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The effect of population density on the spread of COVID-19 in the Catalan territory

Regional Quantitative Analysis Research Group (AQR–UB)

AQR COVID-19 / #1

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BACKGROUND

During March and the beginnings of April 2020, the epidemic of COVID-19 was transmitted exponentially to the population of Catalonia, with a slowdown in the subsequent days possibly associated with the implementation of population confinement.

An interesting fact in this context is that geographical distribution of the spread of the epidemic has been clearly asymmetric. As the Catalan Health Quality and Evaluation Agency (AQuAS) has shown using data from the COVID-19 Registry of the Health Department of the Government of Catalonia, the rate of accumulated positive cases varies substantially between Basic Health Areas (BHA) and between towns. As an example, the map in Figure 1 shows the rate of accumulated positive cases of COVID-19 in BHA (data reported on April 6th). It can be clearly appreciated how the spread of the disease has not been spatially homogeneous, quite the opposite.

This difference in the incidence of the COVID-19 epidemic that is observed in the Catalan territory is also appreciated in other territories and, in fact, it has been reported in the case of other previous epidemics. In fact, this issue has had a media impact since the spread of the epidemic in our environment, relating the differences among regions, provinces, towns and even districts with various factors[i]. However, until now a good part of the arguments are based on partial analysis (and in many cases informal) that do not take into account the simultaneous effect of other potential factors[ii].

For all these reasons, it is interesting to explore in more detail the origin of the spatial differences in the spread of COVID-19. Among other issues, this could be useful for the organization of health resources and even for the design of confinement / unconfinement measures, which could become spatially asymmetric.

OBJECTIVE

Based on what has been said so far, the objective of this research is to analyze the relationship between the spread of the epidemic and population density in BHA. More specifically, we want to check whether the areas with the highest population density are those with the highest number of cases in relation to their size. There are several reasons why the incidence of COVID-19 may be higher in densely populated areas. Briefly, and without trying to be exhaustive, compared to low-density areas, a higher concentration of the population in the territory favors the interaction and contacts in the daily life of individuals, which is essential for the rapid transmission of the illness. Likewise, the use of public transport may have been a key factor in the rapid spread of COVID-19, and there is a clear relationship between endowment and use of public transport (access to metro, suburban trains, bus service) and population density. Finally, even the size of the dwellings could play a role in the spread, and this tends to be lower in the areas that are densely more populated (even other characteristics of the dwellings could be important).

This note summarizes some of the results on the analysis of the geographical distribution of COVID-19 in Catalonia that is being carried out by researchers from the AQR Research Group of the UB (http://www.ub.edu/ aqr/). Special emphasis is placed on considering geographic and territorial aspects, facts of special interest in the research for the group.

The detailed results that have been used in this note are available to the interested reader.

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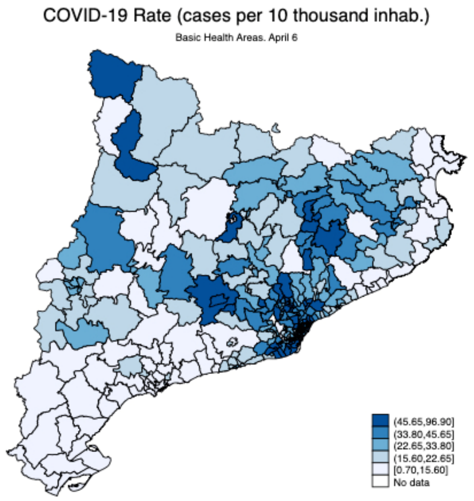
Figure 1.

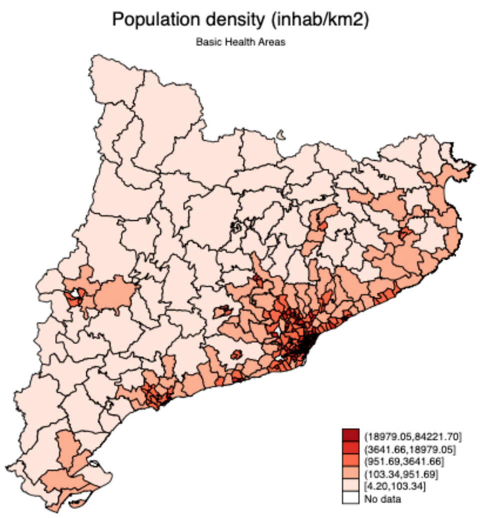


Source: Own elaboration based on data from the Health Department of the Government of Catalonia and AQuAS

POPULATION DENSITY AND SPREAD OF COVID-19

As it is well known, the population of Catalonia is not uniformly distributed throughout the territory, but rather on the contrary, it tends to be concentrated in specially populated places, leaving other territories with relatively low density (see Figure 2). So, the question is whether or not this difference in BHA density is associated to the diversity of COVID-19 positive cases rate. The comparison of the maps in Figures 1 and 2 reveals that this could be the case, given that there is some overlap in the spatial distribution of the two variables.

