Country-level factors associated with the early spread of COVID-19 cases at 5, 10 and 15-days since the onset

Kasim Allel [a,b,*], Thamara Tapia-Muñoz [c,d], and Walter Morris [a]

[a] Institute for Global Health, University College London, United Kingdom; [b] Millennium Nucleus for Collaborative Research on Bacterial Resistance; [c] Mailman School of Public Health, Columbia University, United States of America; [d] The Research Foundation of The City University of New York, United States of America.

[*] **Corresponding author**. Institute for Global Health, University College London, United Kingdom. 30 Guildford Street, WC1N 1EH, telephone number: 020 7905 2646.

Email addresses: , K. Allel k.allel@ucl.ac.uk (https://orcid.org/0000-0002-2144-7181), T. Tapia tft2106@cumc.columbia.edu (https://orcid.org/0000-0001-9248-1056), W. Morris walter.morris.19@ucl.ac.uk (https://orcid.org/0000-0001-8070-1832)

Abstract

The COVID-19 pandemic is causing a significant global health crisis. As the disease continues to spread worldwide, little is known about the country-level factors affecting the transmission in the early weeks. The present study objective was to explore the country-level factors, including government actions, that explain the variation in the cumulative cases of COVID-19 within the firsts 15 days since the first case reported.

Using publicly available sources; country socioeconomic, demographic and health-related risk factors, together with government measures to contain COVID-19 spread, were analysed as predictors of the cumulative number of COVID-19 cases at three-time points (t=5, 10 and 15) since the first case reported (n=134 countries).

Drawing on negative-binomial multivariate regression models, HDI, healthcare expenditure and resources, and the variation in the measures taken by the governments, significantly predicted the incidence risk ratios of COVID-19 cases at the three- times points. The estimates were robust to different modelling techniques and specifications.

Although wealthier countries have elevated human development and healthcare capacity in respect to their counterparts (low-and-middle income countries) the early implementation of effective and incremental measures taken by the governments are crucial to controlling the spread of COVID-19 in the early weeks.

Keywords: COVID-19; country-level factors; government measures; pandemic; coronavirus; global health.

Introduction

Since the outbreak of the 2019 Novel Coronavirus (National Committee on Covid-19 Epidemiology & Medical Education), the world has experienced a devastating global health crisis, causing an economic, governmental, and human wellbeing catastrophe (Baker, Peckham, & Seixas, 2020; Dong & Bouey, 2020; Ferguson et al., 2020; Fernandes, 2020; Miller, Becker, Grenfell, & Metcalf, 2020; Sohrabi et al., 2020; Tuite, Bogoch, et al., 2020; Tuite, Ng, et al., 2020; Velavan & Meyer, 2020; Word Health Organization, 2020; Yang et al., 2020).

There has been a shift in the epicentre from China to Europe and the United States, where the number of confirmed cases and deaths greatly surpassed those in China (Kokudo & Sugiyama, 2020). Many of these are in developed countries with sound surveillance systems in place leading to a greater concerns over the poorer countries that could experience far greater suffering (Peters, Vetter, Guitart, Lotfinejad, & Pittet, 2020). Poverty and inequality contribute to the burden exacerbating the spread of infectious diseases (Goscé & Johansson, 2018; Jackson & Stephenson, 2014; Li, Richmond, & Roehner, 2018; Quinn & Kumar, 2014), while the lack of resources and underfunded health systems severely limit the country's capacity to cope with the extent of this pandemic. This makes early detection and containment their top priority (Acharya, 2020). The aim of this study, therefore, is to explore the country-level factors, including government actions, that could determine the variation in the cumulative cases of COVID-19 within the first 15 days since the first case reported.

The recent literature has shown a significant focus on the formulation of policies (i.e. potential measures to be taken by governments) to control the transmission of COVID-19 (Maier & Brockmann, 2020) Recorded government measures range from social distancing and isolation practices to nationwide lockdowns including the halt of economic activities and closing of borders (Hale & Webster, 2020; Leung, Wu, Liu, & Leung, 2020; McIntosh, 2020). While it is too early to evaluate these measures fully, studies using early figures in China has indicated the effectiveness of the isolation measures in suppressing the spread (Maier & Brockmann, 2020; Zhang et al., 2020) . Furthermore, previous studies from Severe Acute Respiratory Syndrome (SARS) pandemic suggest that early and rapid implementation of control measures, such as social isolation and quarantine, are effective in reducing the transmission (Koo et al., 2020; Wallinga & Teunis, 2004; Zhang et al., 2020). Therefore, it is likely that early government actions are a significant factor in determining the spread that could prevent the health systems from being overloaded (Grasselli, Pesenti, & Cecconi, 2020; Hasan & Narasimhan, 2020; Koo et al., 2020; Melnychuk & Kenny, 2006; Rosenthal, 2020).

