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Research Article

Cross-national associations of IQ and infectious diseases: Is the prevalence of Corona an exceptional case?

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David Becker[1], Claudia Kiel[1], Heiner Rindermann[2]

1. Department of Psychology, Technische Universität Chemnitz, Germany; 2. Technische Universität Chemnitz, Germany

Background: Previous studies reported negative associations between a country's mean IQ and economic development at the one side and the prevalence of infectious diseases on the other, arguing that a more rational behavior and better living conditions decreased health risks. The purpose of this study was to transfer these previous findings on the relationship between IQ and the burden of infectious diseases on a cross-national level to the SARS-CoV-2 pandemic. Countries with higher IQ results and rich countries in North-East Asia and the West are more affected by Corona than poorer countries in the Middle East or in sub-Saharan Africa (IQ: $r_{IQ↔Cases}$ = .41 and $r_{IQ↔Deaths}$ = .28; wealth: $r_{GDP/c↔Cases}$ = .45 and $r_{GDP/c↔Deaths}$ = .22). Intelligence can have contradicting effects on Corona, i.e., it increases health and makes people more rationally cautious, but at the same time leads to an older population that is more susceptible to corona health problems and allows societies to detect more Corona cases.
Methods: The effects of IQ on the impact of the SARS-CoV-2 pandemic (per capita: reproduction rate R_0, hospitalizations due to Corona, Intensive Care Unit treatments, cases, deaths, excess mortality) were controlled in a sample of up to 207 countries for climatic conditions, air pollution, wealth, demographic factors, health burden (e.g., cardiovascular diseases), peoples' mobility, test coverage and anti-Corona regulations. The stability of effects was checked in six country sub-samples and controlled for the factors named above in regressions with 73 successful runs.
Results: The effect (standardized β) of IQ shows an average negative (reducing) effect of −.19 on the pandemic's impact. Intelligence has a small effect on the spread of corona and the severity of its consequences. Stronger effects are given by climatic conditions (colder climates) and air pollution. Detailed regressions and additional path analyses show that the reducing effect of IQ is limited to the direct path and the long term (β = .08 in 2020 but −.21 in 2021).
Conclusions: In the context of the SARS-CoV-2 pandemic, the previous findings about the relationship between IQ and the burden of infectious diseases could only be partially reproduced. The assumption of a weakening effect on the impact of the pandemic was confirmed, but only to a limited extent and along unknown ways.

Corresponding author: David Becker, david.becker@psychologie.tu-chemnitz.de

Running head: IQ & Corona

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Highlights

- Cross-national analyses for 207 countries on the IQ-Corona relationship were done.
- Environmental, economic, demographic, medical and political factors are controlled.
- The overall reducing effect of IQ on Corona in 73 model runs is β = −.19.
- Path analyses revealed direct reducing effect of IQ on Corona.
- Climatic conditions (cold winters) and air pollution have increasing effects.

1. Introduction

The pandemical spread of the Coronavirus is certainly the most decisive event of 2020 and 2021. The "severe acute respiratory syndrome coronavirus 2" (SARS-CoV-2) particularly affects the human respiratory system [1]. Until the 29th of June 2021 180,492,131 cumulative cases and 3,916,771 cumulative deaths were recorded worldwide [2]. No region in the world was spared, however, the relatively well-developed countries with higher levels in student assessment and psychometric test results in Europe and Northern America were disproportionately affected, with up to 90% of the worldwide cases [2].

From the perspective of cross-national research on education and intelligence, this is remarkable and surprising, since the prevalence of infectious diseases is usually highly negatively associated with the mean educational and cognitive ability level of countries [3][4]. The evidence is especially strong for a health improving effect of cognitive ability (intelligence including some knowledge aspects); many papers reported such associations (at the international level comparing countries [5][6][7][8][9]. In a paper by Daniele and Ostuni (2013) only one of 15 infectious diseases did not negatively correlate with IQ (Japanese encephalitis) [10]. In parallel, the authors found strong positive correlations of DALYs (disability-adjusted life years lost) due to infectious diseases with mean temperature (the higher the average temperature the more years are lost) and strong negative correlations with absolute latitudes (far from the tropics less life years lost).

