BACKGROUND

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

An interesting fact concerns the unequal geographical distribution of the spread of the epidemic. The Catalan territory is divided into seven health regions from which health resources for primary care and specialized care are organized to meet the needs of the population. Each region is organized, in turn, into 29 health sectors, which group 374 Basic Health Areas (BHA), made up of neighborhoods or districts in urban areas, or one or more towns in rural areas. As the Catalan Agency for Quality and Health Assessment (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 across BHA and across towns. As an example, the map in Figure 1 shows the rate of positive cases of COVID-19 accumulated 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 observed in other territories and, it has been reported in the case of other previous epidemics¹. In fact, this issue has had a media impact since the spread of the epidemic in our environment, relating the differences across regions, provinces, towns and even districts, with various factors. However, until now a good part of the arguments are based on partial analyses (and in many cases informal) that do not take into account the simultaneous effect of other potential factors².

For all these reasons, it is interesting to explore in 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.

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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WEATHER CONDITIONS AND SPREAD OF COVID-19

As mentioned so far, the objective of this research note is to analyse the relationship between the spread of the epidemic and the meteorological conditions in BHA. More specifically, we want to study the influence geographic differences in temperature and relative humidity had on the number of infections.

Several recent studies have shown how temperature and relative humidity affect the transmission speed of COVID-19 based on the comparison of the contagion rate across different cities and countries. In fact, the evidence obtained is compatible with the greater expansion of SARS-Cov-2 in a wide East-West corridor located between the 30N parallel and the 50N parallel. These areas are characterized by a similar weather pattern. Specifically, average temperatures between 5 °C and 11 °C and relative humidity levels between 50% and 70% are observed. Therefore, it would be expected that an increase in temperatures and air humidity levels associated with the arrival of Spring in the Northern hemisphere could significantly reduce the transmission and spread of the coronavirus.

At the Spanish level, preliminary results of an investigation carried out by the Institute of Health Carlos III (ISCIII) and the State Meteorology Agency (Aemet) also show similar evidence as a negative correlation between temperature and contagions is found from a statistical analysis of information related to Autonomous Communities.

The "normal" meteorological conditions of Catalonia are within the range of values in which a high speed has been observed in the spread of the coronavirus. Specifically, based on own calculations using the Aemet data for the period 1981-2010, the average normal temperature during the month of January is 5.1 °C, in February 6.2 °C and in March 9.0 °C. Regarding relative humidity, according to calculations made from the same source, there are no such important variations during the first quarter, with average values around 70% and ranging between 60% and 80%.

The meteorological conditions that have been observed during this first quarter of 2020 show temperatures higher than usual, both in January and February, but much more intensely in this second month. The first two weeks of March maintained this trend, but the second half was much colder than usual. As for humidity, it has been a significantly wetter quarter than usual.

In the analysis below, the temperatures and relative humidity levels for the BHA corresponding to March 15th have been used. This date has been chosen for different reasons: firstly, because fairly representative values for the month as a whole (despite the high temperature range observed during March) were observed during this day; secondly, because they correspond to the first weekend after school closures, but prior to confinement, so it is likely that many families took advantage of this situation to carry out leisure activities outdoors or visit friends or family; and thirdly, because it seems an appropriate date to analyze the possible impact of meteorological conditions on the rate accumulated until April 6th, the data shown in Figure 1.

Figures 2 and 3 show the average temperature and the average relative humidity in the 374 BHA on March 15th. These data have been obtained from the information recorded in the 184 stations of the Automatic Meteorological Stations Network (XEMA) of the Meteorological Service of Catalonia and from their geolocation they have been assigned to the different BHA using spatial interpolation methods.

As it can be seen in Figure 2, there is a wide variation in the average temperatures observed in such date. Specifically, they range between 5.2 °C and 13.5 °C, with the warmest values located on the coast.

As for relative humidity, Figure 3 shows that it was a fairly humid day throughout the country with values ranging between 68.6% and 88.5%. The areas with the lowest relative humidity levels are located in the interior areas of the country, especially in the West and North.

Comparing the map in Figure 1 with the ones in Figures 2 and 3, we can appreciate a certain overlap in the spatial distribution of the three variables analyzed, which seems to confirm the evidence obtained internationally.
To take into account the effect of temperature and relative humidity on the rate of accumulated positive cases of COVID-19 in BHA, a multiple regression analysis has been performed, where in addition to meteorological conditions, we have considered the potential contribution of other factors in each of the BHA to the spread of the disease. Specifically, the population density of each BHA, a synthetic indicator of the socioeconomic situation of the population and a battery of demographic, morbidity, and lifestyle indicators have been added to the analysis. In addition, the level of pollution (PM10 and NO2) has also been considered, all of them measured in mid-March, and an identifier of the BHA of the Òdena Basin (to consider the specificity of the epidemic in this territory).

The estimates obtained, which are available upon request from the authors, confirm the negative relationship between meteorological factors and the spread of the coronavirus detected in previous studies. Specifically, an increase of 1°C in the mean temperature reduces the contagion rate by 3.7 percentage points, keeping the rest of the factors the same, while an increase in relative humidity of 1 percentage point would also mean a reduction in the contagion rate of 1.7 percentage points.

These estimates are within the range of values obtained in the studies mentioned above. For example, Wang et al. (2020) find that a 1°C increase in temperature and a percentage point in relative humidity would reduce the SARS-CoV-2 infection rate by 2.25 percentage points and 1.58 percentage points, respectively.

Thus, considering that one would expect an increase in temperatures around 2°C during the month of April in relation to March and about 4°C during the month of May in relation to April, this factor could help to contain the expansion of the coronavirus during the deconfinement period. However, it must also be taken into account that with the relative humidity decreases as we approach the summer period, the positive effect of temperature will be compensated, although only partially. The results obtained also allow us to conclude that the fact that we had a warmer and wetter first quarter in Catalonia has favorably contributed to slowing down the expansion of the coronavirus, especially in the coastal areas of the two extremes of the country.

CONCLUSION

The results summarized in this research note suggest the existence of a negative association between meteorological factors and the spread of COVID-19 in BHA during the period of exponential growth of the disease in Catalonia. Although it cannot be roundly concluded that there is a causal relationship between temperature and relative humidity and spread, the results are consistent with other studies that have also shown a more rapid spread of the coronavirus in colder and drier climates. This circumstance can be particularly important both for the monitoring of possible future waves of the epidemic and for the organization of the population’s lack of confidence that could take into account weather forecasts, as well as possible anomalies with respect to the normal conditions that may occur during the upcoming weeks.