In addition to the importance of taking early restrictive measures to diminish the transmission, the latest clinical evidence indicates that there are gender and age-related differences in the severity of symptoms and mortality rates of COVID-19 cases (R. Li et al., 2020). The elderly, particularly older men, appear to be more vulnerable to the disease and suffer from a higher risk of mortality globally (Betron, Gottert, Pulerwitz, Shattuck, & Stevanovic-Fenn, 2020; R. Li et al., 2020; Wenham, Smith, & Morgan, 2020). People with underlying health conditions have been linked to an increased risk of severity and fatality, especially for those with tuberculosis and high blood sugar levels (diabetes) (Bornstein, Dalan, Hopkins, Mingrone, & Boehm, 2020; Guan et al., 2020; Wingfield, Cuevas, MacPherson, Millington, & Squire, 2020). Other risk factors include smoking, alcohol consumption, high blood pressure (hypertension), and obesity (Dietz & Santos-Burgoa, 2020; Emami, Javanmardi, Pirbonyeh, & Akbari, 2020; Guan et al., 2020; Xu, Mao, & Chen, 2020; Zhou et al., 2020), all of which are common risk factors for non-communicable diseases (NCDs). Moreover, some parameters of the health systems are critical to tackle infectious diseases including the number of physicians, hospital beds, and health resources and expenditures, which indicates the capacity to conduct testing and the availability of personal protective equipment for health workers in an attempt to contain the infection (Dewar, Barr, & Robinson, 2014; Lancet, 2020). Finally, the transmission of infectious diseases is known to depend on the frequency and the nature of contact between the infectious and the healthy individuals (Aagaard-Hansen, Nombela, & Alvar, 2010; Goscé & Johansson, 2018). Hence, population characteristics, e.g. urbanicity, and population size, may determine the speed of the spread of the disease.

This study evaluates the association of the accumulated number of COVID-19 cases in the first two weeks with specific country-level factors across the world.

Material and Methods

1.1 Study data

The study was conducted using cross-section and panel data derived from secondary sources. Using data from the European Centre for Disease Prevention and Control (ECDC), a new database was generated containing information on the number of COVID-19 cases for 134 countries, taken at different time points (time “t” =5, 10, 15 days) since the first case was reported in the respective countries. Additionally, country-level socioeconomic and sociodemographic factors, population risk-factors for NCDs, healthcare resources and expenditures, and government measures, among other specific characteristics, were obtained from the same 134 countries (excluding government measures, N=93). Data were collected from various sources including the World Bank (WB), United Nations (UN), World Health Organization (WHO), and the Oxford University online repositories (supplementary material, section A).

1.2 Dependent variable

The cumulative number of COVID-19 cases at time “t” = 5, 10, 15 days since the first confirmed case were used to allow for meaningful comparison between countries. This was necessary to account for the reported variation in the estimated incubation period of the virus from 4 to14 days (Lauer et al., 2020); thus the timespan was divided into three equivalent periods.

Information on the number of daily reported cases are publicly available at ECDC (European Center of Disease Control and Prevention, 2020); a total of 134 countries that recorded data a minimum of 15 days since first confirmed case as of the 10^{th} April 2020, were included in the analysis.

1.3 Independent variables

Six country-level factors used in the analysis are outlined below with a brief description of the variables (supplementary material, section A for further details).

1. Socioeconomic factors: to account for the possible impact of wealth and inequality, the model includes both Human Developed Index (Sohrabi et al.) and the GINI coefficient. The HDI summarises "*key dimensions of human development*" including a long and healthy life represented by the life expectancy at birth; the level of access to knowledge, represented by the expected and mean years of schooling; a decent standard of living, indicated by the Gross National Income (GNI) per capita (Conceição, 2019). The GINI coefficient is derived from the difference in the cumulative proportion of population and income to indicate the level of inequality within a country (Organization of Economic Cooperation and Development, 2020 (accessed 20th of April 2020)). Both datasets are publicly available from the UN and WB official reports (Conceição, 2019; Organization of Economic Cooperation and Development, 2020 (accessed 20th of April 2020)).

2. Sociodemographic factors: four variables including the proportion of the urban population, the median age (in years) of the people, the dependency ratio and the percentage of the female population are accounted in the index.

3. Risk factors for non-communicable diseases (NCDs): accounts for five key risk indicators including, daily cigarettes consumption per smoker, annual alcohol consumption per person (in litres), high blood sugar levels (diabetes), obesity status, and high blood pressure levels (hypertension) of the population.

4. Healthcare resources and expenditures: three variables including health expenditure as a percentage of the GDP by nation, the number of beds per 10,000 people and the number of physicians per 10,000 people are accounted in the index.

5. Government measures in response to the outbreak of COVID-19: Oxford COVID-19 Government Response Tracker (OxCGRT) contains information on 11 indicators of government response against the

COVID-19 crises across countries and time (recorded daily, date accessed: 6 April 2020). This article uses the government stringency index comprised of seven indicators related to containment and closure policies which are believed to effectively reduce the spread of virus (Hale & Webster, 2020). Included in the seven indicators are policy response measures related to public gatherings (school and workplace closures, public event cancellations), restriction on population movement (closure of public transport, restriction on internal and international travel) as well as general public health campaigns. By rescaling each of the ordinal values for the seven categories, the Oxford dataset generates a government stringency index ranging from 0 (no government stringency) to 100 (very strict government stringency) offering a standardised measure in comparing government responses at t=5, 10 and 15 days since the onset. This index is being constantly monitored and updated to include more details (see supplementary material, section A).

6. Other factors: include historical incidence of tuberculosis as a percentage of the population, the quantity of international inbound tourists and population size per country.

All variables were standardised by subtracting the mean and then dividing by the general SD. Based on the reliability analysis (supplementary material, section B), three indices were constructed: sociodemographic status, health expenditure and risk factors (NCDs). Each of these indices was derived from combining variables within items 2, 3 and 4, which was computed based on the sum of the respective standardised variables. Finally, a small proportion of missing data (<10% of the original sample) were replaced following a specific protocol (supplementary material, Table D1, D2, D3).