This contradicts the geographic pattern of all SARS-CoV-2-pandemic. The origin of the phylogenetic tree of the virus is SARS-CoV and it first occurred in 2003 in southern China [11][1]. Countries affected by the older SARS-CoV pandemic were distributed all around the globe, however most affected regions were China, Hong Kong, Taiwan, Singapore, Hanoi in Vietnam and Toronto in Canada [12]. Africa, the Middle East and Central Asia were almost completely spared [13]. A further SARS-CoV-2 predecessor, MERS-CoV, spread through the Middle East in 2013, affected 23 countries, mostly at the Arabic Peninsula [1]. The 2020 SARS-CoV-2-pandemic is the third and most serious pandemic caused by this family of viruses, with higher death rates and also possible negative long-term effects [14].

Cognitive ability does not appear to predict SARS-CoV-2 pandemic outcomes at the cross-national level in the way it has for other infectious diseases. An influence by other factors is possible. What other factors are there that can accelerate the spread of the virus and exacerbate its consequences?

1. The first factor mentioned in studies is *disease burden*. A statement from the World Heart Federation identified cardiovascular disease, hypertension, diabetes, chronic respiratory disease, and cancer as risk factors susceptible to SARS [15]. Around 96% of 3,335 observed Italian patients died in hospitals were positively diagnosed for one or more pre-existing vulnerabilities as hypertension, diabetes and heart disease, and case-fatality rates of the SARS were two to four times higher in Chinese patients with cardiovascular diseases and hypertension compared to the general Chinese population [16]. *Behavior* that is detrimental to health, as smoking, chronic obstructive pulmonary diseases, lung cancer, high alcohol consumption, liver dysfunction, and diabetes mellitus, is a further risk factor [17][18]. Additionally, there is rising evidence that Vitamin D, as an essential receptor in cells of the immune system [19], is a crucial factor to protect against infections with SARS-CoV-2 [20][21][22]. All those vulnerabilities worsen the consequences of an infection, complicate treatment and make therapy less successful. Additionally, being in medical treatment by another illness increases the risk to catch an infection. Some risk factors as alcohol consumption seem to be increased during the pandemic and lockdowns [23].
2. The prevalence of diseases increases with age, the *median age* of a population is seen as crucial to the susceptibility to SARS-CoV-2. Additionally, the quality of the health system, i.e., the *quality of health institutions* and the amount of *government funding*, may also play a role here. Not only the risk of severity and duration of health damage from existing

diseases, but also the risk of transmission of infectious diseases due to inadequate hygiene standards could increase the impact of the pandemic.

3. *Air pollution* seems to be a further factor contributing to the impact of the pandemic. A higher concentration of particulate matter in the air may make the lung more susceptible for a more serious progression of a SARS-CoV-2 infection. A study by Tung et al. summarized much of this work and discussed the role of the particulate matter working in promoting aerial transmission by preserving viruses for several days [24]. At the cross-national level, evidence for this mechanism has been found [25], showing that during the first wave the tropospheric concentration of NO_2 in Europe was significantly stronger in areas (north Italy and central Spain) in which the virus spread most, and which counted the highest numbers of deaths.
4. Air pollution is to a certain degree associated with *population density*, *transportation* and *economic activities* simultaneously increasing pollution and interpersonal contacts. Copiello and Grillenzoni showed that, in the case of Chinese provinces, per capita emissions of industrial waste gases were not any longer a positive predictor for pandemic spread if population density, economic activity and climatic conditions were taken into account [26].
5. *Climatic conditions* present a further factor: In general, the burden of pathogens is higher in environments with warmer and more humid climates than in colder and drier environments [27]. However, animal experiments with the Influenza virus, which also spreads via and infected the respiratory system, showed that *lower* temperature and *lower* humidity can boost the transmission of several viruses [28]. This helps to explain the seasonal (winter) flu waves in the northern hemisphere (outside cold, indoors dry) and is possibly an explanation for the SARS-CoV-2-pandemic, whose waves coincident in time with those of the flu.
6. According to the global pattern of the pandemic, there appears to be a positive, at least statistical, association between *wealth* and the number of cases and deaths, even it is not clear at this point to what extent there could be a causality or whether it is just the result of an unknown confounder. From a theoretical perspective, wealth has to be taken into account for its proven negative relationship with infectious diseases, even if the opposite is apparently the case with SARS-CoV-2.

