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COMMENTARY

Effectiveness of population density as natural social distancing in COVID19 spreading

Efficacité de la densité de population en tant que distanciation sociale naturelle dans la diffusion du COVID19

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Population Density;
Social distancing

Summary Recently, many countries have decided to reopen gradually and some of them have thought that social distancing has not had a significant effect. In our study, a new view of the importance of social distancing to prevent the spread of coronavirus has been presented in terms of the relationship between peak day and peak period and population density of nine countries. Data for nine different countries in different coronavirus situations have been analyzed. The analysis process was applied by using three programs, namely; WebPlotDigitizer, WSxM and Origin. The results provide evidence of the effectiveness of social distancing by calculation of the effect of population density on coronavirus infection. That was applied by two stages, the first one by determination of two different groups of countries depending on the rate and range of coronavirus spread. These two groups were countries with developed and developing COVID19 which lead to calculate the peak day and the period times of developed groups. Then,

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analysis of that data with population density was evaluated to indicate there are significant effects of population density on peak day and peak period times which explain the importance of social distancing between people to manage and control that. The results showed that there are increasing in peak day and peak period times with increasing the population density.

MOTS CLÉS
Coronavirus ;
COVID19 ;
Jour de pointe ;
Période de temps ;
Densité de population ;
Distanciation sociale

Résumé Récemment, de nombreux pays ont décidé de rouvrir progressivement et certains d'entre eux ont estimé que la distanciation sociale n'avait pas eu d'effet significatif. Dans notre étude, une nouvelle vision de l'importance de la distanciation sociale pour prévenir la propagation du coronavirus a été présentée en termes de relation entre le jour et la période de pointe et la densité de population de neuf pays. Les données de neuf pays différents, dans des situations différentes en matière de coronavirus, ont été analysées. Le processus d'analyse a été appliqué en utilisant trois programmes, à savoir : WebPlotDigitizer, WSxM et Origin. Les résultats fournissent la preuve de l'efficacité de la distanciation sociale par le calcul de l'effet de la densité de population sur l'infection par le coronavirus. Cette méthode a été appliquée en deux étapes, la première consistant à déterminer deux groupes de pays différents en fonction du taux et de l'étendue de la propagation des coronavirus. Ces deux groupes étaient des pays avec des COVID19 développés et en développement, ce qui a permis de calculer le jour de pointe et les périodes des groupes développés. Ensuite, l'analyse de ces données avec la densité de population a été évaluée pour indiquer qu'il y a des effets significatifs de la densité de population sur les heures de pointe du jour et de la période de pointe qui expliquent l'importance de la distance sociale entre les personnes pour gérer et contrôler cela. Les résultats ont montré qu'il y a une augmentation de la densité de population dans les périodes de pointe et les jours de pointe.

Introduction

The previous recording of influenza pandemics proves that stockpiles of antiviral drugs will be limited to amounts, which can be used mostly for treating the critical cases of influenza. On the other hand, social distancing is one of the most important non-pharmaceutical interventions (NPIs) [1], widely applied by health services to minimize influenza spread in society, which has three obvious benefits. The first positive point would be to delay the date of the infection peak to allow more time for healthcare teams; the second point is to minimize the volume of the epidemic peak profile; and the last one is to make the infection distributions over a longer period of time which enables more significant management of these issues and more potential for drugs to be applied [2]. Infections by viruses, such as COVID 19, are believed to spread more through close contact in homes, workplaces, schools and public places, and especially in crowded and busy cities and countries [3]. Predictive, mathematical and statistical models for epidemics like COVID19 [4] are important and fundamental in terms of understanding the epidemic and planning effective ways to control it. There are many models that have been developed to use in the case of the COVID-19 pandemic, Lin and his colleagues extended a SEIR (susceptible, exposed, infectious, removed) model by considering the risk perception and the cumulative value of cases [5], Anastassopoulou and his colleagues suggested a discrete-time SIR model which covers dead individuals [6], Casella proposed a control-oriented SIR mathematical model which includes the delay effecting and compares that between different containment strategies [7] and Wu and his colleagues applied transmission dynamics concepts to calculate the clinical activity of COVID-19 [8].

In fact, lock-down and social distancing restrictions could lead to poverty and in some cases to undernutrition, educational weakness and undo enhancements in access to health services which have been achieved in the last few years [9]. In our work, we try to analyse the relationship between population density and sizes on COVID19 spreading in the terms of peak day and period times in nine different countries.

Methodology

Fig. 1 shows the steps of methodology of the *chose* and the analysis for nine different countries in detail. Choose nine different countries roughly and analyzed their data as shown in Fig. 1. It can be seen that the first stage is going to the website of Johns Hopkins University [10] to choose the countries randomly in the form of a picture by utilizing the snipping tool. Then, this picture will convert to data by using WebPlotDigitizer and save it in the excel form for the next

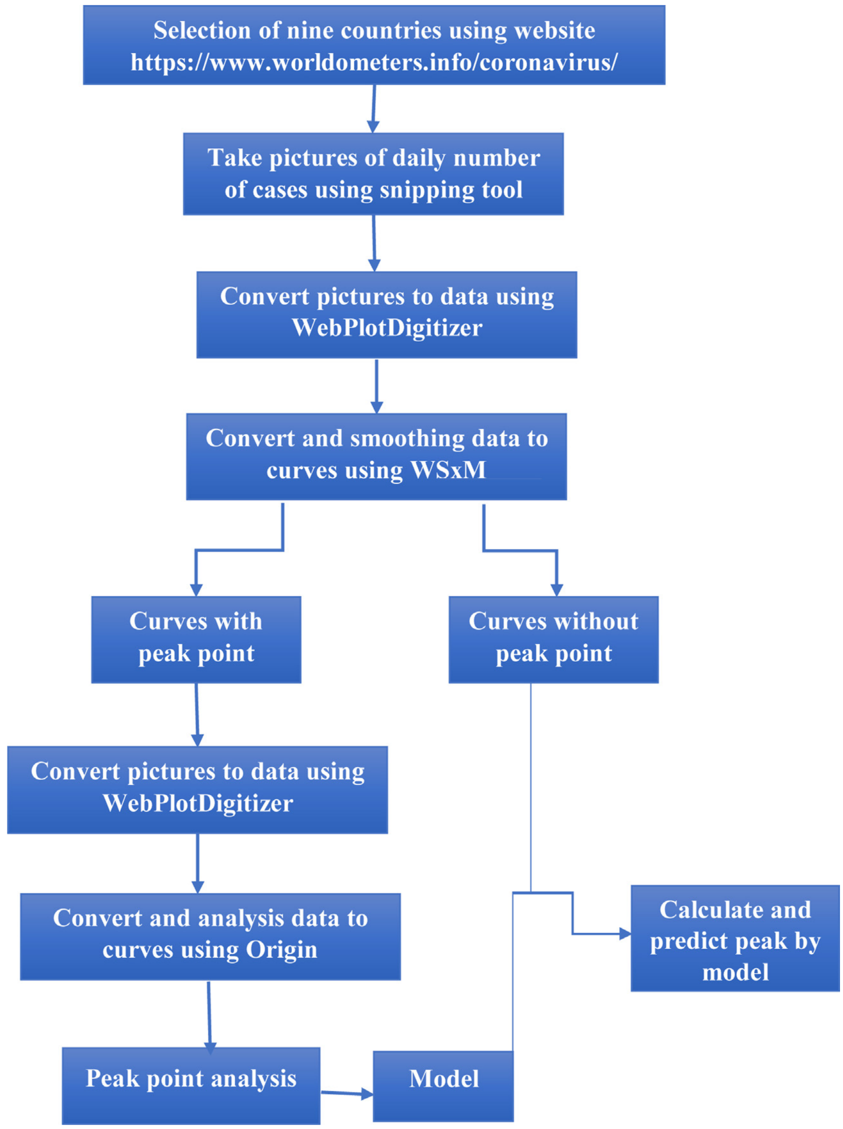

Figure 1. Methodology of choice and analysis the data of different countries.
Méthodologie de choix et d'analyse des données des différents pays.

