

UNDERSTANDING THE COVID-19 PANDEMIC IN CALABRIA: LESSONS LEARNED AND INSIGHTS FROM RETROSPECTIVE DATA

Gianfranco Di Gennaro ¹, Maria V Greco ¹, Carmelo G A Nobile ², Collaborative Group ¹⁻³⁻⁴

Collaborative Group (Antonella Oliverio ¹, Salvatore Rotundo ⁴, Filomena Mortati ⁴, Fortunato Varone ³)

¹ Department of Health Sciences, School of Medicine, University of Catanzaro "Magna Græcia", Catanzaro, Italy

² Dipartimento di Farmacia e Scienze della Salute e della Nutrizione, Università della Calabria

³ Protezione Civile della Regione Calabria,

⁴ Dipartimento Tutela della Salute e Politiche Sanitarie, Regione Calabria

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ABSTRACT

COVID-19 pandemic has had a profound impact on Italy. In this article, we conducted an analysis of mortality and lethality data from three provinces to extract valuable lessons learned from the management of the pandemic in Calabria. Data was collected from the Civil Protection of Calabria and analyzed for the period from March 2020 to January 2022. Statistical analysis, including spline-linear regression models and pairwise comparisons, was conducted to evaluate mortality and lethality rates among the provinces of Catanzaro, Reggio Calabria and Cosenza. In the province of Cosenza, higher overall mortality was observed; Catanzaro had higher lethality. Environmental and organizational factors may have influenced the severity of the virus in different regions. Future research should focus on sector-specific preparedness and individual well-being to enhance overall response to future pandemics.

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1. Introduction

The COVID-19 pandemic has had a profound impact on the world, and Italy was one of the first Western countries to face a widespread outbreak of the virus (1). From its initial epicenter in Lombardy region, the virus quickly spread to other regions, including the economically and organizationally challenged region of Calabria (2). This article provides a scientific overview of the lessons learned from managing the pandemic in the Calabria region of Italy, taking into account various sources of information and different perspectives.

The COVID-19 pandemic in Italy lasted for over two years, with multiple waves of infections and varying lethality rates (3). Italy, including Calabria, faced several challenges in its response to the pandemic. Initial disbelief and inaction resulted in delayed implementation of lockdown measures (4). The country's decentralized healthcare system allowed for tailored responses, but it also impeded integrated efforts, leading to a hospital-centric response and overlooking primary and community care (4). Insufficient preparedness, mismanagement of cases, and a lack of coordination further exacerbated the situation (4).

The impact of the pandemic was not uniform across Italy, with the northern regions, especially Lombardy, experiencing the highest number of cases and deaths (1,5). The progression of the virus varied across regions, and the heavily affected region of Lombardy had a higher basic reproduction number (R0) compared to other Italian regions (6). The containment measures, including lockdowns and nonpharmaceutical interventions, played a crucial role in slowing the spread of the virus (1–3). Vaccines also played a significant role in preventing infections and reducing the number of severe cases and deaths (3).

In the Calabria region, the effectiveness of the Italian government's policies, particularly the implementation of a total lockdown, contributed to the containment of the virus (2). The lockdown measures resulted in a significant decrease in new positive cases and a negative growth rate, indicating a lower number of new cases compared to the number of healed patients (2). However, the region experienced a spike in cases related to the displacement of non-resident individuals from the heavily affected northern part of Italy (2).

Even the geographic disomogeneities in Calabria may have contributed to the disparities in Covid-19 impact.

* Corresponding author: Gianfranco Di Gennaro, gianfranco.digennaro@unicz.it

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Indeed, environmental factors, such as forest coverage and plant-emitted volatile organic compounds (VOCs), were found to be associated with the severity of the virus (7). Highly forested Mediterranean regions, including Calabria, showed lower percentages of deaths compared to less green northern regions (7). The presence of Mediterranean plants emitting immunomodulatory and antiviral compounds, along with factors like sea proximity and mild climate, may have contributed to the milder impact of the virus in the Mediterranean regions (7).

By examining these aspects, we can gain valuable insights into the challenges faced by the Calabria region, the effectiveness of implemented measures, and the potential implications of environmental factors on the severity of the pandemic.

The aim of this paper is to analyze Covid-19 mortality and lethality in three regions of Calabria and discuss the underlying factors contributing to the observed disparities.