Consideration of these additional factors may yield a truer pattern of potential effects of intelligence on the spread of SARS-CoV-2 and severity of infection. However, intelligence still may have *health-related positive* (i.e., infection decreasing and health increasing) and *specific Corona-positive* (i.e., SARS-CoV-2 increasing) effects:

1. Due to higher insight, more knowledge and a better consideration of risks and goals more intelligent people should be able to *better adapt to a new challenge* as the Corona threat. E.g., avoiding contact (social distancing), wearing a mask or at the political-institutional level to develop and enforce rules to contain the spread of the Corona virus [29]. Intelligence enables a more rational thinking and behavior [30]. However, the complex nature of all effects of behavioral and institutional reactions, including positive and negative side effects, make statements on the rationality of responses to the Corona pandemic opaque. For instance, there are usually no serious Corona effects for healthy persons younger than 70 years old [31]. There are negative consequences of political reactions (lockdowns and school closings) including negative effects on economic growth and long-term health leading in the long run to more losses in DALYs [32][33][34].[1] Lockdowns, social distancing and masks reduce social contact increasing psychological and physical health problems (which already have existed due to Corona anxiety) or simply make people less happy [35][36].
2. Conduct of one's life and politics are polytelic, i.e., rational decisions cannot only focus on avoiding SARS-CoV-2 but also have to consider social, emotional, intellectual, economic and political criteria. As well as income is not the unique criterion for intelligence (or the unique rational life goal) it cannot be a low COVID rate.
3. Intelligence generally helps to *improve the environment*, i.e., creates more wealth, better institutions, more rational politics and a higher quality of the health system all being important for health and an appropriate dealing with new challenges [37][38]. However, higher quality health care also means more testing, which leads to more Corona diagnoses and more registered Corona cases.
4. More intelligent people are generally healthier due to a healthier lifestyle, due to improved environment and because intelligence is an *indicator* of health [39][40]. However, healthier lives mean that the population is getting older on average, leading to increased susceptibility to Corona. Dying young paradoxically leads to a healthier remaining population.

We seek to analyze these contradicting intelligence effects on Corona, we seek to uncover the possible direct and indirect ways of effect and to do so in the context of further important factors such as climate.

2. Method

2.1. Selection of variables

From the factors named above, the following twelve variables as possible factors at the national (country) level were selected for the analysis:

1. Mean national level of *intelligence* in the broader meaning including knowledge (cognitive ability or cognitive competence).
2. Mean *temperature* at the cold season (winter).
3. *Air pollution*.
4. Economic *wealth*.
5. *Demographic conditions* (urbanization, median age, population density).
6. *Health burden* with focus on *diseases* and *behavior* positively associated with the probability of a SARS-CoV-2 infection and a lethal SARS-outcome (cardiovascular disease, diabetes prevalence, cancer, smoking, alcohol consumption).
7. Governmental *expenditures for health*.
8. Quality of the *health system* (number of physicians and hospital beds per capita, overall quality of sanitation).
9. The change in spatial *mobility* in response to the pandemic (e.g., less traveling; public transit; frequentation of public and workplaces).
10. SARS-CoV-2 *test* coverage.
11. The level of *vaccination* coverage.
12. Number of *restrictions* enacted to contain the pandemic (e.g., lockdowns).

Dependent variables represent the pandemic impact in multiple ways:

1. Basic virus *reproduction ratio* (number of cases directly generated by one case).
2. *Rate* and *severity* of registered cases (e.g., cases with need for intensive care).
3. Rate of *deaths* caused by SARS-CoV-2 infections (in different measures).

2.2. Data

2.2.1. Intelligence

International (national) IQ-data were taken from the NIQ-dataset (National IQ V1.3.3) [41]. The variable "QNW+SAS" was selected, which is a combination of psychometric intelligence measurements from common IQ-tests as Raven's Matrices, Wechsler Scales, the Stanford-Binet- and the Cattell Culture Fair Intelligence Test and country results from large international student assessment studies (PISA, TIMSS, PIRLS). It is representing intelligence in a broader sense, including both fluid and crystallized intelligence or thinking ability with the acquisition of modern knowledge and its intelligent use. The international student assessment studies measure to a certain degree also intelligence; specific knowledge aspects are rather small [42]. Information is given for 149 countries.