step. After that, the data will change to a smooth curve by using WSxM and save it in the form of picture again. Depending on the form of the curve, these curves will be divided into two types; with a peak, which represents developed countries and without a peak, which represents developing countries. The first group will convert again to data in the form of an excel file which will plot as a curve by using Origin. Analysis and fitting of data will be applied by that program to calculate the peak point data analysis, which will be used next in the model analysis. Otherwise, the second group of curves will pass directly to the general model to predict and calculate the peak point.

Results and discussions

The most important five steps in the analysis of data are reported in the first in Fig. 2. The figure shows the first analysis stage is taking a picture by using the snipping tool. Then, this picture converts to data in the form of an excel file using WebPlotDigitizer in stage two. After that, that data has to change and to smother curve by utilizing of WSxM in stage three. Depending on the last stage, these curves will be divided into groups as we mentioned in Fig. 1, the first one that has a peak point, while the other does not. If the curve has a peak point, it will be saved. Then, this curve

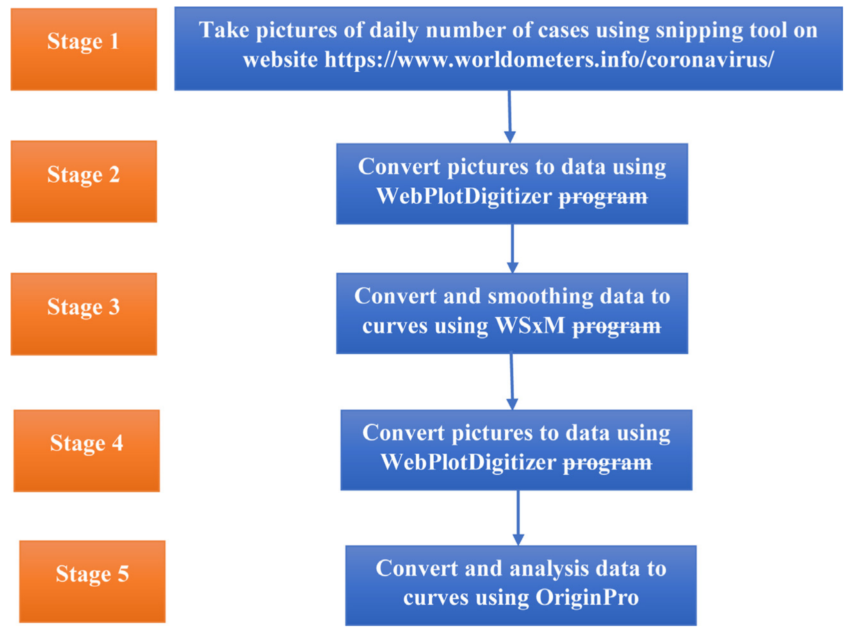

Figure 2. The important five steps of results data analysis.
Les cinq étapes importantes de l'analyse des données de résultats.

will be converted into data by using again WebPlotDigitizer in stage four and finally it will be changed into a curve and analysed to produce the model by Origin in stage five. On the other hand, curves that do not have peak point will be calculated and predicted by the determined model.

The main five steps of each country in our work are presented in Figs. 3—11, which represent China, France, Germany, Iran, Iraq, Italy, Spain, the United Kingdom and the United States, respectively. In each figure, there are five curves which show the mentioned five steps in Fig. 2, which are calculated until 14 May 2020. The main goal of these five steps is calculation of period and date of peak to analyse that with the population size of these countries in the next stage. Generally, it is clear that China, France, Germany, Italy and Spain belong to the developed coronavirus group because they have and show a peak point, while Iran, Iraq, the United Kingdom and the United States belong to the developing group. For the developed coronavirus countries group, Fig. 3 shows the peak point was after 43 days for China and the period time of the peak was 100 days, while Figs. 4 and 5 illustrate the peak points were after 30 and 28 days for France and Germany, and the period times of peak were 60 and 70 days, respectively. In Figs. 8 and 9, the peak points of Italy and Spain were after 33 and 30 days, respectively, while the period times of the peak was 80 days for them. On the other hand, Figs. 6, 7, 10 and 11 show that Iran, Iraq, the United Kingdom and the United States do not have a peak point.

The relationship between the dates of peak days, novel coronavirus daily cases, peak period times, the ratio of peak period times and the dates of peak with the density of population per square mile are shown in Figs. 12—15, respectively, for five different countries which are regarded as developed coronavirus countries. The countries are France, China, Italy, Spain and Germany which have the density of population per square mile about 100, 142, 197, 210 and 235, respectively [11]. It is clear that the peak day decreases with increasing the density of population. However, there are increases in the peak day in the range of density of population between 99—140 million per mile square. That is may be due to the random distribution of population and the high age level of Italy, as an example.

Novel coronavirus daily cases increases with increasing the density of population because the social contact will be more likely and the infection rate will be higher. It seems that Italy has lower point compared to the other four countries. That may be because of high restricted procedure applied by the government which also explains why it has a higher peak point in Fig. 12.

Fig. 14 provides evidence about the increasing of peak period times as the population density increases. This happened as we have mentioned and discussed in the last figure, because the high density of population leads to a higher incidence of contact between people and makes social distancing less feasible.

The relationship between the ratios of peak period times to peak day with population density shows significant effects on of these parameters. Where there are increases in that ratio with increasing population density, the number of people in specific areas will be higher. That number encourages a higher level of infection as a result of minimizing social distancing between people.