2. Material and methods

The data was collected daily and released by the Civil Protection of Calabria and made available on the monitoring platform of the Calabria Region. The observed period goes from March 10th 2020 to January 31st 2022. The built database contained information relating to the number of beds occupied in critical and non-critical areas, the number of infections, the number of deaths, the number of recovered and the number of positives per day. Data relating to the five Calabrian provinces and also those relating to residents outside the region but present in the Calabrian territory were collected.

For the purposes of our evaluation, however, we considered only the provinces of Catanzaro, Reggio Calabria and Cosenza because they were the only ones to have intensive care units and therefore able to manage patients with Covid-19.

Statistical analysis

Region-specific mortality and lethality rates were calculated and plotted against the daily timeline. Two Restricted Cubic Splines linear model were developed to investigate the between-provinces difference in mortality and lethality. For each of the two regression models, seven knots were placed at the 2.5th, 18.3rd, 34.17th, 50th, 65.8th, 81.7th and 95th percentiles, as recommended by Harrell 2001(8). A first-order autoregressive matrix was used to model the correlation of within-province values and the stability of the models was evaluated by visual inspection of the standardized Pearson residuals. Finally, the model-predicted marginal mortality and lethality for each province were calculated at the above percentiles and Bonferroni-adjusted pairwise comparisons were performed.

3. Results

Mortality

Mortality among the three provinces (Figure 1, Table 2), as predicted by the regression model (Table 1), was not significantly different in the first three timepoints analyzed (day 18, 127 and 237). At day 346, mortality in the province of Catanzaro was significantly lower than both the Cosenza (-13.32; p=0.000) and Reggio Calabria (-8.15; p=0.018) provinces. Conversely, the difference between Reggio Calabria and Cosenza was not

statistically different (p=0.245). At the timepoints 457, 567 and 677 days, the mortality of the province of Cosenza increased steadily compared to that of the province of Catanzaro, with +29.94 (p=0.000), +38.46 (p=0.000) and +43.68(p=0.000) deaths, respectively. Even compared to Reggio Calabria, mortality in Cosenza remained constantly higher, with +17.14 (p=0.000) on day 457, +21.52 (p=0.000) on day 567 and +12.94 (p=0.000) on day 677. Finally, when compared with the province of Catanzaro, mortality in Reggio Calabria was consistently higher (day 457: +12.80, p=0.000; day 567: +16.95, p=0.000; day 677: +30.74, p=0.000).

Outcome: Mortality	Coefficient	Low: 95% CI	Upp: 95% CI	P
Province (ref: Reggio Calabria)				
Catanzaro	1.23	0.26	2.19	0.013
Cosenza	0.54	-0.43	1.50	0.273
Province*Day18-126				
Catanzaro	0.03	0.03	0.04	0.000
Cosenza	-0.51	-0.64	-0.39	0.000
Province*Day127-236				
Catanzaro	3.50	3.13	3.88	0.000
Cosenza	-6.28	-6.79	-5.77	0.000
Province*Day237-346				
Catanzaro	2.93	2.40	3.46	0.000
Cosenza	2.79	2.28	3.31	0.000
Province*Day347-456				
Catanzaro	0.01	0.00	0.03	0.032
Cosenza	0.00	-0.01	0.01	0.902
Province*Day457-566				
Catanzaro	0.03	-0.15	0.20	0.745
Cosenza	0.17	-0.01	0.34	0.061
Province*Day567-676				
Catanzaro	-1.05	-1.57	-0.52	0.000
Cosenza	-0.61	-1.14	-0.08	0.023
Province*Day677-786				
Catanzaro	2.77	2.05	3.50	0.000
Cosenza	1.79	1.07	2.52	0.000
Province*Day787-896				
Catanzaro	-2.65	-3.40	-1.90	0.000
Cosenza	-3.26	-4.01	-2.51	0.000
Province*Day897-906				
Catanzaro	0.72	0.00	1.44	0.051
Cosenza	2.40	1.68	3.13	0.000

Table 1. Restricted Cubic Spline Linear model of Mortality trajectories stratified by province. Seven knots were located based on Harrell’s recommended percentiles (2.5th, 18.3rd, 34.17th, 50th, 65.8th, 81.7th, 97.5th). Time span: March 26th, 2020 to January 14th, 2022

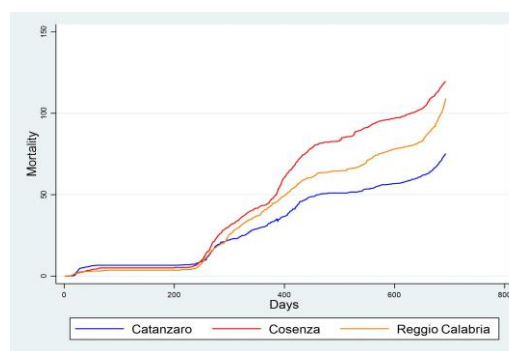


Figure 1. Mortality time-series stratified by province. Time span: March 10th 2020 to January 31st 2022

Lethality

The maximum lethality in all three provinces was observed in the first two hundred days of the pandemic, then it collapsed and remained at a plateau that lasted until the end of the observation (Figure 2).

