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## Microarticle

## Second wave of COVID-19 in Italy: Preliminary estimation of reproduction number and cumulative case projections

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## ARTICLE INFO

## Keywords:

Second wave COVID-19  
Italian population  
Projections  
Epidemic size

## ABSTRACT

The second wave of a novel coronavirus in Italy has caused 247,369 new cases and 1782 deaths only in October 2020. This significantly alarming infectious disease controlling board to impose again mitigation measures for controlling the epidemic growth. In this paper, we estimate the latest COVID-19 reproduction number ( $R_0$ ) and project the epidemic size for the future 45 days. The  $R_0$  value has calculated as 2.83 (95% CI: 1.5–4.2) and the cumulative incidences 100,015 (95% CI: 73,201–100,352), and daily incidences might be reached up to 15,012 (95% CI: 8234–16,197) respectively.

## Introduction

The European countries are exposing to the resurgence of novel coronavirus disease (COVID-19) cases after effectively controlling the early outbreaks this year [1]. Most of the countries are already declared that a high number of daily cases are recording now than they seemed during the first epidemic wave of the year 2020. Italy is also not exceptional for this condition. When the first COVID-19 epidemic has raised to start in March, the Italian government announced a serious lockdown to control the pandemic severity [2]. After these mitigation measures, the epidemic curve has appeared steadily till July. In the second half of August, cases started to rise again with more than 6000 cases per week. However, from October situation seems out of control because of the appearance of 247,369 (as of 27 October) new cases only in this month [3]. This proves that Italy becoming the latest European nation for announcing new measures for stopping the spread of novel corona virus. In this study, we modelled the latest COVID-19 outbreak of Italy and estimate the reproduction number ( $R_0$ ) status of the present epidemic. Also, we projected the country epidemic size under different  $R_0$  values.

## Methods

We collected daily reporting COVID-19 cases in Italy from 1 September to 27 October 2020. We considered new outbreak cases

associated with primary COVID-19 to follow  $R_0$  mean and serial interval (SI). The SI value has been assumed to follow the gamma distribution with a mean of 6.6 days (95% CI) that has successfully calculated by analysis of different serial intervals among 55 clusters appeared in Lombardy which high epidemic centre in Italy during the first phase. The low epidemic curve has appeared till mid-august; the continuing exponential development may have appeared since September 2020. The  $R_0$  has calculated by estimation of maximum likelihood (ML) function with the fitting of reporting cases by using Poisson-distribution function presented in the study of [4] which follows

$$I_t = \text{Pois}(R_0 \sum_{i=0}^t \varphi(i) x(t - i)); x(t) \text{ is new cases that arrived from outbreak onset.}$$

Two epidemic packages ‘early R’ [5] and ‘incidences’ [6] were applied to estimate the reproduction number and cumulative incidences. We simulated total cumulative case incidences for the next 45 days and to get a large set of  $R_0$  distribution, bootstrap sampling (of 1000 times) has been used.

## Results and discussion

In Fig. 1, we estimated the  $R_0$  of phase 2 COVID-19 pandemic in Italy and is equal to 2.83 (95% CI: 1.5–4.2) which is higher than the first

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<https://doi.org/10.1016/j.rinp.2021.104604>

Received 3 November 2020; Received in revised form 22 July 2021; Accepted 24 July 2021

Available online 27 July 2021

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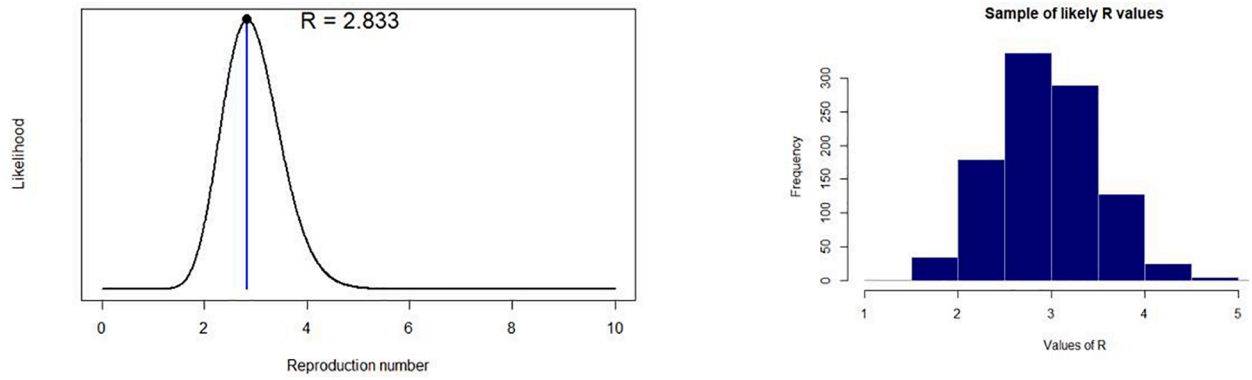


Fig. 1. Average reproduction value (left) and bootstrap sampling approach (right) of maximum likelihood  $R_0$  values.