Doubts about the validity of this data were and are often expressed, e.g., by The European Human Behaviour and Evolution Association Committee in a statement from 2020 [43]. However, in two independent works [44][45], international data for educational attainment were published, expected human capital and learning outcomes, with correlations between .65 and .87 to the IQ-data used in this study. To compare and test the robustness of our results, we drew on two alternative collections of cognitive abilities: One source used results from international school assessment studies (TIMSS, PIRLS) and psychometric data from administrations of Wechsler Scales and Raven's Matrices to estimate the variable "Learning" for 1990 and for 2016. Their average correlates to NIQ(QNW+SAS) with r = .87 (CI = .82 | .90). NIQ(QNW+SAS) correlates with "Human capital" from the same source at r = .81 (CI: .74 | .86) and NIQ correlates with "Educational attainment" with r = .65 (CI: .54 | .74) [44]. In the second source data for a variable named "Harmonized Learning Outcomes (HLO)" were published, estimated from international and regional assessments [45]. It correlates to NIQ(QNW+SAS) with r = .87 (CI: .83 | .91). For details, see supplementary material.

2.2.2. Winter temperature

A list of the annual and monthly average temperatures by country in °C was taken from www.weatherbase.com [46]. It is based on measurements from 38,348 cities (N_{ctry} = 205). For the variable representing the *winter temperature* we first calculated the 1910-2020 average for each month, then we selected the temperature of the coldest month for each country. We did not focus on a fixed cold season for all countries as geographic positions and differences give each country a specific temperature profile.

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2.2.3. Air pollution

We used data from the WHO for the variable *air pollution* [47]. We took "Ambient air pollution attributable YLLs" standing for premature death lost years of life per capita (population data provided by CIA [48]). Information is given for 183 countries. YLLs directly refer to the amount of life affected by air pollution in health, it is insensitive to regional air pollution and regional population density within the country and also to differences in risk from different types of air pollution.

2.2.4. Wealth

Wealth was taken as average GDP/c in 2017 dollars (purchasing power parity, PPP), source CIA for 204 countries [48]. Finally, GDP/c was logarithmically transformed since the real meaning of an increase in per capita income by a value x can be seen as negatively related to the level of per capita income (hereinafter GDP/c log). That means an increase of average GDP/c from 1,000 dollars to 2,000 dollars means a larger increase in life quality than an increase from 100,000 to 101,000 dollars.

2.2.5. Demographics

Demographics include the *median age* in years (N_{ctry} = 181), the % of a population's *urbanization* (N_{ctry} = 205), given by the CIA [48], based on measurements mostly between 2015 and 2020 (obtained on June the 30th in 2020), and *population density* (capita/km^2; N_{ctry} = 185), taken from the "Coronavirus Pandemic Data Explorer" [49]. The *demographics* variable was built from by averaging numbers for *age*, *urbanization* and *population density* after *z*-standardization.

2.2.6. Health risk

Health risk was measured by five variables: (1) *Cardiovascular diseases death rate* (N_{ctry} = 183), (2) *Diabetes prevalence* (N_{ctry} = 187), (3) share of female and male *smoking* adults (N_{ctry} = 140), all from Our World in Data (2021). The total share of smokers was calculated from the numbers of both sexes on average. (4) The total per capita *alcohol consumption* for individuals 15+ is given in average litres of pure alcohol from 2016 to 2018 (N_{ctry} = 182) [50]. (5) "*Years lived with disability due to cancer*" given for 188 countries as years per 100,000 capita (for the year 2018) [51]. This variable not just reflects cancer per capita but also the severity of the disease. The health risk variable was built from those five variables by averaging after *z*-standardization.

We did not include Vitamin D deficiency in *health risk*, although possibly an important factor according to medical research, as we failed to obtain valid data for a large number of countries. Ilie et al. provided the biggest cross-national dataset findable with just 20 overwhelmingly European countries [20]. Alternatively, it would have been possible to use UV intensity as a proxy for Vitamin D since it is primarily formed by light. The WHO provided exposure to solar ultraviolet radiation data for 192 countries, however, the correlation of these numbers with the *winter temperature* is .85 and thus already covered [52].

2.2.7. Quality of the health system

Two variables indicating the *quality of the health system* were used, calculated from data obtained from The World Factbook of the CIA [48]. First, we calculated current *health expenditure per capita* by multiplying the numbers for current health expenditure as % of annual GDP (N_{ctry} = 186) and GDP/c (PPP). A second variable named *health system quality* was calculated as the average of (1) *physician density* (N_{ctry} = 191), (2) *hospital bed density* (N_{ctry} = 174) and (3) shares of people with access to *improved sanitation* (N_{ctry} = 196). Again, all three variables were *z*-standardized before averaged. Current *health expenditure* reflects the overall strength of a health system, whereas physician and hospital bed density reflect the ability of health facilities to treat seriously ill patients. Access to improved sanitation was added to cover the hygiene standards outside the health system, which are likely to play an important role in disease containment.