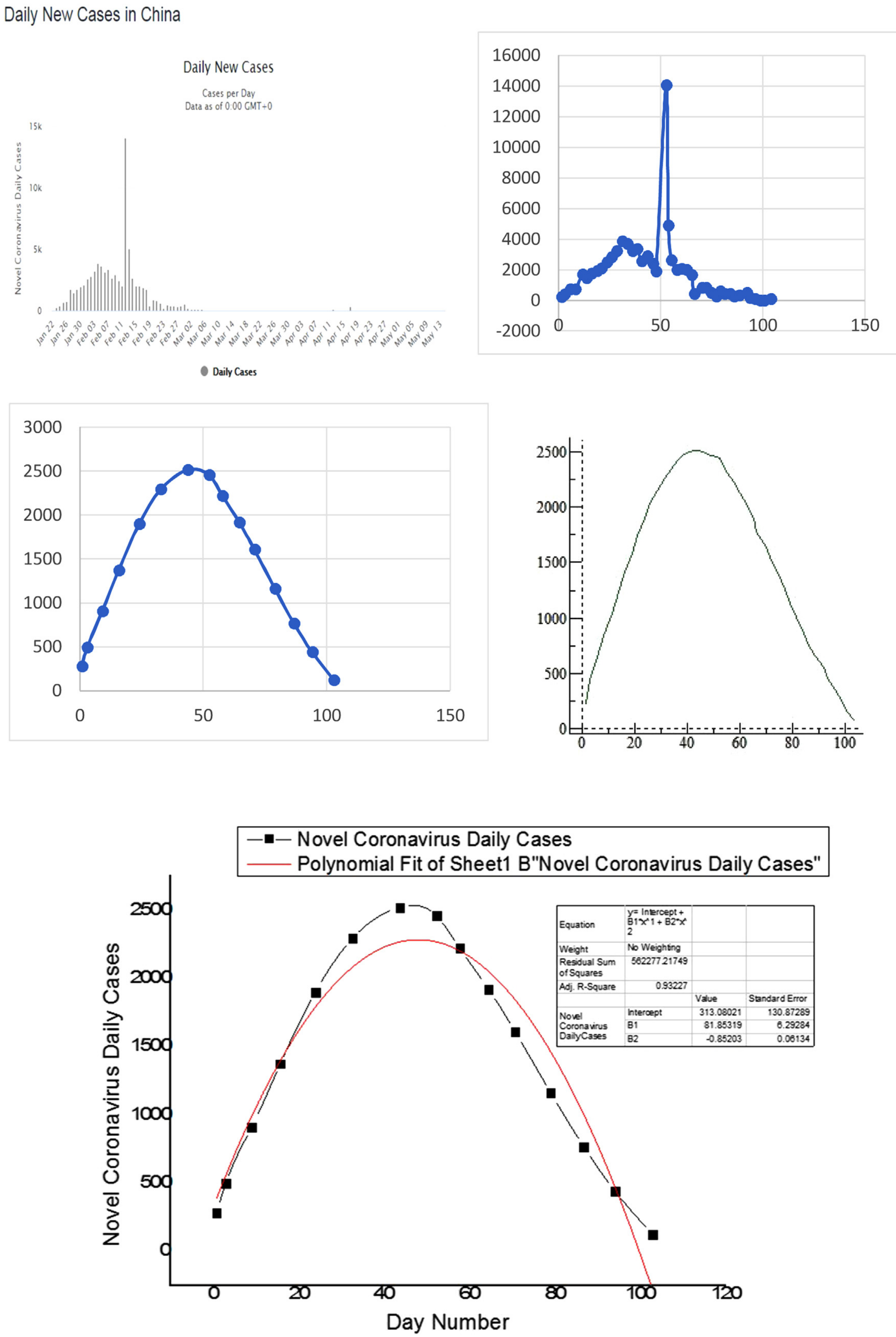

Figure 3. The main five steps in the data analysis of novel COVID19 daily cases in China.
Les cinq principales étapes de l'analyse des données des nouveaux cas quotidiens de COVID19 en Chine.

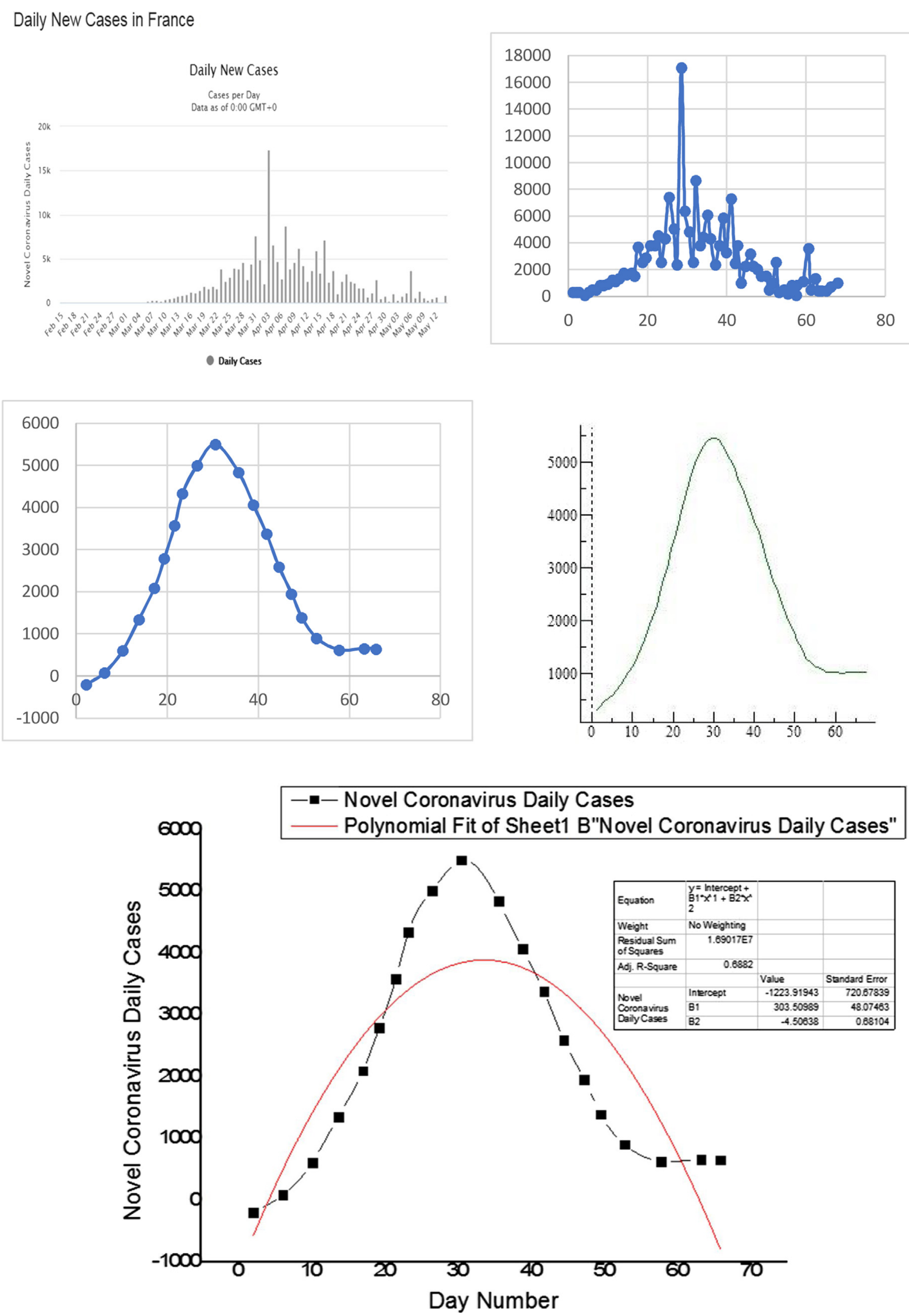

Figure 4. The main five steps in the data analysis of novel COVID19 daily cases in France.
Les cinq principales étapes de l'analyse des données des nouveaux cas quotidiens de COVID19 en France.

