The Severity of Covid-19 in Italy Seen from Its Epicenter

Ilia Negri [1] and Marcella Mazzoleni [2]

[1] Department of Economics, University of Bergamo, Bergamo, Italy – ilia.negri@unibg.it
[2] CESC, University of Bergamo, Bergamo, Italy – marcella.mazzoleni@unibg.it

The onset, the spread, and the outcome of COVID-19 at the beginning of 2020 in Italy has been characterized by multiple socio-territorial factors that can help to read the pandemic evolution from different points of views. This paper has a special focus on statistical significative aspects emerged in a multidisciplinary research of the University of Bergamo that has the aims to identify some factors of contemporary urban and mobile living, which favored the spread and propagation of COVID-19 in Italy. We describe the methods used and the results obtained to describe the severity of the impact of COVID-19 epidemic in the first months of its spread in Italy, and in particular in its epicenter, the Bergamo province. We aim also, on the one hand, to integrate and validate different information from various sources of territorial data, and, on the other hand, to provide a measure of the severity of the impact of COVID-19 epidemic on the territories of the area of Bergamo, Italy.

1 Introduction

The onset, the spread, and the outcome of COVID-19 at the beginning of 2020 in Italy has been characterized by multiple socio-territorial factors that can help to read the pandemic evolution from different points of views. This paper has a special focus on statistical significative aspects emerged in a multidisciplinary research of the University of Bergamo that has the aims to identify some factors of contemporary urban and mobile living, which favored the spread and propagation of COVID-19 in Italy. The project engaged geographers, urbanists, cartographers, jurists as well as statisticians, to outline the different roles of the disciplines involved and to highlight different point of view starting from the idea that pandemic is not only a biomedical problem, but also a socio-territorial problem. In this direction, the social, economic, geographical, and political aspects are considered and compared with the population of the territories, the spread of the contagion and the severity of the pandemic. The contribution as statisticians to the project was related, on one hand, to integrate and validate different information from various sources of territorial data, on the other hand, to provide a measure of the severity of the impact of COVID-19 epidemic on our

DOI: 10.54103/milanoup.73.59

territories. The number of deaths classified by age group were estimated for each Italian region keeping as a constraint the data provided by the Italian Higher Health Institute (ISS). In[1] the results are highlighted by a reflexive cartography that shows the relationships between the intensity of the contagion and socio-territorial aspects as well as it can identify the correlations between intensity, severity, and outcome of the COVID-19 on the Italian population. In the next sections, we describe the methods used and the results obtained to describe the severity of the impact of COVID-19 epidemic in the first months of its spread in Italy, and in particular in its epicenter, Bergamo province.

Starting from the first case recorded, information on the spread of COVID-19 in Italy is communicated daily by the institutions. The number of deaths related to COVID-19 is provided by the ISS but only at the regional level and by age at national level. At present, information on the age of deceased persons at regional level has not yet been given. Also, during the most critical phase of contagion, several people died without a swab test that would have established whether they had contracted the virus.

For these reasons, we decided to analyze deaths rates using ISTAT (Italian Office of Statistics) mortality tables. From these data emerges that mortality rates in March in Lombardy arose from 9 (mean of the previous 5 years) to 25 for 10,000 inhabitants in 2020. The same rate for the Bergamo province arose from 8 to 55 in the same period. Induced from these astonished numbers we decide to go further in the investigation and to provide a method to estimate the number of deaths from causes attributable to COVID-19.

2 Methods

The ISS data included subjects who tested positive to a swab by region and by age group at national level. However, it did not provide information relating to deaths by age group in each region. The number of deaths from all causes attributable to COVID-19 is estimated by comparing the number of deaths recorded in March 2020 with the number of deaths recorded in the same month over the previous five years, from 2015 to 2019, and keeping as a constraint the data provided by the ISS. This number is defined: "number of deaths due to COVID+" where + stands for deaths due to COVID-19, but also for the other three causes related to the presence of the virus on the Italian territory, as described in.[2] We denote this number with C^{+}_{re}, where r stands for the geographic area and e denotes the age group. Let D_{re} denote denote the number of deaths in area r and in the age group e and G_{re} the number of deaths due to other causes not attributable to COVID-19 in area r and in the age group e, which is estimated by the mean of deaths in the previous years in the area r and for the age class e. We have the following equality: $D_{re} = G_{re} + C^{+}_{re}$. Moreover, $C^{ISS}_{r.}$ and $C^{ISS}_{.e}$, respectively the total deaths for COVID-19 in the area r and in the age

class e, are known and provided by ISS but, unfortunately, they underestimate the deaths for COVID-19 in some areas and for some age classes.

