SHORT COMMUNICATION

Modeling and Estimating the COVID-19 Incidence and Fatality in Europe

Fernando Almeida, PhD

Abstract

Background: The estimation of the real number of COVID-19 infected people is one of the concerns of the governments around the world. In this sense, this study seeks to assess the incidence and fatality of COVID-19 in Europe considering the expected number of the infected cases.

Methods: A quantitative exploratory study was performed on the top 10 countries most affected by COVID-19 by 9th June in Europe. Furthermore, this study presents three propagation estimation models of the COVID-19 that help us to understand the real incidence of the pandemic in each country. Each model is briefly explained and applied.

Results: The findings revealed a great heterogeneity of COVID-19 cases and deaths among the countries. The indicator of the number of deaths reveals the greatest disparity between other countries with the United Kingdom, recording about 6 or 7 times more deaths than Russia or Germany. Infection fatality rate (IFR) tends to be a more reliable indicator when analyzing data because it is less dependent on the number of tests performed.

Conclusion: Several estimation models can be used to determine the incidence of COVID-19. However, their results in European countries are still quite asymmetrical although they are more reliable than just looking at the perspective of the number of cases or deaths recorded. The infection fatality rate (IFR) emerges as a more accurate indicator by estimating the expected number of registered cases, which includes asymptomatic cases and patients with mild symptoms that are not known and reported by health authorities.

University of Porto, INESC TEC & ISPGAYA, Porto, Portugal

Correspondence:
Fernando Almeida, PhD
University of Porto, INESC TEC & ISPGAYA, Porto, Portugal
Tel: +351 225081400
Fax: +351 225081440
Email: almd@fe.up.pt

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Introduction

The COVID-19 pandemic has alarmed the world's population. National and international health authorities have sought to follow the evolution of the new coronavirus surge; at the same time, research and development (R&D) centers have collaborated in finding solutions to combat and mitigate it. Several challenges are common to the various research proposals related to COVID-19, namely the need to involve the community and researchers with interdisciplinary expertise, and the creation of transparent mechanisms for sharing data with the scientific community.[1, 2]

In addition to scientific knowledge, health decision-making processes are also influenced by political, economic, and socio-cultural factors.[3] The various actions taken by governments to combat and mitigate the effects of COVID-19 are based on the number of registered cases and deaths. However, these indicators, although relevant, only look at the past situations. Furthermore, these indicators are strongly conditioned by the number of the tests performed. According to the Organization for Economic Co-operation and Development,[4] the number of tests performed is a key element in bringing the real results closer to the number of registered cases and the number of estimated cases. Furthermore, the massification of the tests enables early detection of COVID-19, which contributes to reduction in the severity of symptoms and relieves pressure on the health systems.[5]

In parallel with the number of confirmed cases, governments are concerned to find models to trace the future evolution of COVID-19. Through the number of estimated cases, it is possible to make a real estimate of the incidence rate of COVID-19 in the population. In this sense, this short communication aims to synthesize and compare the main models adopted to estimate the incidence of pandemic in each country. This study intends to briefly explain the assumptions of each model and applies them to the 10 top European countries with the highest number of confirmed cases of COVID-19.

Methods

Three estimation models were considered given their relevance and distinctive approaches to estimate the number of COVID-19 cases.

Confirmed Case Fatality Risk (cCFR) Estimate

According to the model proposed by Nishiura et al.,[6] to assess the pandemic potential of a respiratory infection, there are two critical aspects: the transmission potential and the clinical severity of the infection. The first dimension can be quantified by the average number of secondary cases generated by a primary case and by the characterization of transmission patterns. The second dimension explores specific genetic virulence and can be quantified by the case fatality rate (CFR), which is given by the conditional probability of death from the disease. This model emerged mainly due to SARS and H1N1 pandemics, but it has also been applied within COVID-19.

The cCFR looks to the proportion of deaths among confirmed cases and adjusts the underestimation of the infected cases due to the time delay between the detection of a case and the death of a patient. cCFR considers only confirmed cases and estimates the number of infected individuals based on this information. Therefore, in this process which serves as the basis for the cCFR estimate, patients who do not seek medical treatment are not considered, apart from all asymptomatic cases.

Institute for Health Metrics and Evaluation (IHME) Estimate

IHME is an independent research institute that conducts statistical analysis in the healthcare field. The IHME estimate is a multi-stage hybrid model that relies on the basic pillars of the number of deaths and infections.[7] This model seeks to generate predictions of deaths and infections in several countries and regions. Furthermore, it is also the objective of this model to offer alternative scenarios for the evolution of COVID-19 based on temperature, population density, the tests performed, and social distancing measures taken by governments that restrict human mobility. The modeling is composed of four fundamental elements: (i) daily temperature; (ii) percentage of the population in densely populated areas; (iii) number of tests performed; and (iv) changes in urban mobility.

Corona Surveys

The Corona Surveys project has been promoted by several universities and health research institutions. Data on the incidence of COVID-19 are collected from open and anonymous surveys.[8] The projection of the estimated number of cases is performed using the Network Scale-up Method. This technique has been successfully used in studies in the health area as in Bernard et al.'s study,[9] in which the number of infections in sexually transmitted diseases is estimated. This approach provides estimates based on the population's perception of the evolution of COVID-19. Unlike direct surveys, this approach offers specific population coverage through the multiplicative effects of each response. Despite the difficulties of accuracy in the estimation of each person, this information is compensated by the increase in the coverage rate.