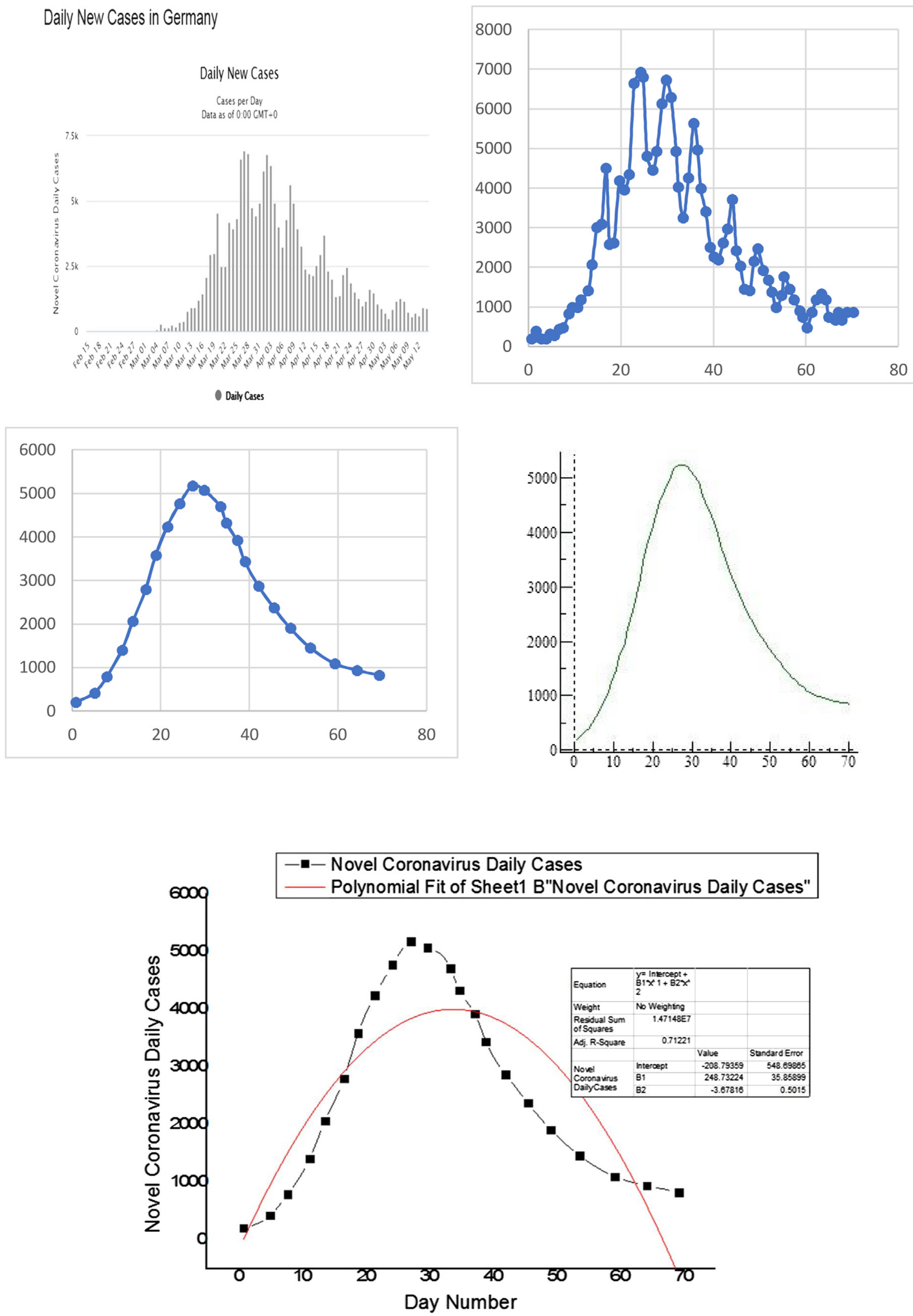

Figure 5. The main five steps in the data analysis of novel COVID19 daily cases in Germany.
Les cinq principales étapes de l'analyse des données des nouveaux cas quotidiens de COVID19 en Allemagne.

