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Short Communication

Timing of national lockdown and mortality in COVID-19: The Italian experience

Angelo Silverio, Marco Di Maio, Michele Ciccarelli, Albino Carrizzo, Carmine Vecchione, Gennaro Galasso

Department of Medicine, Surgery, and Dentistry, University of Salerno, Baronissi, Salerno, Italy
Division of Cardiology, Maria SS. Addolorata Hospital, Eboli, Salerno, Italy
Vascular Pathophysiology Unit, IRCCS Neuromed, Pozzilli, Ischia, Italy

Objective: To evaluate if the pandemic mitigation effects of lockdown in Italy have been influenced by the level of penetration of COVID-19 in Italian Regions at the onset of containment (March 9, 2020).

Methods: We collected data published day by day from the first COVID-19 case until March 5, 2020, the end of lockdown, by Italy's Protezione Civile Department. Linear regression analyses were performed to evaluate possible correlations between the number of confirmed cases/100,000 residents and the number of new cases/100,000/day before lockdown, with the number of deaths/100,000 residents at sixty days, in each Italian region.

Results: We found a significant positive correlation between the number of confirmed cases before lockdown and mortality up to sixty days ($p < 0.001; R^2 = 0.57$) as well as between the incidence rate of new cases per day and mortality up to sixty days ($p < 0.001; R^2 = 0.73$). Regression coefficients indicated about two deaths up to sixty days for every new patient with confirmed COVID-19 before lockdown, and 37 deaths for every new infected subject per day until the lockdown decree of March 9, 2020.

Conclusions: Every new infected subject before lockdown counted on the death toll of the COVID-19 pandemic in Italy.

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Introduction

On February 20, 2020, a 30-year-old patient admitted to the intensive care unit in Codogno Hospital (Lombardy, Italy) tested positive for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), a novel beta-coronavirus that causes Coronavirus disease 2019 (COVID-19). During the next 24 h, the number of reported positive cases increased to 36 (Sebastiani et al., 2020; Grasselli et al., 2020).

In Italy, COVID-19 spread out in a north-south direction, determining geographical disparities in the number of confirmed cases and deaths among the twenty Italian regions (La Maestra et al., 2020; Russo et al., 2020). On March 9, 2020, the Italian government imposed a nationwide community containment, restricting the movement of the population except for well-defined circumstances of necessity such as work or health reasons, to avoid the uncontrolled spreading of infection throughout the country.

We hypothesized that the pandemic mitigation effects of lockdown in terms of mortality have been influenced by the level of penetration of COVID-19 in Italian Regions at the onset of containment.

Methods

We collected data published daily from the first COVID-19 case until May 3, 2020, the end of lockdown, by Italy's Protezione Civile Department (Presidency of the Council of Ministers, 2020). The level of penetration of COVID-19 was investigated by using the number of confirmed cases per 100,000 residents and the incidence rate of new cases (new cases per 100,000 residents per day) before the lockdown decree in Italian regions. The former was calculated by dividing the total number of new confirmed cases (from the first case until the last before the lockdown decree) for the number of residents in each region and multiplied per 100,000; the latter was calculated by dividing the number of
## Table 1
COVID-19 pandemic features in Italian regions.

| Region                  | Population | Days from the first case to lockdown | Number of cases before lockdown | Number of cases/100,000 residents/day before lockdown | Number of deaths/100,000 residents at 60 days |
|-------------------------|------------|--------------------------------------|--------------------------------|-----------------------------------------------------|---------------------------------------------|
| Abruzzo                 | 1,304,970  | 12                                   | 30                             | 0.19                                                | 22.61                                       |
| Aosta Valley            | 125,332    | 5                                    | 15                             | 2.39                                                | 110.11                                      |
| Apulia                  | 4,012,310  | 12                                   | 50                             | 0.10                                                | 9.94                                        |
| Basilicata              | 599,084    | 7                                    | 5                              | 0.13                                                | 4.47                                        |
| Calabria                | 1,935,414  | 11                                   | 11                             | 0.05                                                | 4.29                                        |
| Campania                | 5,772,625  | 12                                   | 120                            | 0.17                                                | 5.98                                        |
| Emilia-Romagna          | 4,459,477  | 15                                   | 1386                           | 2.07                                                | 73.30                                       |
| Friuli-Venezia Giulia   | 1,215,220  | 9                                    | 93                             | 0.85                                                | 23.45                                       |
| Lazio                   | 5,867,097  | 10                                   | 102                            | 0.17                                                | 6.39                                        |
| Liguria                 | 1,550,640  | 14                                   | 109                            | 0.50                                                | 69.39                                       |
| Lombardy                | 10,088,484 | 19                                   | 5469                           | 2.85                                                | 121.06                                      |
| Marche                  | 1,518,796  | 13                                   | 323                            | 1.64                                                | 57.55                                       |
| Molise                  | 302,931    | 7                                    | 14                             | 0.66                                                | 6.93                                        |
| Piedmont                | 4,356,406  | 15                                   | 350                            | 0.54                                                | 60.37                                       |
| Sardinia                | 1,632,892  | 7                                    | 19                             | 0.17                                                | 7.17                                        |
| Sicily                  | 4,969,147  | 14                                   | 54                             | 0.08                                                | 4.39                                        |
| Trentino-South Tyrol    | 1,074,430  | 14                                   | 42                             | 0.28                                                | 60.68                                       |
| Tuscany                 | 3,729,641  | 14                                   | 208                            | 0.40                                                | 19.89                                       |
| Umbria                  | 879,337    | 9                                    | 28                             | 0.35                                                | 7.51                                        |
| Veneto                  | 4,909,013  | 18                                   | 744                            | 0.84                                                | 22.05                                       |

