Status of COVID-19 in Spain and recommendations

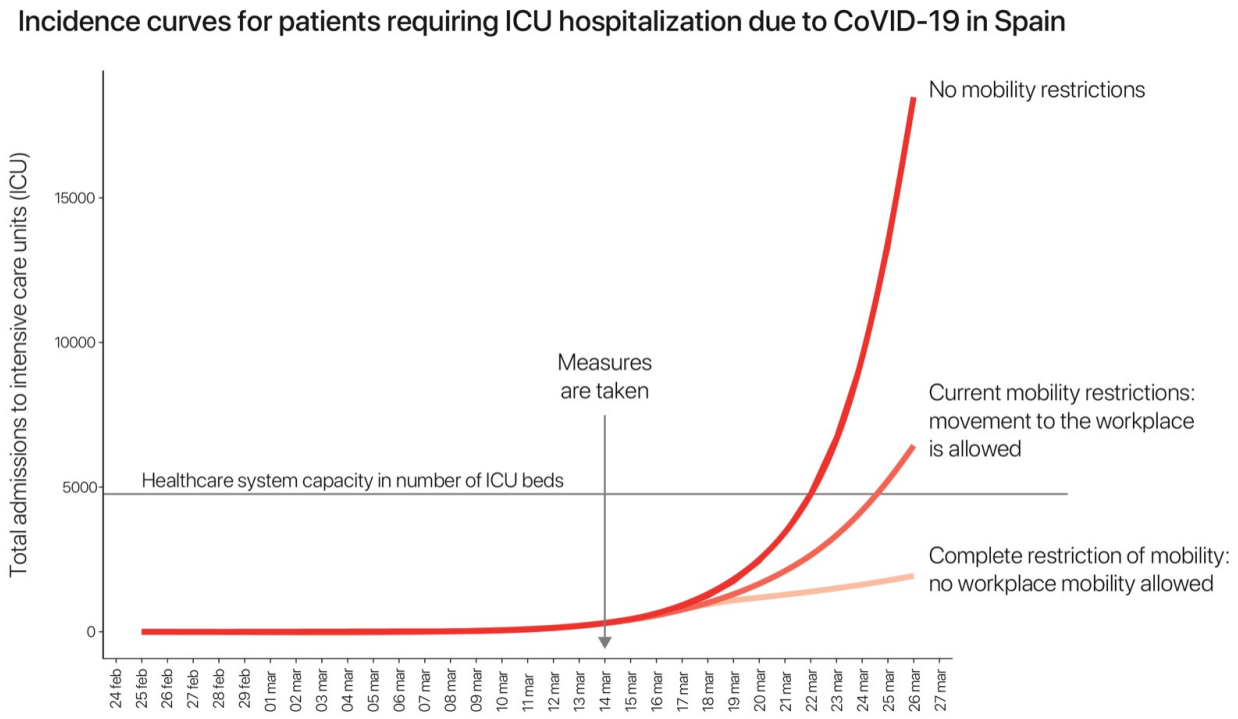
Scientific Report

The undersigned are members of the scientific community, including 36 experts working in 25 research groups investigating the dynamic and spread of epidemics in the setting of infectious and respiratory diseases. We would like to express our concern about the limited capacity of actions taken by the Spanish Government to successfully control the SARS-CoV-2 outbreak and leave the exponential growth phase of new cases, once we can see the effects in the coming weeks. The measures taken so far, consisting primarily of partial restriction mobility, are in the right direction, although some researchers have warned about the pressure placed on the building blocks of the health system.[1]

Given that the actual extent of an epidemic can only be assessed retrospectively, governments and policymakers are forced to make decisions based on mathematical models of other diseases and previous experiences of other countries taking different actions.[2] In the case of Spain, various models simulating the spread of infection and using different assumptions converge in a landscape of a high number of new cases within the next few weeks. Simulations have been conducted using the URV and UNIZAR models to predict the progression of the number of patients who will require hospitalization in intensive care units because of CoVID-19 in three scenarios (Supplementary material; mathematical method): scenario 1, no mobility restrictions; scenario 2, partial restriction of mobility (i.e., movement to the workplace allowed for 50% of people); scenario 3, complete restriction of mobility (i.e., no workplace mobility allowed except for essential services).

The model suggests that the actions taken to date will be insufficient to prevent hospitals and intensive care units from being overwhelmed in the next few weeks. The foreseen collapse of the health system, along with the age distribution of the Spanish population (i.e., 18% of people aged ≥65 years), warns about the potential high mortality rate associated with CoVID-19 in our

country. According to our models, the current state is associated with a very high risk of saturation of our health system, which is expected to occur by March 25 (Figure 1). Therefore, we urge the Spanish Government to implement, as swiftly as possible, more drastic measures to minimize the impact of the pandemic on the Spanish population.