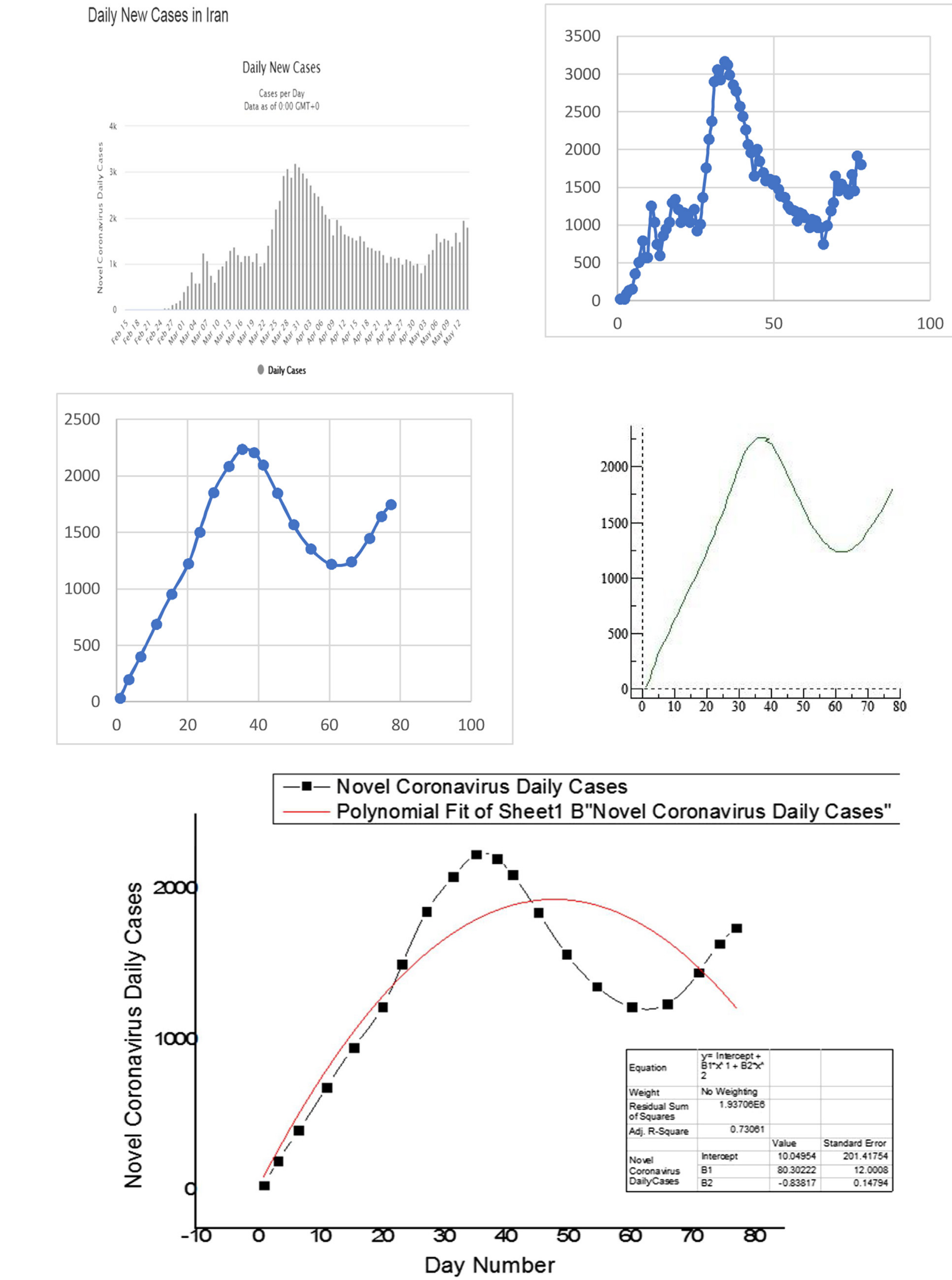

Figure 6. The main five steps in the data analysis of novel COVID19 daily cases in Iran.
Les cinq principales étapes de l'analyse des données des nouveaux cas quotidiens de COVID19 en Iran.

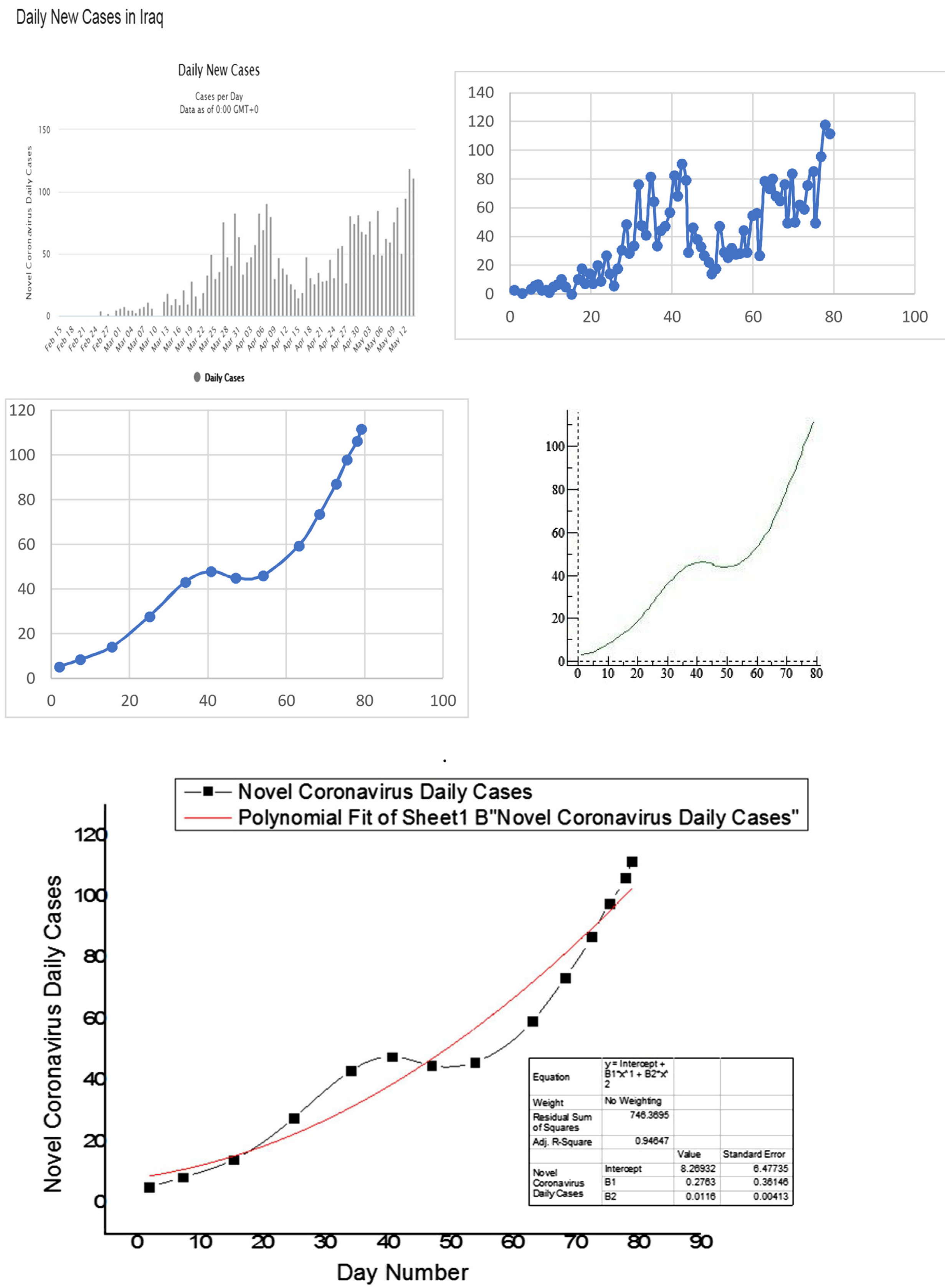

Figure 7. The main five steps in the data analysis of novel COVID19 daily cases in Iraq.
Les cinq principales étapes de l'analyse des données des nouveaux cas quotidiens de COVID19 en Iraq.