Results

Before applying each of the estimation models, the incidence of COVID-19 in Europe as one of the countries most affected by this pandemic was analyzed. For this purpose, the top 10 European countries with the highest number of confirmed cases were considered. In this process, the proportion of cases by population was not studied, but only the absolute number of cases confirmed by local authorities. These data were obtained from Worldometer[10] on the 9th of June 2020. Table 1 presents the total cases (TC), total deaths (TD), number of deaths per 1 million individuals, total tests performed, and number of tests per 1 million individuals.

Table 2 shows the estimated number of cases of COVID-19 on the 9th of June 2020 considering three models: (i) cCFR; (ii) HMI; and (iii) CoronaSurveys. Furthermore, the case fatality rate (CFR) and infection fatality rate (IFR) were determined as proposed by Verity [11]. In calculating the IFR, the average of the three estimates (EC), when available, was considered. CFR is calculated as indicated in (1) and the formula for IFR is provided in (2).

$$CFR = \frac{TD}{TC} \quad (1)$$

$$IFR = \frac{TD}{EC} \quad (2)$$

Table 1: Impact of COVID-19 in Europe

Country	TC	TD	Deaths/1M pop	Total Tests	Tests/1M pop
Russia	485253	6142	42	13255k	90.828
UK	289140	40883	602	5871k	86.501
Spain	289046	27136	580	4465k	95.507
Italy	235561	34043	563	4319k	71.422
Germany	186516	8831	105	4349k	51.915
France	154591	29296	449	1385k	21.215
Belgium	59437	9619	830	958k	82.724
Belarus	50265	282	30	644k	68.169
Netherlands	47903	6031	352	424k	24.774
Sweden	46616	4717	467	276k	27.289

Table 2: Estimation of cases in Europe

Country	cCFR (%)	IHME (%)	CoronaSurveys (%)	CFR (%)	IFR (%)
Russia	566k (85.69)	1380k (35.14)	n/a	1.27	0.63
UK	3260k (8.87)	2587k (11.17)	2887k (10.01)	14.14	1.40
Spain	2029k (14.24)	2230k (12.96)	2121k (13.63)	9.39	1.28
Italy	2545k (9.27)	2204k (10.71)	3269k (7.22)	14.45	1.27
Germany	657k (28.46)	739k (25.30)	2401k (7.79)	4.73	0.70
France	2232k (6.94)	2710k (5.72)	3535k (4.38)	18.95	1.04
Belgium	732k (8.06)	1022k (5.77)	n/a	16.18	1.10
Belarus	25.8k (-48.40)	n/a	n/a	0.56	1.09
Netherlands	462k (10.39)	556k (8.63)	n/a	12.59	1.18
Sweden	432k (10.88)	491k (9.57)	n/a	10.12	1.02

Discussion

There are significant differences in the behavior of the European countries most affected by COVID-19. The behavior is rather asymmetric. some care must be taken in interpreting these data since the process of accounting for the number of cases depends essentially on the rate of the test coverage.[12] It is quite clear that the coverage of the tests is higher in countries such as Spain, Russia, UK, and Belgium when compared with countries such as France, Netherland, or Sweden that exhibit average coverage rates of the tests between 3 and 4 times lower.

The data from Table 2 indicate significant discrepancies between the estimations, especially in countries such as Russia, Germany, and France. In the latter two countries, the estimate made by Corona Surveys is higher due to the features of this model in including asymptomatic cases identified by the community. The idea of Corona Surveys is to have a more realistic estimate of the incidence of COVID-19 in the population, especially among the urban population of large cities and suburbs. However, Corona Surveys is still implemented in a small number of countries and depends strongly on community involvement. The CFR is quite heterogeneous, with the highest values in countries like France and Belgium. The high incidence rate of COVID-19 in the elderly population and the severity of cases registered in hospitals contribute to this result. It is evident that the symptoms of COVID-19 do not manifest with the same critical level in all individuals. Moreover, in the case of Belgium, cases of suspected deaths of COVID-19 are officially registered, even those reporting to individuals who have not been tested.[13] In the IFR, the results tend to be more homogeneous since the estimated values of the number of infected people also include cases of asymptomatic and patients with mild symptoms of the disease. Nevertheless, some significant oscillations persist with the IFR in the UK, being twice that of Germany.

Conclusion

This short communication helps to understand the way each estimate works and explore its impact in Europe. The impact of COVID-19 in Europe has been quite heterogeneous, even when considering only the 10 countries with the highest number of registered cases. A determining factor in understanding this phenomenon is the number of tests carried out in each country, as their higher number also causes an increase in the number of identified cases.

To overcome this limitation in data analysis, several models of estimation of COVID-19 were developed. In this study, cCFR, HMI, and Corona Surveys were comparatively analyzed. The findings reveal high discrepancies in the number of cases confirmed and estimated, particularly in countries such as Russia, Germany, and France. Finally, the CFR is also rather asymmetric and has rather high values in France and Belgium, while the IFR tends to be more homogeneous as it includes asymptomatic cases and those patients who do not report their situation to national health authorities because they have mild symptoms. Despite the disparity in estimates in some countries, the IFR tends to be a more robust indicator for measuring the mortality rate caused by COVID-19 than the CFR. This study has some limitations because it was not feasible to collect data on the incidence of COVID-19 in all countries using the Corona Surveys. Moreover, data reported by the 9th of June 2020 may not be fully updated by all countries, as the update cycles of this information by local government entities are distinct and not uniform.

Conflict of Interest: None declared.

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