1.4 Statistical analysis

To study the association between country-level factors and the accumulated number of COVID-19 cases, univariate and multivariate models were fitted to the data to understand the most relevant factors that explain the variation in the number of worldwide COVID-19 cases. Firstly, the correlation between each variable were analysed in a univariate setting. Secondly, the regression model was formulated by employing different functional forms of the outcome at t=5,10, and 15 days after the first case occurred. Finally, based on the modelling diagnostics, cross-section and population-averaged (GEE, (Hardin, 2005)) negative binomial regressions model were used to report the incidence risk ratios (IRR) for each of the country-level factors used as explanatory variables (see 1). The distribution of the number of cases emulate that of count-variable (supplementary material, Figure C1-3) and the coefficients (β) in the model indicates the association between the number of cases and each of the explanatory variables. To capture the effect of the government measures on the number of cases, the difference between the government index at time t=5 and t=10 was added to the model analysing the number of COVID-19 cases at t=10, and the difference between t=15 and t=10 to the model accounting for the cases at t=15. Robust standard errors were applied accordingly, and simple robustness checks were performed to account for the delay in the impact of the government measures on the number of COVID-19 cases.

$$
\begin{aligned}
log\ \ (Nº\ of\ cases)_{ct} &= \beta_0 + \ \beta_1 * HDI_c + \ \beta_2 * GINI_c + \ \beta_3 * Sociodemographic_c \ + \beta_4 \\
&* RiskFactorsNCD_c \ + \beta_5 * Healthcare_c \ + \ \beta_6 * Tuberculosis_c \ + \ \beta_7 \\
&* International\ tourists_c \ + \beta_8 * Population_c \ + \ \beta_9 \\
&* \Delta_{(t-[t-1])}(\text{government measures})_c\ \mu_c
\end{aligned}
\qquad (1)
$$

$\forall\ country\ c$. “t” stands for 5, 10 and 15 days. Cross-section and panel data models are used; the “t” term is constrained depending on the specification of the model. Therefore, for cross-section models, t is fixed and equal to only one time period.

Additional variables were tested (i.e. weather characteristics, contamination, lack of immunization, population with basic sanitation, stock of immigrants), however, excluded from the principal analysis based on the overall significance of the model and R^2.

All analyses were done using STATA 15.1 (StataCorp, College Station, TX, USA) and QGIS 3.6 (QGIS Geographic Information System).

Results

Table 1 summarises the descriptive statistics of the sample of 134 countries. It was possible to observe a rapid growth in the average number of confirmed cases, where t=10 is five times the number of cases at t=5, and t=15 is almost seventeen times the cases at day five ($Mean_{(t:5)}$ =11.31, $SD_{(t:5)}$ =14.40, $IQR_{(t:5)}$ =12; $Mean_{(t:10)}$=50.97, $SD_{(t:10)}$ =117.23, $IQR_{(t:10)}$ = 51; $Mean_{(t:15)}$=179.31, $SD_{(t:15)}$ =555.27, $IQR_{(t:15)}$ =168). The sampled countries consisted of a higher female middle-aged population living in the urban areas ($Mean_{(female)}$ =50.48%, SD=3.26; $Mean_{(age)}$ =32.3, SD=9.03; $Mean_{(urban)}$ =64.16%, SD=20.73). The sample population also displayed a high concentration of NCDs with a sizeable proportion indicating high blood pressure or hypertension (Mean=23.81%, SD=5.79) and obesity levels (Mean=19.67; SD=9.31). Furthermore, the average annual consumption of alcohol (Mean=6.77, SD=4.14) was slightly above the world average of 6.4 litres per person (Ritchie & Roser, 2018), however, this varied considerably across countries indicated by the higher IQR in comparison to the mean (IQR>Mean; IQR=7.10). Healthcare resources and expenditure as a proportion of the GDP was consistent across countries, however, the number of beds, and in particular, the physicians, varied considerably (IQR>Mean). Same observations can be made with the incidence of tuberculosis (Mean=87.09; IQR=101) and the number of international tourists (Mean=9,117.05; IQR=9,202). Finally, the government index changed, in comparison with t=5, by 44.63% at t=10, and by 87.87% at t=15 where the highest level of variations in government responses were observed across countries indicated by the IQR ($Mean_{(t:5)}$ =25.88, $SD_{(t:5)}$ =23.97, $IQR_{(t:5)}$ = 35.72; $Mean_{(t:15)}$ =48.62, $SD_{(t:15)}$ =29.48, $IQR_{(t:15)}$ = 47.62).

[INSERT TABLE 1 HERE]

The univariate analysis indicated that HDI, the risk factors (NCDs), the government indices and the GINI coefficient were positively correlated to the number of COVID-19 cases for all three periods (Pearson coefficient ranging from 0.07 to 0.41; supplementary material, Table C1). On the other hand, health resources index and incidence of tuberculosis were inversely correlated (Pearson coefficient ranging from -0.16 to -0.03). The remaining variables were inconsistently correlated to the number of cases at different points in time.

Figures 1 and 2 illustrates the changes in the number of COVID-19 cases and the government index respectively, by quartiles, over the specified time period of interest. From figure 1, we observe the tendency that middle-income countries experience the highest increase in the number of cases over this period. Furthermore, those nations with the higher number of COVID-19 cases at time “t” appear to have more stringent measures imposed by the government. Figure 3 shows the cross-country variation of the three indices we have constructed. A higher sociodemographic status is observed within countries in the northern hemisphere, while regions with the higher risk factors (NCDs) were found in some east-central European countries and Chile, Peru and Venezuela in South America. Finally, the countries with the lowest expenditure and investment in healthcare were found in African, Central Asian and Central and Southern Americas countries.