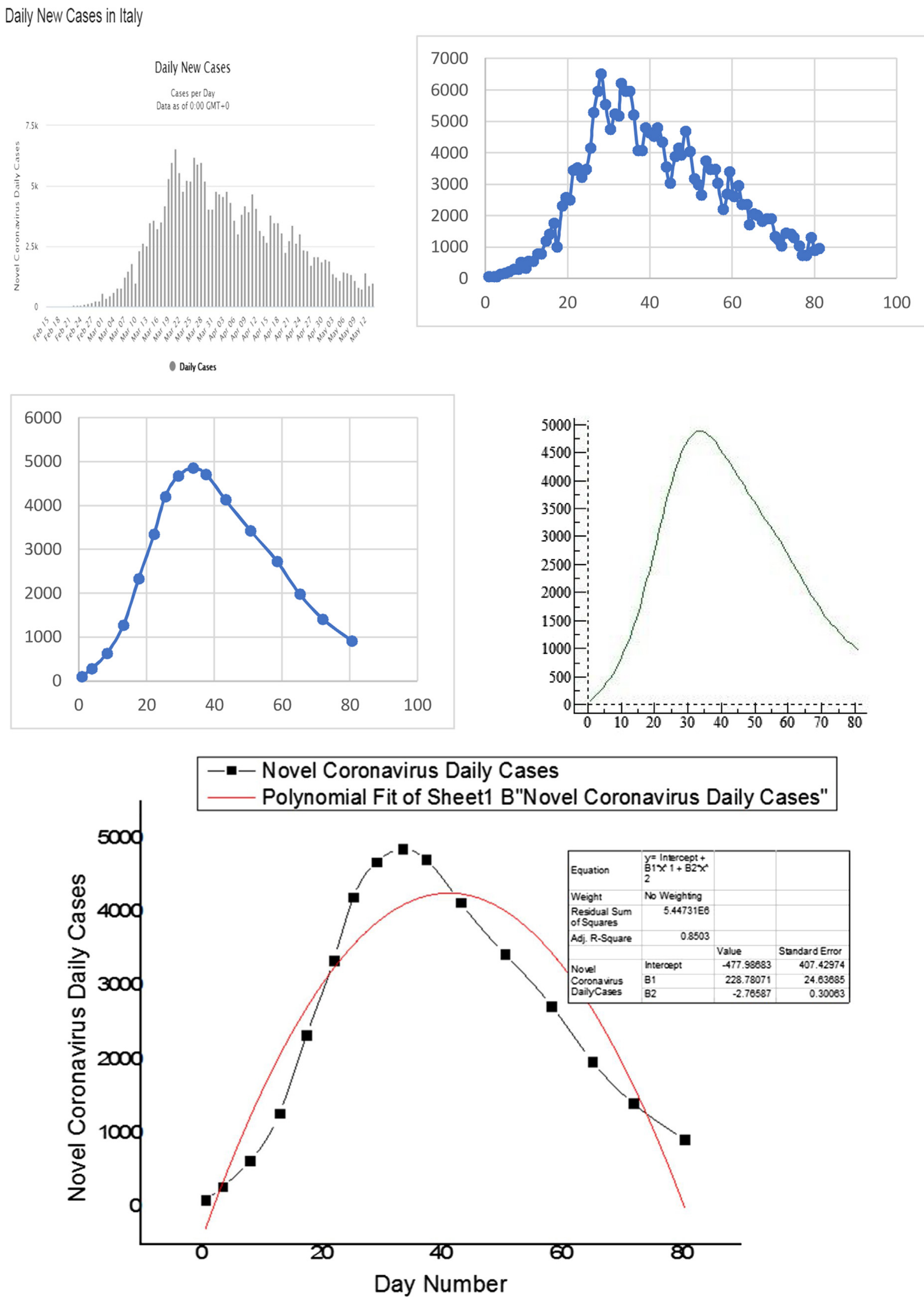

Figure 8. The main five steps in the data analysis of novel COVID19 daily cases in Italy.
Les cinq principales étapes de l'analyse des données des nouveaux cas quotidiens de COVID19 en Italie.

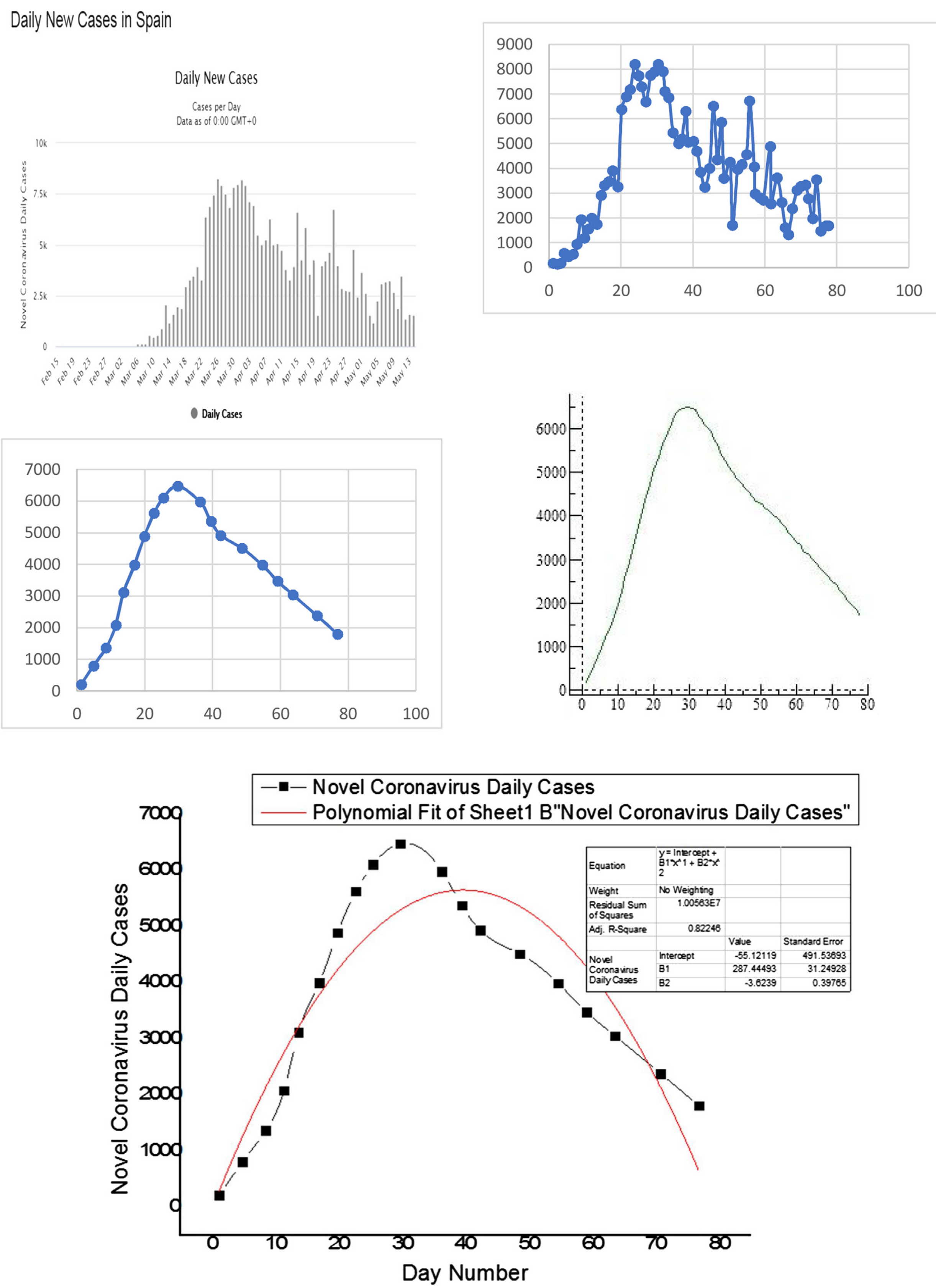

Figure 9. The main five steps in the data analysis of novel COVID19 daily cases in Spain.
Les cinq principales étapes de l'analyse des données des nouveaux cas quotidiens de COVID19 en Espagne.