Starting from the marginal, the deaths due to COVID+ for each age e, $C^{+}_{\cdot e}$ is defined as:

$$C^{+}_{\cdot e} = \begin{cases} D_{\cdot e} - G_{\cdot e}, & \text{if } D_{\cdot e} - G_{\cdot e} > C^{ISS}_{\cdot e} \\ C^{ISS}_{\cdot e}, & \text{otherwise.} \end{cases}$$

where $D_{\cdot e} = \sum_{r=1}^{R} D_{re}$ and $G_{\cdot e} = \sum_{r=1}^{R} G_{re}$.

Moreover, the total deaths for COVID+ for each area r, $C^{+}_{r\cdot}$, is defined as:

$$C^{+}_{r\cdot} = \begin{cases} D_{r\cdot} - G_{r\cdot}, & \text{if } D_{r\cdot} - G_{r\cdot} > C^{ISS}_{r\cdot} \\ C^{ISS}_{r\cdot}, & \text{otherwise.} \end{cases}$$

where $D_{r\cdot} = \sum_{e=1}^{E} D_{re}$ and $G_{r\cdot} = \sum_{e=1}^{E} G_{re}$.

Once the marginals have been estimated it is possible, at a first stage, to estimate C^{+}_{re} , such as:

$$C^{+}_{re} = \begin{cases} D_{re} - G_{re}, & \text{if } D_{re} - G_{re} > 0 \\ 0, & \text{otherwise.} \end{cases}$$

C^{+}_{re} must be adjusted according to the estimated marginal. If, for an age class e, $\sum_{r=1}^{R} C^{+}_{re} < C^{+}_{\cdot e}$ or, for a geographical area r, $\sum_{e=1}^{E} C^{+}_{re} < C^{+}_{r\cdot}$, then the deaths due to COVID-19 are underestimated. Therefore, the estimate for that age class and for that area must be updated using the method proposed in [2]. Our method is an alternative to the one proposed in.[3]

3 Results

Detailed results are available in[4] e.[5] According to ISTAT mortality tables,[2] in March 2020, in Italy, 85,786 people died against an average of 58,265 over the previous five years. The region where the death toll was the highest is Lombardy, indeed one third of the people who died in Italy in March 2020 were in Lombardy. After obtaining the estimates for COVID+, the death rate for COVID+ is calculated in each region. Analysing the ratio of the estimated mortality rate for COVID+ and the death rate due only to COVID-19, according to data released by the ISS, emerges that this value is always higher than 1, except for few regions, and in Lombardy this value is almost double, which indicates that for every COVID-19 death certified by a swab test there is another death