[INSERT FIGURE 1 AND FIGURE 2 HERE]

Table 2 shows the main results of the multivariate analysis using negative binomial regression (see supplementary material, section E, for how the approach was derived and the main assumptions tested). Note that, for the first analysis, β_9 parameter from Equation 1 is excluded to understand how countries' fixed characteristics were associated with the dependent variable. Countries with higher dependency rate and proportion of females middle-aged population living in the urban area were associated with an 8.1% and 8.7% decrease in the IRR of COVID-19 cases at times 5 and 10 ($IRR_{(t:5)}$ =0.919, SE=0.06; $IRR_{(t:10)}$=0.913, SE=0.06). Higher accumulation of risk factors (NCDs) amongst the population was associated with a higher rate of spread where one unit increase in the index resulted in a rise of 13.7% on the IRR of COVID-19 cases at t=5 days (IRR=1.14, SE=0.05). Higher healthcare resources and expenditures, on the other hand, were associated with a 12% to 19% decrease in the IRR of cases at t=5 and t=15 respectively ($IRR_{(t:5)}$ =0.88, SE=0.06; $IRR_{(t:15)}$ =0.81, SE=0.07). HDI was a constant positive predictor of the IRR of COVID-19 cases over time, while the incidence of tuberculosis was associated with a reduced IRR of COVID-19 cases at t=5, although the association gradually declined as time moved forward to t=15. Finally, inbound international tourists, sociodemographic index, GINI, and population size weakly associated with COVID-19 cases at t=5, the statistical power of these variables were lost beyond this point. Section H of the supplementary material shows how these results did not differ after adjusting the number of cases by population size as dependent variable using two different modelling approaches.

[INSERT TABLE 2 HERE]

Table 3 summarises the results of the multivariate analysis incorporating the variation in the government index (β_9) over time. Table 2 indicates that the effect of the covariates on IRR of COVID-19 cases are consistent with the direction displayed under model 1 at t=10 and t=15. The results indicate that stricter measures imposed by the government are associated with a decrease in the IRR at t=10 (IRR= 0.95; SE=0.02) and even lower at t=15 (IRR= 0.94; SE=0.02)

As a robustness check, a separate model was constructed to contrast the number of COVID-19 cases at t=15 with the government measures taken at t=5. This was done to account for the estimated time lag of about 10 days between government measures and the effect on the COVID-19 cases reported by the euro-surveillance team (Eurosurveillance Editorial Team, 2020). The results from this analysis corresponded to the predicted associations from the earlier models demonstrating consistency with the results from Table 1 and 3 (supplementary material, Table F1).

[INSERT TABLE 3 HERE]

Table 4 presents the panel data results from the negative binomial regression using a GEE population-averaged model. In line with the previous results, there is a consistent positive short-term association for risk factors (NCDs) and HDI (IRR=1.16, SE=0.08; IRR=1.46, SE=0.32, respectively) and an inverse relationship for health expenditures (IRR=0.79, SE=0.09). The results, including the government index, are also compatible with previous models (IRR=0.93, SE=0.01), where countries with lower stringency are associated with a higher number of COVID-19 cases. Additionally, exploratory analysis revealed that government measures with lower stringency at t=15 were inversely correlated to HDI (supplementary material, section G).

[INSERT TABLE 4 HERE]

Discussion

This study presents evidence to support the implementation of early and progressive government measures enforcing social distancing. The results indicate that during the first two weeks since the first case reported, up to 4% of the cross-country variation of the cumulative number of COVID-19 cases can be explained by country-level factors only. More importantly, government measures within the first 5 days were a strong predictor of the spread of the COVID-19 during the next 10 days.

Sociodemographic factors, the HDI, the prevalence of NCDs risk factors, healthcare resources and expenditure, and government intervention are important factors to determine the IRR of cases at the first 5 days. Nevertheless, as the virus progress to day 10 and 15 since the first case reported, the country differences are predicted mainly by the HDI, healthcare resources and expenditure. Higher HDI has been generally associated with better health outcomes and better management of infectious diseases in previous years (Atkinson & Mabey, 2019; Quinn & Kumar, 2014). However, the most recent outbreaks of coronaviruses (SARS and MERS) also occurred in countries with very high HDI (Wallinga & Teunis, 2004; Yang et al., 2020). Two hypotheses have been formulated in attempt to explain this seemingly odd relationship by looking at the components of HDI. Firstly, Higher HDI indicates increased level of Gross National Income and better living conditions, suggesting more robust economic activities, higher volume of international trade and population movement within and outside of the country (Deb, 2015). Evidence from China suggests that social and economic activities, as well as travelling, increase the likelihood of importing and spreading the virus (Leung et al., 2020). However, international inbound of tourists was not a significant factor as it does not fully account for population's movement through economic activities, and it is strongly affected by seasonality. Instead, airport flight activity may have provided a better proxy of the population's movement for the specific timeframe, however this data was not immediately available. Secondly, higher HDI indicates extended life expectancy, which in itself is a risk factor for respiratory illnesses, because older adults are generally more vulnerable to infectious disease (Gavazzi &

Krause, 2002; X. Li et al., 2020). Consequently, although countries with elevated HDI are wealthier, they also possess a higher concentration of older adults (United Nations, 2019). The number of cases in this study were, likewise, predicted by healthcare resources and expenditures, indicating that health systems with substantial amount of investment and health workers are essential in tackling the early spread of the disease. As there are currently no pharmaceutical interventions available, this may link to the availability of appropriate PPE amongst healthcare professions and the capacity to conduct testing – both of which are likely to be correlated with healthcare resources and expenditures (Chang et al., 2019; Goenka & Liu, 2019; Palagyi et al., 2019).