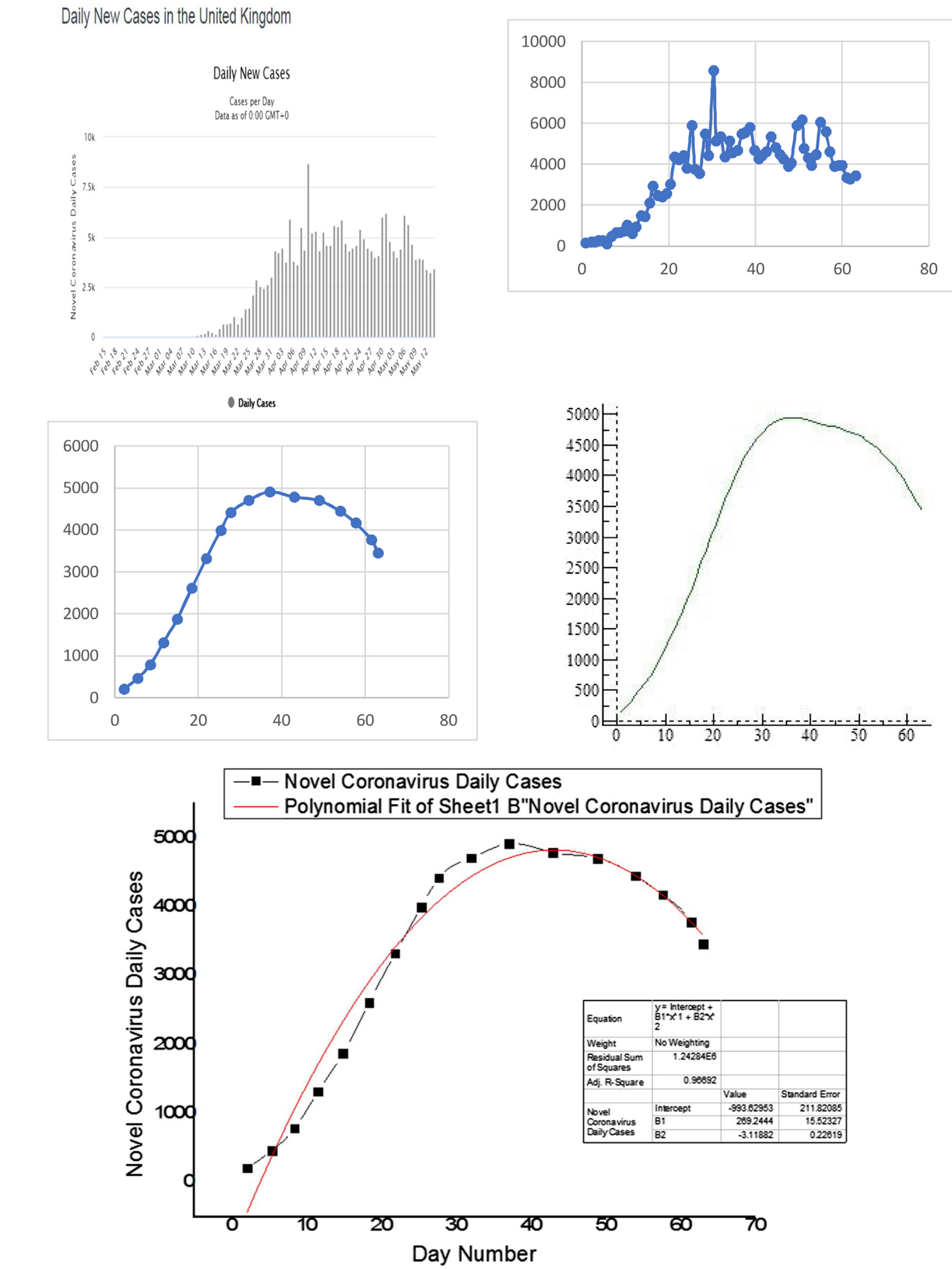

Figure 10. The main five steps in the data analysis of novel COVID19 daily cases in the United Kingdom.
Les cinq principales étapes de l'analyse des données des nouveaux cas quotidiens de COVID19 au Royaume-Uni.

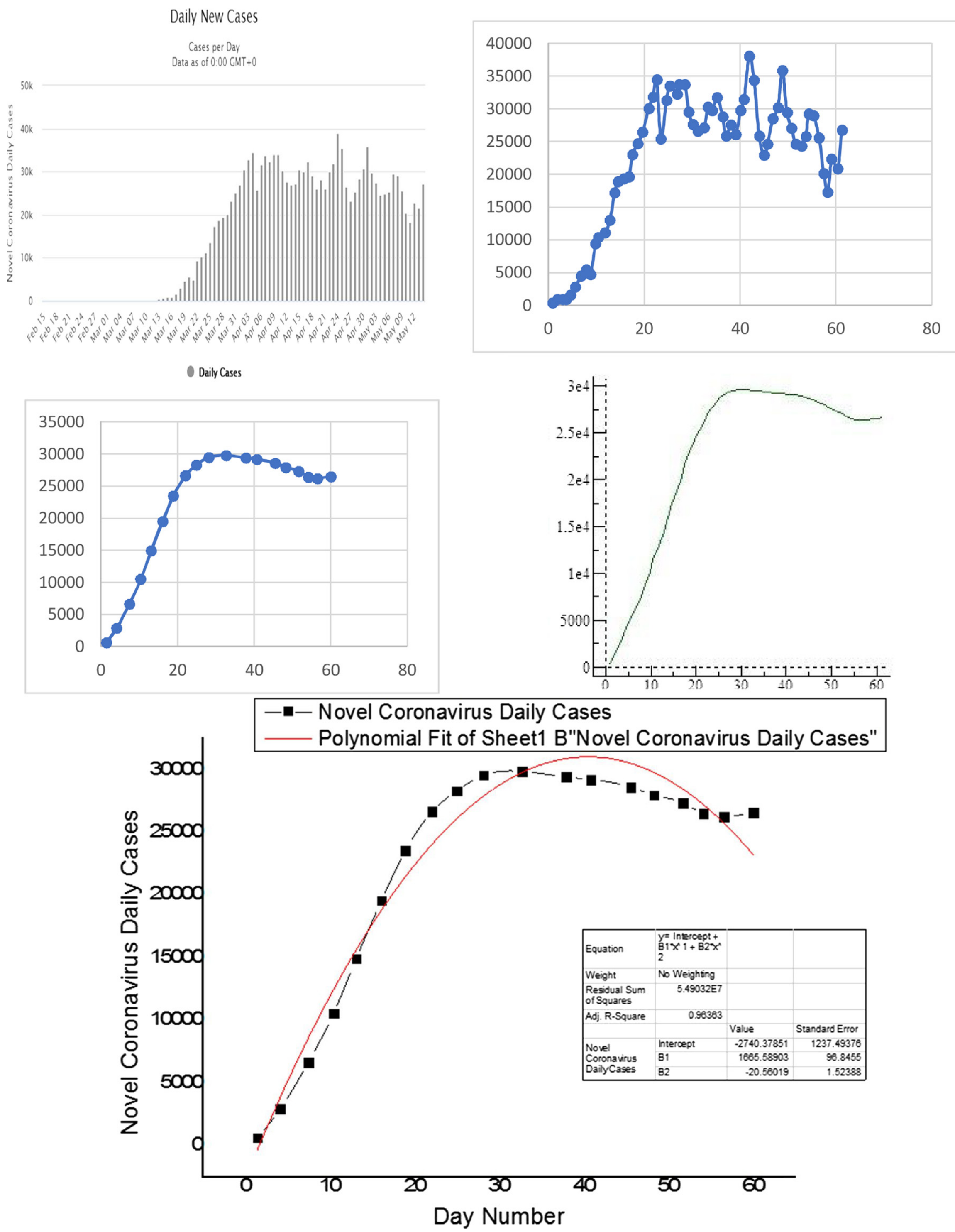

Figure 11. The main five steps in the data analysis of novel COVID19 daily cases in the USA.
Les cinq principales étapes de l'analyse des données des nouveaux cas quotidiens de COVID19 aux USA.