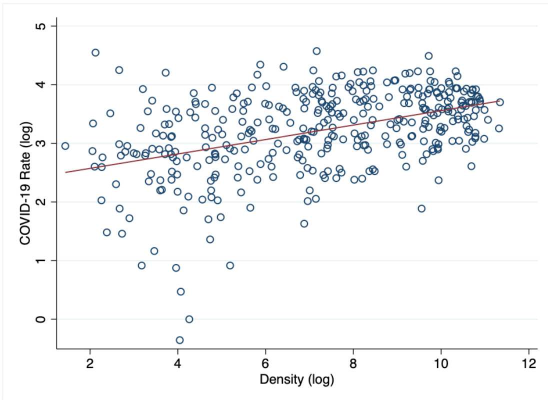
Figure 2.



Source: Own elaboration based on data from the Health Department of the Government of Catalonia

In fact, in the scatterplot shown in Figure 3, a positive correlation is deduced between population density and the accumulated cases rate (both variables in logarithms), which would confirm the existence of a (non-linear) relationship between them. The estimation of the coefficient associated with the logarithm of the density in the simple regression with the logarithm of the rate of accumulated cases takes a value of 0.12, which is significantly different from zero from a statistical point of view. This suggests that doubling the population density leads to an increase of approximately 9% in the rate of COVID-19 cases. Given the range of density variation to the BHA set (with a minimum of 4.2 inhab / km2 and a maximum of 84,221 inhab / km2), it can be considered as an effect of considerable magnitude.

Figure 3.



Source: Own elaboration based on data from the Health Department of the Government of Catalonia

However, this correlation could be "contaminated" by not considering other factors that would also have affected the spread of COVID-19 and that, at the same time, could be associated with population density.

To take this circumstance into account, using multiple regression analysis, in addition to population density, we have considered the potential contribution of other factors of each of the BHA to the spread of the disease. Specifically, a synthetic indicator of the socio-economic situation of the population of each BHA and a battery of demographic, morbidity, and lifestyle indicators have been added to the analysis. In addition, the meteorological situation (temperature and relative humidity) and the level of pollution (PM10 and NO2), all of them measured in mid-March, and an identifier of the BHA of the Ódena Basin (to consider the specificity of the epidemic in this territory).

Once these factors have been controlled, the effect of density on the COVID-19 rate is slightly reduced (estimated coefficient of 0.09 being highly statistically significant), which suggests that, on average, the spread of the disease in a BHA with twice the population density than in another one with similar characteristics (in terms of the aforementioned factors), it was around 6.5% higher.

Finally, it should be added that the availability of data of COVID-19 cases by BHA differentiated by gender, allow us to reproduce the analysis of the effect of population density by women and men separately. The results indicate that once all other factors are controlled, population density does not have a differential effect on the spread of the disease between women and men. Likewise, the results are similar when calculated using the COVID-19 cases rates of other days.

CONCLUSION

The results summarized in this research suggest the existence of a positive association between the population density of BHA and the spread of COVID-19 during the period of exponential growth of the disease. Although it cannot be conclusively concluded that there is a causal relationship between density and propagation, the results are consistent with faster transmission in areas that concentrate high volumes of the Catalan population. This circumstance can be particularly important both for monitoring possible future waves of the epidemic, and for organizing the deconfinement of the population.

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[i] See, for example , Adda, J. (2016) Economic activity and the spread of viral diseases: Evidence from high frequency data. *The Quarterly Journal of Economics,* 131(2), 891-941, Grantz K.H.et al (2016) Disparities in influenza mortality and transmission related to sociodemographic factors within Chicago in the pandemic of 1918. *Proc. Natl. Acad. Sci*., 113(48), 13839-13844, y Chowell et al (2014) Spatio-temporal excess mortality paterns of the 1918-1919 influenza pandèmic in Spain. *BMC Infectious Diseases* 14: 371

[ii] For an exception see the analysis in Orea, L. and Álvarez, I.C. (2020) *How effective has the Spanish lockdown been to battle COVID -19? A spatial analysis of the coronavirus propagation across provinces*. Documento de Trabajo – 2020/03. Fedea, Madrid.