As a reference framework (to be adjusted, if applicable), we suggest the following measures:

Establish regional categories according to the number of cases per 100,000 population and implement a package of multiple interventions that fit each category. For example, type A areas (≥25 cases/10^6 inhabitants) implement a complete shutdown of the region and citizen lockdown, except for essential services (e.g., hospitals, healthcare, and research centers) for a minimum period of 15 to 21 days. This category includes, at this moment, the Autonomous Communities of Madrid (132 cases/10^6 inhabitants), Castilla y León (27), Castilla-La Mancha (39), La Rioja (132), Basque Country (44), Navarra (59) and Catalonia (27). Type B areas (<25 cases/10^6 inhabitants) apply partial confinement (50% of work activity and 25% of internal movement allowed) and

close monitoring of the growth rate of new infections; switch to type A in the event of a sharp rise in the number of cases. This category includes all regions not considered type A. Total interruption of non-essential inter-regional land, sea, and air transport for a minimum period of 15 days (e.g., until April 4, approximately) is also warranted.

To implement combined non-pharmacological interventions for several weeks, including complete restriction of movement, work interruption, and social distancing, banning all travel and all non-basic economic activities, together with the intensified use of diagnostic tests in suspected cases has proven to yield good results.[3] Also, there is an urgent need to establish a purchasing and supply channel for personal protective equipment, which is currently insufficient for health personnel who are highly exposed to contagion and are prone to contagion. The recent finding on the spreading capacity of SARS-CoV-2 by contamination of eyelashes and hair reinforces this need.[4]

The proposed suppression policies will not mean the end of CoVID-19 in Spain in the initial three to four weeks; therefore, the development of strategies to sustain the gains is critical. A key lesson from South Korea is the need to create a robust surveillance system capable of collecting and reporting epidemiological data down to the individual or household level.[5] There are two pillars for the development of such a system: first, increased laboratory capacity to perform PCR diagnostic tests on all individuals with symptoms for early isolation, and second, the development and implementation of a universal mobile application for self-reporting of observations suspicious of COVID-19. The identification of an increase in the number of cases in an area would trigger quick remedial measures like the implementation of early and targeted suppression actions.

Importantly, we beg the Spanish Government to facilitate the access of the scientific community to outbreak data, thus providing artificial intelligence support in simulation and modelling, and to create core support groups that coordinate a comprehensive, objective, and transparent scientific response.

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Supplementary material – Mathematical model

The simulation was conducted using the last version of a family of discrete-time epidemiological models,[1] specifically tailored to describe the transmission dynamics of SARS-COV-2, the etiological agent of COVID-19. The model aims to estimate the risk rate for each Spanish municipality, considering the following parameters: (1) the transmission dynamics of SARS-COV-2, (2) the usual movement patterns of the Spanish population, and (3) the demographics of the Spanish population.

Transmission dynamics

Virus transmission was described using a compartmental model that groups the population according to the infection status into the following categories:

- **Susceptible:** individuals without COVID-19, but still at risk.
- **Exposed:** infected individuals within the incubation phase and no transmission capacity.
- **Asymptomatic:** infected individuals without clinically relevant symptoms but transmission capacity.
- **Infected:** individuals with symptoms that are likely to be attributed to COVID-19.
- **Hospitalized:** infected individuals who have been identified and admitted to a hospital, thus blocking the transmission capacity.
- **Recovered:** individuals who have been infected but cannot transmit the disease because they have either died or recovered and developed immunity.

Movement patterns of the Spanish population

Transitions between the infection states drive the probabilities of transmission, recovery, etc., obtained from COVID-19 studies published to date. Regarding movements, we have included data from the National Institute of Statistics (NIS) on travel to the workplace between and within towns.[2] The NIS record includes all movements between Spanish municipalities greater than 100 inhabitants and reporting more than 10 trips. The inclusion of individual movements into the model is essential to understand how the virus spreads across the country and allows simulating the outcome of movement restrictions both globally and locally.

Spanish demographics

The Spanish population has been divided into three age groups:

- Young (from 0 to 25 years old).
- Adult (from 26 to 65 years old).
- Older (more than 65 years old).

The rationale for age grouping has been based on the recent evidence on COVID-19 that shows a different effect of the infection in each age group.[4] In our model, the following differences between age groups have been considered:

- Young and older are less likely to move across the territory than adults.
- Young are more likely to experience an asymptomatic disease (or with mild symptoms) and are, therefore, more challenging to identify.
- Older people are more likely to require hospitalization than young and adults.

Limitations

- The model does not predict or consider international inputs of infected individuals.
- The model has been based on epidemiologic parameters reported to date; however, these parameters may change in the near future.
- The model assumes the movement data reported by the NIE, which may vary in case of mobility restrictions.

Strengths

- The model allows modifying the epidemiologic parameters as new reports come up.
- The model allows for investigating the influence of the asymptomatic period and associated infectivity.
- Based on the current parameters, we can build risk maps of new cases and foresee infection spread by asymptomatic subjects.
- General mobility restrictions can be quickly introduced into the model to yield new predictions with these assumptions. This feature is of particular interest for policymakers

and health authorities, which will be able to explore the foreseen impact of the previewed restrictions on infection spread.

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