2.2.8. Mobility Changes

Mobility changes were measured by the use of Google data [53]. The "COVID-19 Community Mobility Reports" provide daily data about how the movement patterns of societies changed. These numbers were collected and aggregated from data anonymously measured by Google apps and software, e.g., Google Maps. For each day between the 15th of February 2020 and 17th of Mai 2021, data were reported for six categories of movements: (1) retail and recreation, (2) grocery & pharmacy, (3) parks, (4) transit stations, (5) workplaces and (6) residential. A score for each country was calculated by first averaging the daily numbers between 15th of February 2020 and 17th of Mai 2021 within each category, then averaging these six scores again.

The numbers given by the source represent the percentage deviation of mobility on one day compared to average mobility on the same day before the pandemic (3rd of January and 6th of February 2020). Therefore, it is not a measurement of the absolute mobility and also not for the relative mobility by a global standard. However, it reflects the reaction of a population on the pandemic in terms of de- or increasing mobility. A possible weakness is the determination of the baseline based on the data from January to February 2020, as it does not take into account seasonal and weather-related changes in mobility outside of the pandemic. However, it is the most detailed and extensive available database for *mobility*.

2.2.9. SARS-CoV-2 countermeasures

Several countermeasures were implemented by governments during the pandemic, mainly *lockdowns*, *testing* and *vaccinations*. For all, Our World in Data gives daily data between 1st January 2020 and 8th June 2021 [49]. We used daily new *tests per capita* and daily new *vaccinations per capita*, both cumulated across the available time span.[2] Additionally, we used the average of a variable named "*stringency index*", described as a 0-100 score about closures of schools, workplaces or travel bans, representing the lockdown.

2.2.10. COVID-19 data

COVID-19 data should reflect the relative impact of the pandemic in terms of cases of infections and deaths. We used six variables from Our World in Data [49]:

1. The *reproduction rate* (also known as ratio or "R_0").
2. The number of *hospitalized* patients with SARS-CoV-2 per capita.
3. The number of *Intensive Care Unit* (ICU) admissions due to SARS-CoV-2 per capita.
4. The cumulated number of daily new *registered cases* of SARS-CoV-2 per capita.
5. The cumulated number of daily new *registered deaths* attributed to SARS-CoV-2 per capita.
6. The *excess mortality*, which is a measurement of deaths "from all causes during a crisis above and beyond what we would have expected to see under 'normal' conditions."

The *positive rate* ("7-day rolling average of daily cases, divided by the 7-day rolling average of daily test") was also available but not used in this study, as the test coverage is already in use as an independent variable. Table 1 gives a survey of all variables used with information about polarity and usage.

Name	Abbrev.	Polarity (+)	Usage
National level of intelligence	NIQSAS	higher IQs	Ind. var
Winter temperatures	MTEMPL	higher temperatures	Ind. var
Air pollution	APDALY	stronger pollution	Ind. var
Wealth [GDP/c (PPP) log]	GDPLOG	higher wealth	Ind. var
Demographics	DEMOGR	higher vulnerability	Ind. var
Urbanization	URBAN	higher urbanizations	Sub-var.
Median age	MEDAGE	higher median ages	Sub-var.
Population density	POPDEN	higher densities	Sub-var.
Health risk	HEACON	higher burdens	Ind. var.
Cardiovascular diseases death rate	CARDIS	higher death rate	Sub-var.
Diabetes prevalence	DIAPRE	higher prevalence	Sub-var.
Years lived with disab. due to cancer	CADALY	more years with cancer	Sub-var.
% of population smoking	SMOKMF	more smokers	Sub-var.
Alcohol consumption	ALCCON	higher consumption	Sub-var.
Health expand./c (US$)	HEXABS	more expenditures	Ind. var
Health system quality	HESYSQ	better health systems	Ind. var
Physician density	PHYDEN	higher density	Sub-var.
Hospital bed density	HOBDEN	higher density	Sub-var.
% of pop. with improved sanitation	IMPSAN	better sanitation	Sub-var.
Mobility changes	MOBCHA	stronger increases	Ind. var
SARS-CoV-2 tests/kc	TESTPK	more tests	Ind. var
People fully vaccinated/hc	PVACPH	more vaccinations	Ind. var
Political stringency	STRIND	more counter actions	Ind. var
Reproduction rate	COVREP	higher rate	Dep. var.
Hospitalizations/mc	COVHOS	more cases	Dep. var.
Intensive Care Unit treatments/mc	COVICU	more cases	Dep. var.
Regist. cases/mc	COVCAS	more cases	Dep. var.
Regist. deaths/mc	COVDEA	more deaths	Dep. var.
Excess mortality	COVEXM	higher exc. mortality	Dep. var.
Continental affiliation	CONAFF	-	Filter
Statistical capacity	STACAP	-	Filter
GDP/c (PPP)	GDPSTD	-	Filter