Interestingly, we found that countries with a higher incidence of tuberculosis had a lower IRR for COVID-19 cases at 5, 10, and 15 days. Based on the higher incidence of tuberculosis in South-East and Africa (MacNeil, Glaziou, Sismanidis, Maloney, & Floyd, 2019), a potential explanation could be an unmeasured effect modification because of the region of the countries. Consequently, our results showed that contrary to South East Asia, countries in Africa had lower cumulative cases of Covid-19. Further research is needed to understand the apparent differences between these regions. Additionally, some similarities between both diseases, especially considering the common risk factors, could mean a strong and positive correlation between them over time, however, the nature of this relationship is yet to be clarified (World Health Organization, 2020).

In line with findings from other studies that note the effectiveness of different government actions (Ferguson et al., 2020; Hale & Webster, 2020; Wallinga & Teunis, 2004), the analysis of the government interventions to address the propagation of COVID-19 suggest that higher government stringency is a key predictor for the cumulative number of cases at t=5, 10 and 15 days. It also becomes more critical as we move forward over time and overshadows the impact of other country-level factors. Therefore, early intervention by the government in enforcing strict social distancing measures is key in slowing down the spread of the diseases.

Due to its limitations, the results of this study should be interpreted cautiously. First, the study uses the reported number of cases by each government and this varies across countries, because of the limited capacity for testing and the higher presence of mild/asymptomatic cases that go undetected (R. Li et al., 2020). Therefore, we are inevitably observing the accumulated incidence of more severe cases (i.e. patients at ICUs) for which the underlying risk factors are critical, and hence, a reduced sample size of the population is examined. Second, many countries had missing data for either the number of COVID-19 cases at time “t” or the selected covariates, which limited the sample size and the more significant cross-country variability. Third, the covariates were formed from country-level data, which reflect the ability of each country to collect accurate data on their national data systems. Fourth, neither the data on society’s culture nor how people behaved following the instructions dictated by the government were captured.

Fifth, studies from broader literature relating to other diseases, including evidence from previous outbreaks of Coronaviruses, were used. Sixth, the government stringency index is comprised of 7 components, and while this is a useful measure, it was not possible to analyse the level of variation in the implementation or which measures in particular were effective in containing the spread within each country.

Future research could measure the long-term effects of the measures taken by the governments incorporating additional time-varying characteristics of the population that could be linked to the spread of COVID-19.

The present article depicts how countries’ HDI, healthcare resources and expenditures, and the higher presence of NCDs in the population, are associated to the cumulative number of COVID-19 at time t=5, 10 and 15 since the first reported case. Furthermore, although the underlying characteristics of the countries play a key role in determining the spread, earlier interventions by the government enforcing strict social distancing measures are crucial to control the short term spread of COVID-19.

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Contributors: KA, TT and WM conceived and designed the study. KA conducted data analyses, interpreted the findings, and prepared the main draft. TT and WM supported data analysis and interpretation of results and handled the data to be put together. All authors critically reviewed and edited the manuscript.

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Tables & Figures

Table 1

Descriptive Statistics (N=134 countries)

Variables	Mean	SD	IQR (75%-25%)
COVID-19 testing at t=5,10,15 days after the first case appeared			
Number of cases at t=5	11.31	14.40	12.00
Number of cases at t=10	50.97	117.23	51.00
Number of cases at t=15	179.39	555.27	168.00
Socio-economic factors			
Human Development Index (HDI)	74.84	14.49	19.02
GINI coefficient	37.58	7.60	9.60
Sociodemographic factors [a]			
Urban population (%)	64.16	20.73	30.50
Median age in years	32.30	9.03	14.84
Dependency ratio	15.65	9.99	16.84
Male population (%)	49.52	3.26	1.00
Risk factors (NCDs) [a]			
Daily cigarettes consumption per smoker	17.31	7.79	13.00
Annual alcohol consumption per person (in litters)	6.77	4.14	7.10
High blood sugar level or diabetes (%)	8.50	2.65	2.90
High blood pressure level or hypertension (%)	23.81	5.79	6.80
Obesity status (%)	19.67	9.31	17.20
Healthcare resources and expenditures [a]			
Number of physicians (per 10,000 people)	20.33	15.59	24.67
Hospitals beds (per 10,000 people)	31.98	24.61	32.00

Health expenditure (% of the GDP)	6.77	2.5	3.919
Other country-level characteristics			
Tuberculosis Incidence (per 100,000 people)	87.09	119.12	101.00
International inbound tourists (in thousands)	9,117.05	15,529.03	9,202.00
Population (in 1,000,000)	52.87	171.54	30.80
Government measures*			
Government index at t=5	25.88	23.97	35.72
Government index at t=10	37.43	27.38	42.85
Government index at t=15	48.62	29.48	47.62

Notes: [a] The distribution of the standardized indices is shown in Figures C4-C6.
[b]: stands for infants of one-year-old.
* These variables were included in the subsample analysis (N=93). IQR expresses the difference in the two middle quartiles of the distribution. [c] variable used only for descriptive purposes, not included in the analysis as HDI is calculated based on it.