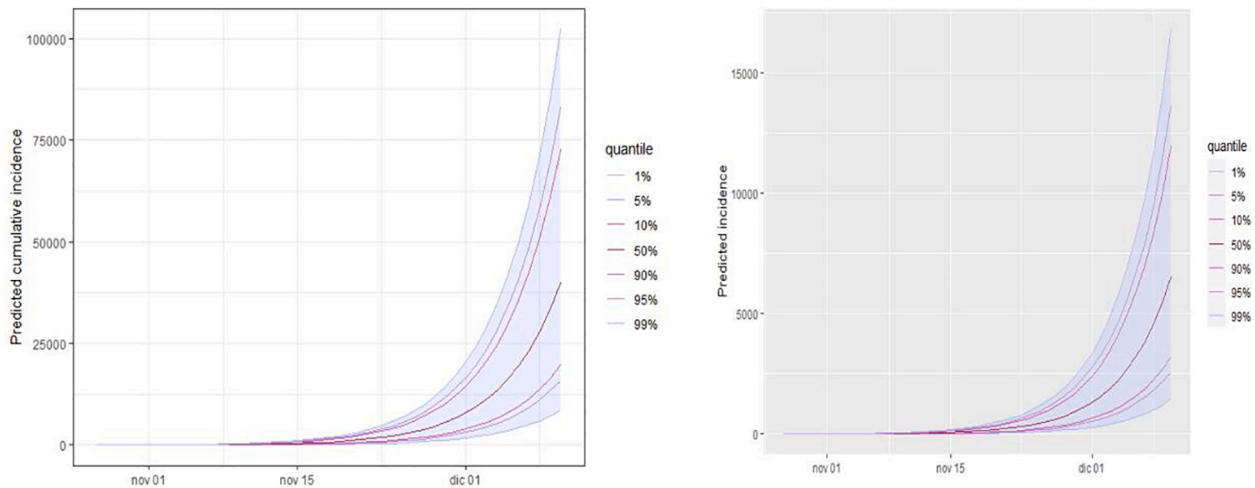


Fig. 2. Cumulative case outcomes (left) and Daily reproduction cases (Right) for  $R_0 = 2.83$ .

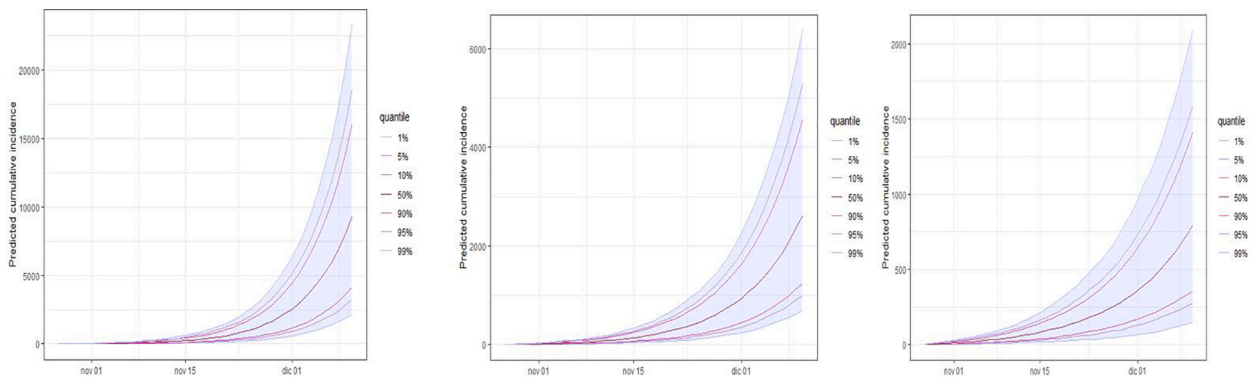


Fig. 3. Cumulative incidence projections for different percentage of  $R_0$  values: 90% (Left), 80% (Middle), and 70% (Right).

reproduction value ( $R_0 = 2.2$ ) observed in Wuhan by the result of direct contact tracing [7]. This got suspect because of the volume of cases, prompting the breakdown of medical services frameworks and deficient testing offices at that stage, just as developing case definitions. If the  $R_0$  is kept remains the same in the upcoming days, the total case projections were mentioned in Fig. 2. The projections concluded that at the end of the 45th day the cumulative incidences 100,015 (95% CI; 73,201–100,352) and daily incidences might be reached up to 15,012 (95% CI: 8234–16,197). However, it is a well-known fact that a new epidemic size has relied on  $R_0$ . The infectious disease control board of Italy is planning to apply again controlling measures like curfew in

nights, closing of bars, theatres, and encourage online education. These actions can help them control the pandemic as they did in March. Therefore, we performed other projections on the decrease of different  $R_0$  percentages (90%, 80%, and 70%).

From Fig. 3, it is evident that if  $R_0$  is decreased by 90% of the present value, there is a possibility of new cases around 24,517 (95% CI: 18,300–26,322). Similarly, for 80% and 70% of the current reproduction rate the new infections assumed to be 6321 (95% CI; 4184–6498) and 2106 (95% CI; 1016–2243) respectively. Italian specialists need to abstain from forcing a second lockdown that would limit individuals' self-sufficiency and affect economic activities [8]. They additionally

need to keep schools open. To this end, schools are being outfitted with fast COVID-19 tests that give results inside 15 min. This study is in line with research on COVID-19 modelling for creating awareness among Nigerian population [9]. Therefore, generating epidemic knowledge among individuals and timely joining of active cases in hospitalization are the effective measures of controlling pandemic and these actions should be controlled by the local health authorities.

### Conclusions

Current study projections are encouraging to impose again lockdown in the country for controlling this sudden outbreak. But most citizens felt that another lockdown would mean being secured with our families again. Promoting controlling measures such as handwashing, having a face mask, and sanitization must be done persistently through media which is enormous impacts the regenerative number of COVID cases. “Anything but having locked up again” has impossible.

### Funding

This study is supported by institutional funding of the University of Camerino, Italy.

### CRedit authorship contribution statement

**Nalini Chintalapudi:** Data curation, Investigation, Software, Visualization. **Gopi Battineni:** Conceptualization, Writing – original draft, Methodology, Formal analysis. **Francesco Amenta:** Supervision, Writing - review & editing, Project administration.

### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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