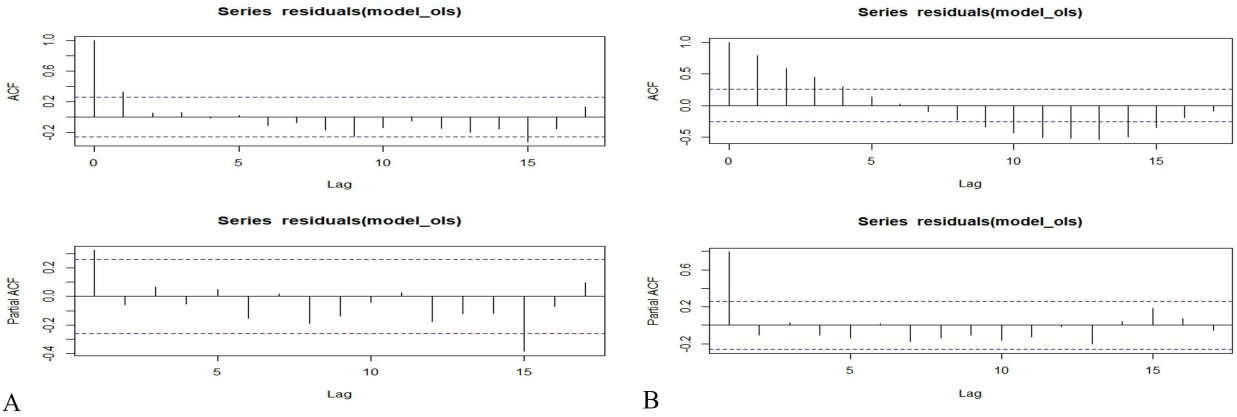


Figure 3

Residuals from the OLS regression (A: new confirmed cases, B= new deaths)



A B

Figure 4

Autocorrelation and partial autocorrelation function (A: new confirmed cases, B= new deaths)