### Figure 1.
COVID-19 at the time of lockdown and mortality after 60 days.

Geographical distribution of the number of confirmed cases (Panel A) and the incidence rate of new cases (Panel B) per 100,000 residents at the time of the lockdown decree in Italy. Panel C displays the number of deaths per 100,000 residents up to sixty days from the first case of COVID-19 across Italian regions. Scatter plots of mortality against the number of confirmed cases (Panel D) and against the incidence rate of new cases (Panel E) in Italian regions. Regression beta coefficients indicate 2.1 deaths up to 60 days for every new case per 100,000 residents before lockdown and 37.4 deaths for every new case per 100,000 residents per day before lockdown.
confirmed cases per 100,000 residents for the number of days from the first case to the lockdown decree.

The study outcome measure was COVID-19-related mortality per 100,000 residents. COVID-19-related mortality was assessed at the longest observation time achieved in all regions from the first case (sixty days) and expressed as the number of COVID-19-related deaths per 100,000 residents. The mortality rate was calculated by dividing the total number of COVID-19-related deaths from the 1st to the 60th day after the first case, by the number of residents in each region and multiplied per 100,000.

Linear regression analyses were performed to evaluate possible correlations between the number of confirmed cases/100,000 residents at the time of lockdown against the number of deaths/100,000 residents as well as between the number of new cases/100,000 residents/day before lockdown and the number of deaths/100,000 residents at sixty days from the first case, in each Italian region.

Regression beta coefficients were calculated to measure the contribution of the independent variable (number of cases or number of new cases) to explain the mortality variable (number of deaths). The goodness of fit of the models was tested by using coefficients of determination (R^2) to appraise the fraction of variation of the dependent variable. A p-value <0.05 was considered statistically significant. Scatter plots were employed to display the results of the analyses. All tests were performed using R version 3.5.1 (R Foundation for Statistical Computing, Vienna, Austria).

Results

The COVID-19 pandemic features of the twenty Italian regions considered in this analysis are summarized in the Table 1. At the time of lockdown, 9,172 confirmed cases of COVID-19 had been reported in Italy, with 463 dead.

Regression analysis showed a significant positive correlation between the number of confirmed cases before lockdown and mortality up to sixty days (p < 0.001, R^2 = 0.57; Figure 1). Furthermore, the analysis of deaths against the incidence rate of new cases displayed a stronger significant positive relationship (p < 0.001, R^2 = 0.73; Figure 1), confirming that the burden of cases before community containment has influenced mortality across the Italian territory. Beta coefficients indicated about two deaths up to sixty days for every additional patient with confirmed COVID-19 before lockdown, and 37 deaths for every new infected subject per day until the decree of March 9, 2020.

Discussion

Italy was the world’s first country to place its entire territory under lockdown, considered the most radical strategy implemented against the COVID-19 pandemic, and thus paved the way for other Countries. The efficacy of nationwide contingency measures depends on the ability to detect the presence of infection and speed of response by governments (Wilder-Smith and Freedman, 2020). Every new infected subject before lockdown counted in the death toll of the COVID-19 pandemic in Italy, suggesting that every day matters to save lives using this containment strategy.

What is the best strategy for control of the COVID-19 pandemic is not the aim of the present analysis, which is focused on the relationship between the penetration of the disease at the time of lockdown and mortality across Italian territory. Our exploratory analysis has some limitations. First, we did not account for different strategies adopted across regions in testing/screening subjects suspected for COVID-19. Moreover, the unavailability and/or fragmentation of data did not allow us to consider earlier contingency measures established in specific sub-territories before the national lockdown.

Timely containment demands courageous decisions by authorities since delay may affect the efficacy of these measures in extinguishing sparks and reducing the spread of the COVID-19 outbreak.

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Ethical approval

Ethical approval was not required.

Conflict of interest

We declare no competing interests.

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