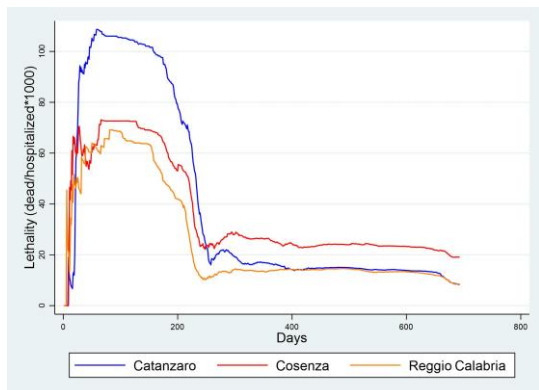


Figure 2. Lethality time-series stratified by province. Time span: March 10th 2020 to January 31st 2022

Outcome: Lethality	Coefficient	Low. 95% CI	Upp. 95% CI	P
Province (ref. Reggio Calabria)				
Catanzaro	-0.05	-3.54	3.43	0.987
Cosenza	3.96	0.45	7.47	0.027
Day 18-126				
Day 18-126	0.51	0.47	0.54	0.000
Day 127-236	-8.23	-8.68	-7.78	0.000
Day 237-346	22.54	21.19	23.90	0.000
Day 347-456	-21.72	-23.39	-19.96	0.000
Day 457-566	9.23	7.50	11.16	0.000
Day 567-676	-2.80	-4.66	-0.94	0.003
Province*Day 18-126				
Catanzaro	0.51	0.46	0.56	0.000
Cosenza	0.01	-0.04	0.06	0.626
Province*Day 127-236				
Catanzaro	-5.69	-6.33	-5.06	0.000
Cosenza	0.62	-0.01	1.26	0.054
Province*Day 237-346				
Catanzaro	12.81	10.89	14.73	0.000
Cosenza	-2.35	-4.28	-0.43	0.016
Province*Day 347-456				
Catanzaro	-7.14	-9.78	-4.51	0.000
Cosenza	3.17	0.54	5.81	0.018
Province*Day 457-566				
Catanzaro	-1.81	-4.55	0.92	0.195
Cosenza	-1.61	-4.34	1.12	0.248
Province*Day 567-676				
Catanzaro	2.38	-0.25	5.02	0.076
Cosenza	-0.10	-2.73	2.54	0.941

Table 2. Restricted Cubic Spline Linear model of Lethality trajectories stratified by province. Seven knots were located based on Harrell's recommended percentiles (2.5th, 18.3rd, 34.17th, 50th, 65.8th, 81.7th, 97.5th). Time span: March 26th, 2020 to January 14th, 2022

Pairwise comparisons (Table 3), after regression modelling (Table 2), showed how the initial lethality peak was significantly higher in the province of Catanzaro, both when compared with Cosenza (day 127: p=0.000; day 237: p=0.000) and with Reggio Calabria (day 127: p=0.000; day 237: p=0.000).

Similarly, in the Cosenza province a higher lethality was observed when compared to Reggio Calabria at day 127 (p=0.000). This Difference became insignificant at day 237.

		Mortality		Lethality		
		Cosenza vs Catanzaro	Reggio Calabria vs Catanzaro	Reggio Calabria vs Cosenza	Cosenza vs Catanzaro	Reggio Calabria vs Cosenza
Day 18	Difference	-0.41	-0.62	-0.21	-6.86	-9.11
	P	1.000	1.000	1.000	1.000	0.971
Day 127	Difference	-2.05	-3.44	-1.40	-39.40	-47.45
	P	1.000	0.728	1.000	0.000	0.000
Day 237	Difference	0.55	-2.36	-2.89	-8.03	-22.65
	P	1.000	1.000	0.992	1.000	0.036
Day 346	Difference	13.32	8.15	-5.17	10.71	-1.01
	P	0.000	0.018	0.245	1.000	0.583
Day 457	Difference	29.94	12.80	-17.14	8.51	-0.95
	P	0.000	0.000	0.000	1.000	1.000
Day 567	Difference	38.46	16.95	-21.52	9.45	-0.74
	P	0.000	0.000	0.000	0.828	1.000
Day 677	Difference	43.68	30.74	-12.94	10.25	-0.09
	P	0.000	0.000	0.000	0.799	1.00