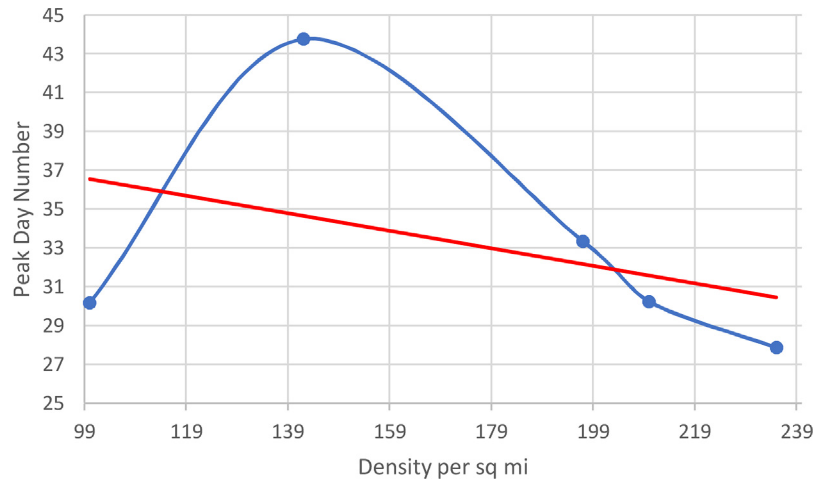

Figure 12. The relationship between density of population per square mile and the date of peak day.
La relation entre la densité de population par kilomètre carré et la date du jour de pointe.

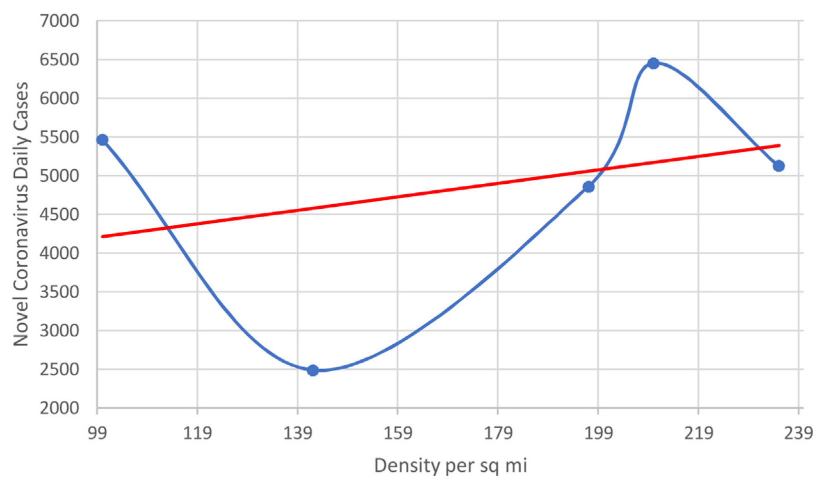

Figure 13. Novel coronavirus daily cases.
Nouveaux cas quotidiens de coronavirus.

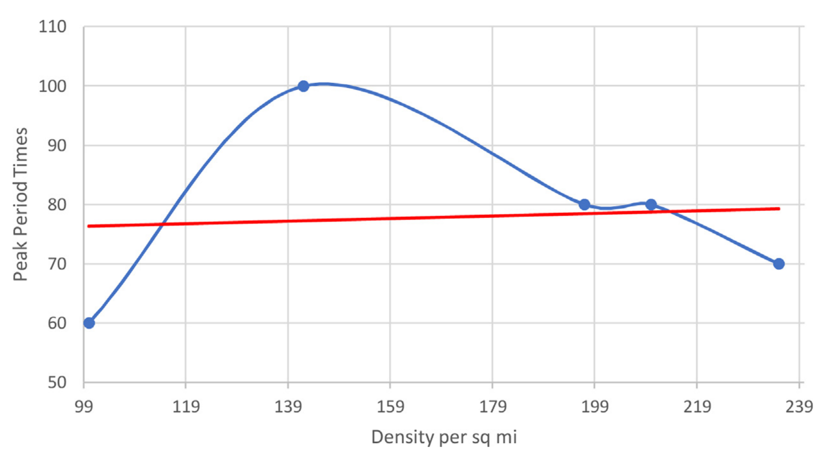

Figure 14. Peak period times.
Périodes de pointe.

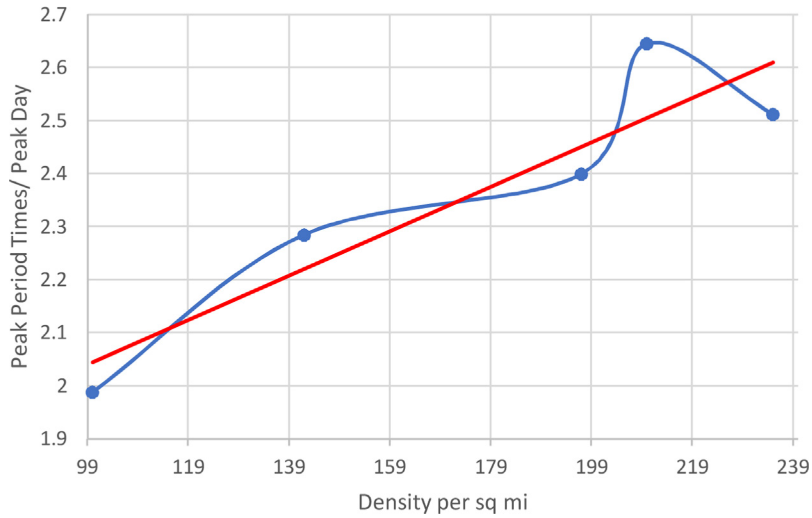

Figure 15. The relationship between the ratio of peak period times and peak day with population density per square mile. *Relation entre le rapport entre les périodes de pointe et le jour de pointe et la densité de population par kilomètre carré.*

Conclusions

This work provides evidence of the effectiveness of social distancing by calculation of the effect of population density on coronavirus infection. That was applied by two stages, the first one by determination of two different groups of countries depending of the rate and range of coronavirus spread. These two groups namely developed and developing COVID19 which lead to calculate the peak day and the period times of developed groups. Then, analysis of that data with population density was evaluated to indicate there are significant effects of population density on peak day and peak period times which explain the importance of social distancing between people to manage and control that situation. Generally speaking, the results showed that peak day and peak period times rise with increasing the population density.

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Disclosure of interest

The author declares that he has no competing interest.

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