Table 2

Negative binomial regression results (N=134 countries)

	Model 1		**Model 2**		**Model 3**	
	Nº of cases 5-days' time		Nº of cases 10-days' time		Nº of cases 15-days' time	
Independent variables	**IRR**	**(SE)**	**IRR**	**(SE)**	**IRR**	**(SE)**
Main factors						
HDI	1.572**	(0.29)	1.858***	(0.34)	2.002***	(0.54)
GINI	1.183*	(0.11)	1.138	(0.12)	1.165	(0.14)
Sociodemographic [a]	0.919*	(0.06)	0.913*	(0.06)	0.969	(0.09)
Risk factors (NCDs) [a]	1.137***	(0.05)	1.157***	(0.06)	1.080	(0.07)
Healthcare [a]	0.884**	(0.06)	0.832**	(0.06)	0.808**	(0.07)

Other factors						
Tuberculosis incidence	0.734***	(0.08)	0.760**	(0.10)	0.741*	(0.12)
International tourists	0.836	(0.12)	1.026	(0.30)	1.177	(0.41)
Population	1.188*	(0.13)	0.963	(0.15)	0.810	(0.13)
Constant	9.894***	(0.89)	40.330***	(4.65)	135.403***	(19.77)
F-test(p-value)	48.02(p-value<0.001)		57.61(p-value<0.001)		46.23(p-value<0.001)	
Pseudo R^2	3.9%		3.5%		2.6%	
AIC	913		1281		1570	
Ln(alpha), SE	0.775**(0.09)		1.16***(0.13)		1.641***(0.18)	

Notes: * p < 0.1; ** p < .05; *** p < .01 (two-tailed tests). Robust standard errors were used. [a] Index variable computed through the standardisation of sub variables.

Table 3

Negative binomial regression results including government index (N=134 countries)

	Model 1		**Model 2**	
	Nº of cases 10-days' time		Nº of cases 15-days' time	
Independent variables	**IRR**	**(SE)**	**IRR**	**(SE)**
Main factors				
HDI	1.634***	(0.28)	1.819**	(0.46)
GINI	1.118	(0.12)	1.133	(0.13)
Sociodemographic [a]	0.909	(0.06)	0.977	(0.09)
Risk factors (NCDs) [a]	1.191***	(0.07)	1.122*	(0.07)

Healthcare [a]	0.840**	(0.06)	0.795***	(0.07)
Other factors				
Tuberculosis incidence	0.734**	(0.10)	0.734*	(0.12)
International tourists	0.930	(0.26)	1.042	(0.37)
Population	0.976	(0.15)	0.822	(0.14)
Government index [b]				
Δ day t=10 and t=5	0.954***	(0.02)		
Δ day t=15 and t=10			0.940***	(0.02)
Constant	46.716***	(6.19)	161.864***	(27.30)
F-test(p-value)	68.59(p-value<0.001)		63.46(p-value<0.001)	
Pseudo R^2	3.8%		2.9%	
AIC	1278		1576	
Ln(alpha), SE	1.13***(0.13)		1.592***(0.18)	

Notes: * p < 0.1; ** p < .05; *** p < .01 (two-tailed tests). Robust standard errors were used.

[a]Index variable computed through the standardisation of sub variables.

[b]Missing data for government measures were imputed based on the mean of the population at the corresponding time period.

Table 4

Negative binomial panel regression results including government index

GEE Population average model			
	Nº of cases of COVID-19		
Independent variables	**IRR**	**(SE)**	**(P-value)**
Main factors			
HDI	1.462*	(0.32)	0.084
GINI	1.126	(0.14)	0.347
Sociodemographic [a]	1.010	(0.07)	0.875
Risk factors (NCDs) [a]	1.155**	(0.08)	0.032
Healthcare [a]	0.786**	(0.09)	0.044
Other factors			
Tuberculosis Incidence	0.708**	(0.12)	0.044
International tourists	0.935	(0.20)	0.757
Population	0.899	(0.10)	0.331
Government index			
Δ in government measures [b]	0.926***	(0.01)	<0.001
Constant	83.774***	(12.03)	<0.001
Chi^2(p-value)	169.8(p-value<0.001)		
Number of observations	402		
Number of countries	134		
VCE	robust		

