The contagion rate of the COVID-19 in Catalonia: Some descriptive in the municipalities and basic health areas of Catalonia

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BACKGROUND

The spread of the COVID-19 epidemic in Catalonia has experimented a differentiated evolution both in time and in the territory – initial days of the epidemic with few cases, located in different focuses along the territory. As time went on, the propagation increased with a clearly heterogeneous pattern in the territory. A popular measure that synthesizes the rate of spread is the contagion rate or R0 rate – also known as the effective reproduction number – which collects the number of secondary cases caused by primary cases. This measure could be used as an additional indicator when planning deconfinement, both in terms of time and territory. The policy of information transparency adopted by the Government of Catalonia through its open data portal has made it possible to have detailed information that makes it possible to approximate the R0 rate both over time and throughout the Catalan geography with a territorial breakdown according to Basic Health Areas (BHA) and municipalities.

OBJECTIVE

This research note computes an approximation to the R0 rate of the COVID-19 epidemic using data from the RSAcovid19 registry of the Department of Health of the Government of Catalonia at the level of BHA and municipalities. The available data correspond both to the cases that have tested positive in a diagnostic test (PCR or rapid test) and to the suspicious cases that correspond to people who at some point have presented symptoms and a health professional has classified them as a possible case, but they do not have a diagnostic test with a positive result.

As indicated on the website of the Department of Health, all of them are cases activated by the surveillance service and it has been possible to identify the area of residence that appears on the individual's health card. There are, however, a small number of observations for which the area of residence could not be identified, observations that have been excluded from the analysis.

Although the study could be carried out distinguishing between positive and suspicious cases, it must take into consideration that for some BHA and municipalities the number of positive cases may reach zero in some subperiods of time, which would imply obtaining a meaningless R0. This situation reflects the consequences of not being able to conduct massive diagnostic tests on suspicious cases. Consequently, this research note uses the total number of cases (positive and suspicious) when calculating the R0 rate for BHA and municipalities.

The data file available on May 3rd, 2020 covers the period from February 25th to May 1st, 2020 – *T = 67* temporary observations – for a total of *N = 374* BHAs and *N = 805* municipalities. This information is combined to define the total number of cases.

APPROACH TO THE R0 RATE FOR CATALAN BHA AND MUNICIPALITIES

The method used in this research note to approximate the rate R0 – the approximation is denoted as ρ – is based on the expression:[i]

$$\rho_{i,t} = \frac{y_{i,t} + y_{i,t-1} + \cdots + y_{i,t-q}}{y_{i,t-k} + y_{i,t-k-1} + \cdots + y_{i,t-k-q}}$$

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where $y_{(i,t)}$ denotes the new cases that have occurred on a given day (t) for a given BHA (i) or municipality *(i), i = 1, 2, ..., N, t = k+q+1, ..., T*. As can be seen, the rate R0 is approximated as the ratio between the sum of the new cases in a time window of $w = 1 + q$ days and the sum of new cases in a temporary window of w days lagged k periods. $w = k = 7$ were set to perform the calculation. The popular interpretation of the R0 rate is made in terms of the average of secondary cases caused by primary cases, so a value of the rate higher than one would indicate that the epidemic would be in an expansive phase (the cases detected today are higher than the cases that were detected k days ago). Therefore, what would be desirable is to have a R0 below one.

PROPAGATION RATE R0 OF COVID-19 ACCORDING TO BHA AND MUNICIPALITIES

The analysis of the data disaggregated by BHA and municipality offers similar conclusions in general terms, as shown in Figure 1. A first subperiod of strong growth in the propagation rate is detected, moving to a reduction phase towards mid/late March. However, this evolution is not common to all BHA and municipalities.

*Figure 1. Rate R0 for the total number of cases (25/02/2020 to 01/05/2020)*
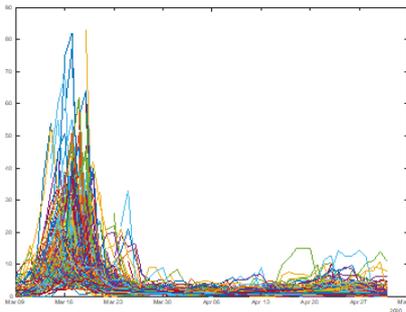
BHA
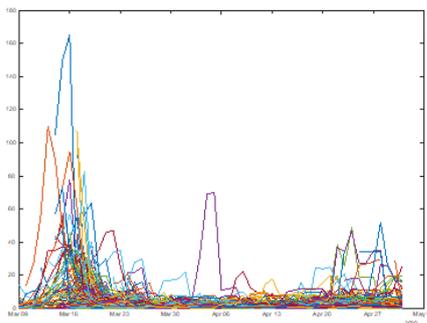
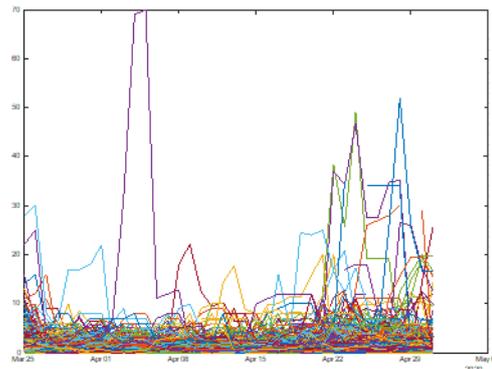*Municipalities*

In order to obtain a clearer view, Figure 2 shows the evolution of the R0 rate in the period from March 25th to the last day considered in this analysis. As can be seen, the main characteristic that emerges from the figure is the high heterogeneity of the R0 rate, with a significant number of BHA and municipalities for which the values are above one – a white, think horizontal line represents the value one.