attributable to COVID-19 for direct or indirect reasons. In[4] reflexive cartography model - which presents localized and cross-referenced data - allows us to interpret mortality in its impact on population and on its regional distribution in a detailed and, at the same time, comparable vision. This recovers the social impact of epidemic mortality and promotes a search for the possible causes of these differences in other socio-territorial data such as type of settlement, mobility, pollution or other. The analysis of reflective mapping outlines a partition of Italy into three geographical areas, in accordance with different mortality rates and COVID-19 contagion severity. Results confirm that the COVID-19 epidemic had a major impact on Italy, and an even more significant impact on Lombardy, both in terms of absolute number of deaths and mortality rate. In this early stage of the epidemic, the spread of COVID-19 had a different impact on different age groups. To analyse this disparity, we estimated the mortality rate for each age group in each region as the institutions in Italy do not provide information on the age of deceased at regional level. COVID-19 impact on people under the age of 60 is virtually negligible compared to impact in older age groups. It may be observed that the oldest class (aged 90 or over) is the most affected. In fact, each region for this class presents the highest mortality rate. An analysis on the impact by age in each region, indicates once again that Lombardy is the region most severely affected by the disease. Lombardy shows, indeed, the highest number of deaths and the highest mortality rate in each age group. It should be emphasized that in the case of people over 70 years of age, COVID-19 is responsible for approximately one in three deaths. Focusing on the Lombardy region, the results show that in some provinces mortality impact was much higher than suggested in official reports. A comprehensive mapping of research estimates confirms that the Bergamo province experienced the highest mortality rates in March, even if the Cremona province had the highest death toll in April. Analysing the ratio of death rates for COVID+ and COVID-19 in March and April, in each Lombard province this value is much above 1, with a maximum of 2.07 in Bergamo, meaning that for every 100 official deaths from COVID-19 there are an estimated 207 deaths from COVID+. Analysing the maps in [3] concerning the data on the mortality for each province and the estimates for COVID+, it is possible to partition the Lombardy in three areas. The provinces of Bergamo, Brescia, and Milan make up a first sub-region, in which COVID-19 impact was more severe and mortality rates were high both in absolute terms and by population. These are the three Lombard provinces characterized by dense urbanization and intense productivity. Then there are the provinces of Pavia, Lodi, Cremona, and Mantua, where the impact of COVID-19 was lower than in the first group while still higher than in the rest of Italy. This is an area of Lombardy with a strong agriculture-driven productive network, made up of smaller urban areas. Finally, the other provinces of Lombardy are the ones less affected by the first COVID-19 outbreak. Contagion impact for these provinces

is like the rest of Italy. Regarding age groups in Lombard provinces, COVID-19 affected age groups differently and the mortality was seen to be highest among the oldest age groups with a significant impact on mortality in the provinces of Bergamo, Cremona, and Lodi, but also in the provinces of Pavia and Brescia. Impact was more attenuated, but still comparatively high, in the other provinces. As expected, throughout all the provinces, oldest age groups recorded the highest mortality rates, which confirms that the disease strongly affects the elderly. In addition, excess mortality recorded in the oldest age groups is almost exclusively to be ascribed to COVID-19 or related causes, since differences between provinces in mortality rate from other causes are negligible.

4 Conclusions

The impact of the COVID-19 disease in March, in Italy was severe, but Lombardy was the region that, in addition to the highest absolute numbers of deaths, revealed the highest rates of variation and the greatest mortality rate. Our estimates confirm that COVID-19 impact in Italy was significant. A meta-analysis of mortality data in the region of Lombardy suggests that, for the purposes of data interpretation, the region may be divided into three macro-areas. The first macro-area is made up of the provinces of Bergamo, Milan, and Brescia, where both the absolute numbers of deaths and mortality rates were very high, between three and four times those of previous years. The second macro-area consists of their south neighbouring provinces: Pavia, Lodi, Cremona, and Mantua. Here the impact of mortality was greater than in other regions of Italy, but lower than the first three provinces. The third group comprises the other provinces, where the incidence of mortality was lower and generally comparable to the Italian average.

References

[1] Casti, E., Adobati, F., Negri, I. (Eds.) (2021). *Mapping the Epidemic, Volume 9. A systemic Geography of Covid-19 in Italy*. First Edition. Amsterdam, The Netherlands: Elsevier.

[2] ISTAT (2020). Decessi per il complesso delle cause. Periodo gennaio-agosto 2020 (in Italian) [Deaths for all causes. January-August 2020]. ISTAT Report.

[3] Modi, C., Boehm, V., Ferraro, S., Stein, G., Seljak, H. (2020). How deadly is COVID-19? A rigorous analysis of excess mortality and age-dependent fatality rates in Italy. MedRxiv. https://doi.org/10.1101/2020.04.15.20067074.

[4] Negri, I., Mazzoleni, M. (2021). Estimating the mortality and severity of the COVID-19 epidemic in Italy. In Casti, E., Adobati, F., Negri, I. (Eds.): *Mapping the epidemic. A systemic geography of Covid 19 in Italy*. Amsterdam, The Netherlands: Elsevier.

[5] Negri, I., Mazzoleni, M. (2021). The mortality and infection severity in Lombardy. In Casti, E., Adobati, F., Negri, I. (Eds.): *Mapping the epidemic. A systemic geography of Covid 19 in Italy*. Amsterdam, The Netherlands: Elsevier.