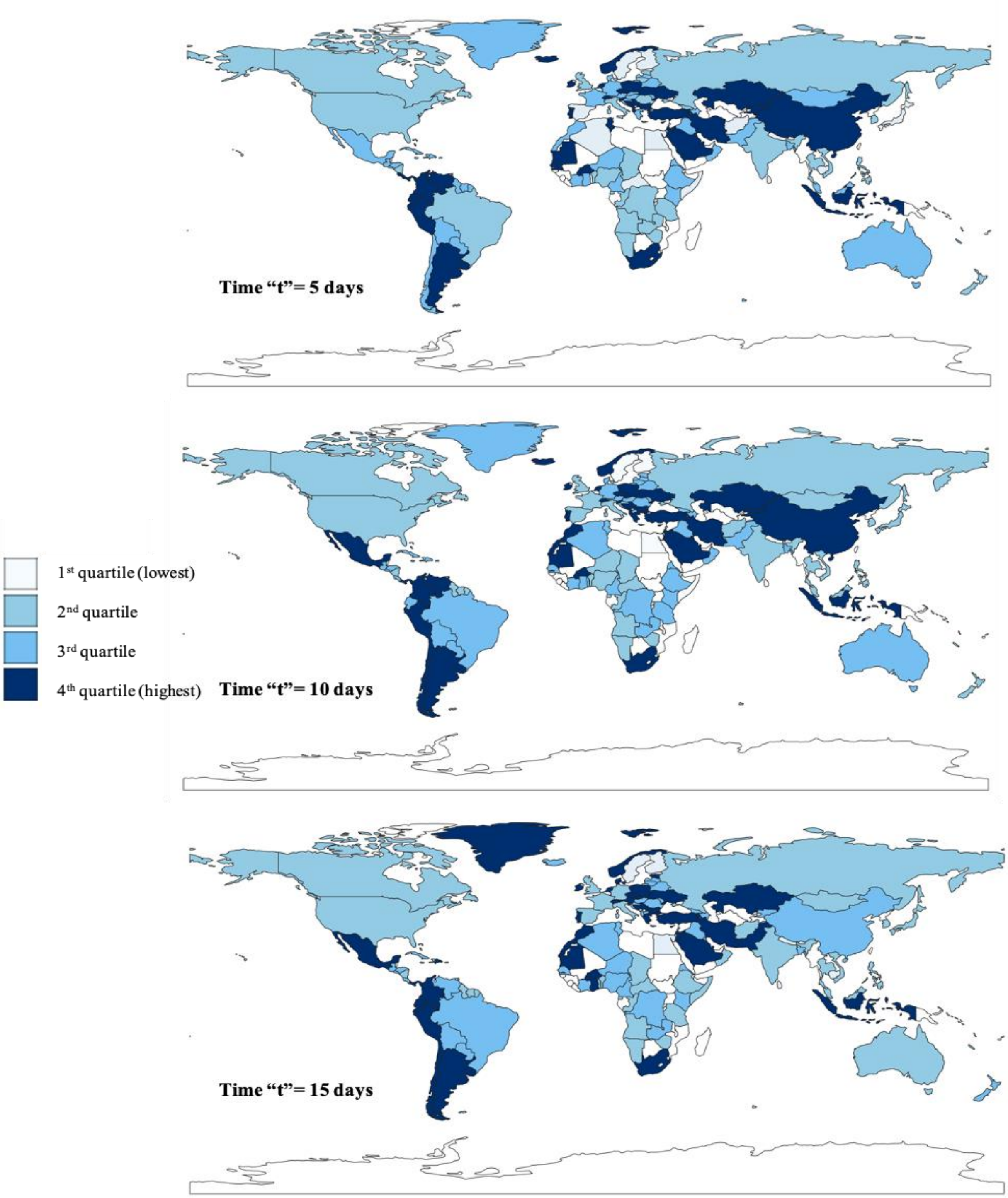
Notes: * p < 0.1; ** p < .05; *** p < .01 (two-tailed tests). Random effects were used.

[a] Index variable computed through the standardisation of sub variables.

[b]Missing data for government measures were imputed based on the mean of the population at the corresponding time period.

Figure 1

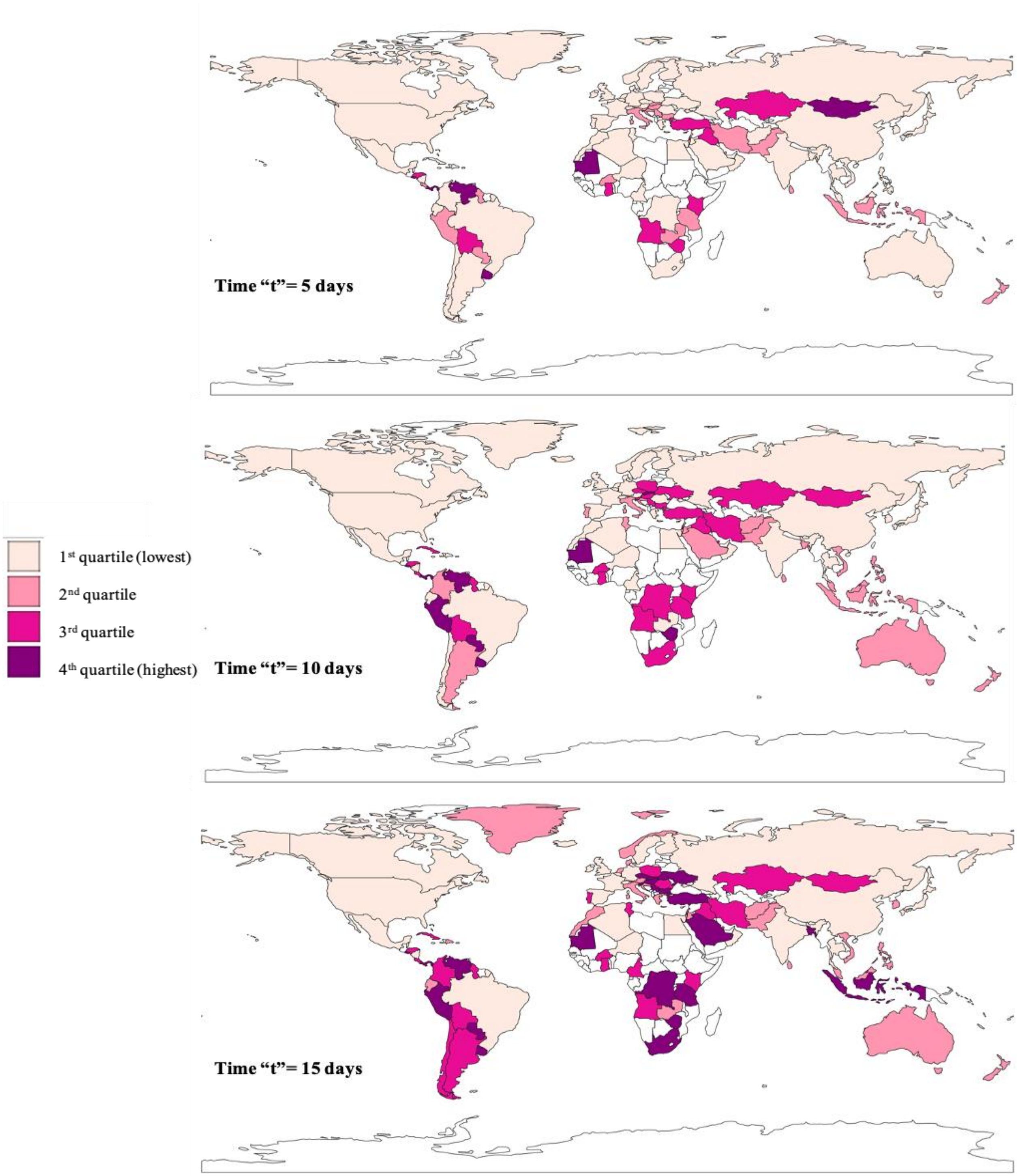
Map of the distribution of the number of cases by period (N=134)