Figure 2. R0 rate for total cases (25/03/2020 to 01/05/2020)
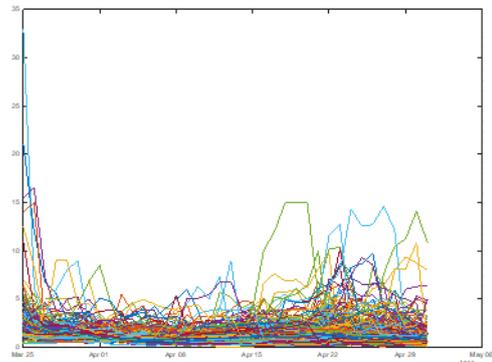

BHA

Municipalities

A clearer idea of the degree of heterogeneity can be obtained from the calculation of the quartiles of the cross-sectional distribution of the values of the R0 rate for each time period. Figure 3 indicates that for more than half of BHA and municipalities, the R0 rate is above one. For BHA, the exception is in the period from April 7th to 15th where the median would be slightly below one – reaching a minimum value for the median of 0.91 – and for the days in between April 29th and May 1st – with a minimum value of 0.84. Finally, it is worth highlighting the change in the trend that the R0 rate seems to have experienced from precisely April 16th – a phenomenon that would be linked to the end of the total confinement period that occurred on April 14th, 2020 – and the subsequent reversal of the trend experienced from April 29th, 2020.

In the case of municipalities, the median is only below one on April 11th (with a value of 0.97) and May 1st (with a value of 0.91) with an upward trend since then.

*Figure 3. R0 rate for total cases. Quartiles of the transverse distribution*
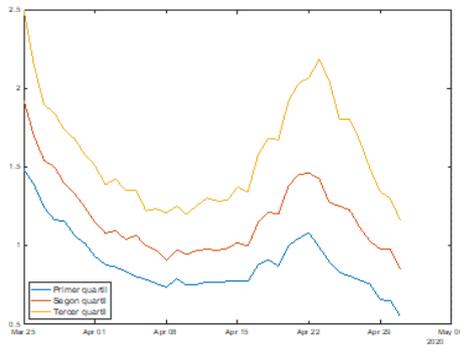
BHA
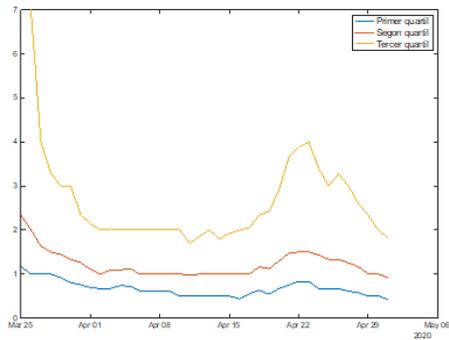
Municipalities

The estimate of the R0 rate for the last day of the analysed period (May 1st, 2020) is presented in Figure 4, where different parts of the territory are detected to still have an intense spread of the epidemic and where it would be advisable to follow a slower deconfinement process than in other parts of Catalonia. On the other hand, there are areas where the epidemic has a very low rate of spread, an indicator that could be used to increase the level of activity of the population within the reference area.

Figure 4. Rate R0 for total cases for BHA
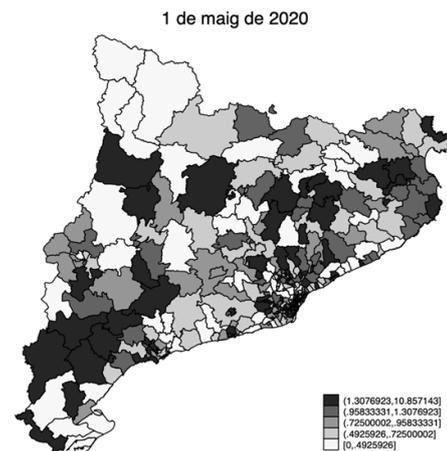
CONCLUSION

The results summarized in this research note show the heterogeneity in the spread of the COVID-19 epidemic, a heterogeneity that has been assessed by calculating the R0 rate disaggregated at the level of BHA and municipalities in Catalonia. The distribution of the R0 rate values over time has not been homogeneous, with propagation speeds clearly higher than one for more than half of the BHA at many time periods. It was not until the last days of April that a R0 rate lower than one was achieved for more than half of the BHA. However, there is a high number of BHA for which the value of the R0 rate is still higher than one. The situation at the municipal level is similar, although it seems that for the 805 municipalities for which information is available, half would present a value of the rate R0 higher than one.

These characteristic features highlight the need to consider different deconfinement speeds depending on the rate of spread of the epidemic. Finally, it should be noted that the calculation of the R0 rate is an element that needs to be updated on a daily basis in order to be able to capture trends in the evolution of the epidemic and thus be able to adapt or moderate measures to relax the mobility restrictions of the population in the territory.

[i] The calculation of the rate R0 from epidemiological models requires information that is not available for BHA and municipalities, which is why this note uses this approach using the statistic ρ.