Table 3. Between-province pairwise comparisons of lethality and mortality at different timepoints. Within timepoint Bonferroni correction was applied. Time span: March 26th, 2020 to January 14th, 2022

4. Discussion

The results of our analyzes show, in general, how in the very first pandemic period Catanzaro was the most affected province. However, in a second period lethality also increased in the other provinces, in particular in Cosenza, since it was also possible to hospitalize Covid-19 patients in the intensive care units in the other two provinces.

A series of considerations can be made in light of what has been observed, especially regarding possible similar health emergencies in the future.

It can be assumed that the initial approach to patients requiring intensive care for Covid-19 was affected by objective difficulties encountered in a pandemic context. At the moment of pandemic outbreak, the pathology had no well-defined therapeutic schemes, and evidence and specific best practices to follow were limited or absent. Moreover, as was the case in most of the southern European countries, healthcare resources (including personnel, facilities, organizations, and supplies) were stretched as healthcare providers were required to deliver an increased number of services within a short period of time(9). All these factors demanded significant efforts from all decision-makers, caregivers, and technical processes, resulting in a negative impact on the quality of the services provided(9).

Subsequently, many challenges were overcome or mitigated thanks to the adaptability and resilience of healthcare services, which adjusted to the new conditions. The severity of the pandemic overturned the previous public health organizational dynamics, necessitating a response to the imbalance between the demand for assistance and the available resources. The subsequent phases of the pandemic exhibited differences in terms of mortality and lethality among the three provinces under consideration. The province of Cosenza showed the most unfavorable data. The available data does not differentiate between deaths that occurred within a hospital setting and those that occurred in other contexts, such as at home. Therefore, it is difficult to attribute poor management solely to hospitals or local services.

Furthermore, the region of Calabria has a predominantly hilly (49%) and mountainous (42%) terrain, with only 9% being flat(10). This

geographical feature negatively impacts accessibility to healthcare services, particularly the major medical centers, as well as proximity to health services in general. The province of Cosenza, being the largest in terms of area and population, also has densely populated villages situated at altitudes above one thousand meters.

The Calabrian healthcare context has witnessed a gradual weakening of many structures and services over the years due to budgetary deficits and subsequent repayment plans.

In light of the aforementioned factors, the results obtained in our study reveal a discrepancy that is challenging to interpret with the available data. However, attention must be directed towards all healthcare contexts, with a willingness to compare the performance of different healthcare providers operating in the area. Identifying disparities in the effectiveness and efficiency of services should prompt further studies that analyze specific sectors or even adopt a macroscopic approach to gain a better understanding of the underlying reasons behind lower patient survival rates compared to neighboring regions.

The experience gained during the COVID-19 pandemic should not be disregarded over time, as the value of the challenges faced and the implemented solutions surpasses any theoretical exercise envisioning future pandemic scenarios. One of the critical lessons is the inadequacy of providing healthcare benefits and services without an adequate system for measuring, evaluating, and reporting them. Additionally, the population has the right to make informed choices and be aware of the differences between various healthcare networks, ensuring that the constitutional right to health, based on the principle of individual centrality, is upheld. Companies can leverage these analyzes to identify and enhance their strengths while implementing corrective actions in deficient contexts. Furthermore, these studies can provide valuable support for managerial activities aimed at achieving strategic objectives in the competitive external context and operational goals within the internal framework.

5. Conclusions

In conclusion, our analysis of the Covid-19 impact on healthcare services in Calabria's provinces reveals significant challenges due to limited therapeutic guidance and strained resources. However, healthcare services demonstrated resilience and adaptability. Variations in mortality and the region's geographical features necessitate further investigation. The experience gained should inform future emergencies, emphasizing the importance of robust measurement systems and informed healthcare choices. These findings empower healthcare companies to address deficiencies, support strategic objectives, and optimize delivery. Further research should explore specific sectors to enhance preparedness for future pandemics and prioritize individual well-being.

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