Notes*:* The 4th quartile indicates the higher number of cases accumulated at time "t". Blank areas are missing data.

Figure 2

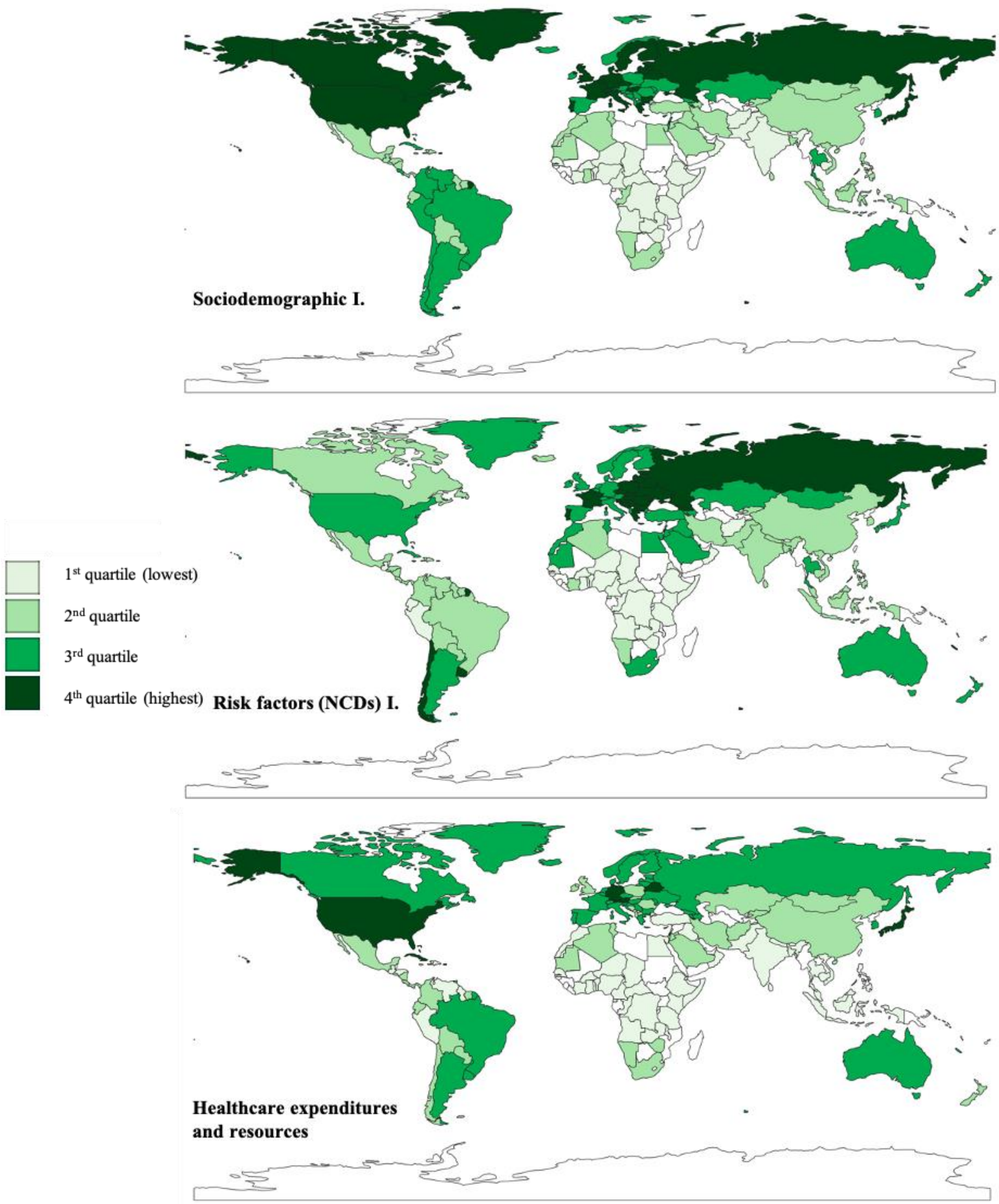
Map of the distribution of the government index (N=93)



Notes: The 4th quartile indicates the higher restrictions or policies taken by the government. Blank areas are missing data.

Figure 3

Map of the distribution of the socio-demographic indexes constructed (N=134)



Notes*:* The 4th quartile indicates the wealthier sociodemographic index and health system, while it also presents the higher accumulation of comorbidities as for risk factors (NCDs). Blank areas are missing data.