Table 1. Overview of variables: names, abbreviations, polarities and hypotheses

Notes. Abbreviation are only used in the appendix and the supplementary material; polarity (+) = higher values represent... .

2.3. Analyses

First, it is important to examine the relationship between the six dependent Corona variables. In theory, these should all represent the impact of the pandemic on health or life expectancy. This check is carried out based on the intercorrelations and by using Kaiser Meyer Olkin test (KMO test) for measurement of sampling adequacy (MSA). Based on these results, factor scores should also be formed from all or a selection of dependent variables for an overall COVID variable that summarizes measures of similar aspects of pandemic impact.

To estimate the impact of intelligence on the effects of the pandemic after accounting for other factors, we first conducted multivariate regression analyses with six linear models, each containing one of the six Corona variables (*reproduction rate*, *hospitalized/c*, *Intensive Care Unit treatments/c*, *registered cases/c*, *registered deaths/c*, *excess mortality*) as a dependent variable and 12 independent variables (see: Table 1).

Results will be presented as standardized regression coefficients (β) and *p*-values. However, all analyses were done in naturally limited samples (countries of the world). No sample to population inferences have to be tested (if at all possible by significance testing). Additionally, the probability of type II errors would be high [54][55][56][57]. Instead, we followed a recommendation by Wasserstein et al. by testing the robustness of effects in several analyses with different sub-samples [58].

Each of the six models was run on three different datasets: for *2020/21* (full data set), for *2020* only and for *2021* only. Variables as INTERAKTION and GDP/c (per capita) remained the same, but *mobility changes*, *tests/c*, *vaccinations/c* and *stringency* as well as all six dependent variables varied with chosen time. For the 2020 dataset, *vaccinations/c* cannot be used (vaccinations in December 2020).

From each of the three different datasets, six sub-samples were created: The first subsample contains only countries from the (1) *northern*, and the second subsample only countries from the (2) *southern hemisphere*. Countries at the southern hemisphere strongly differ from the northern counterparts in terms of climatic conditions and may be affected by *SARS-CoV-2* in different ways or times. The third and fourth subsamples distinguish between countries with above and below average trustworthiness of data, in other words: (3) *high* and (4) *low data quality*. For this purpose, we used the global mean (65.18) of the 2019 Statistical Capacity Indicator scores from the World Bank, which estimated the capacity of a country's statistical system based on "methodology; data sources; and periodicity and timeliness". Similarly, subsamples five and six distinguish between countries with (5) above and (6) below average wealth (*rich* and *poor*) along the mean of non-logarithmized GDP/c (PPP) (22043.63 US$) [59]. The strong impact of SARS-CoV-2 on rich compared with poor countries, especially early in the pandemic, suggests that other factors may be operating along this fault line, such as international travel, which are not accounted for in our models and whose potential impact could be partially reduced by differentiation.

At the end, there are six models (one for each dependent variable) on three datasets (2020, 2020/21, 2021) and seven samples (full and six (sub-)samples), resulting in 126 effect tests of *intelligence* on the pandemic impact. These effects should be moderate or strong and reproducible in most (sub)samples to be recognized as robust. Also, the amount of explained variances should be high enough ($R^2 \geq .26$ according to Cohen [60]). However, reducing data to limited time periods and creating smaller subsamples may result in a high proportion of missing data for one or more variables. This could be countered by adjusting the variables of the models, but this would affect the comparability of the results. We decided to leave the models unchanged and instead include models whose results are doubtful only to a limited extent in our study.

For path analysis, we constructed a model that includes mediators between intelligence and *Total-COVID*. Effects $\gamma_{Int.\rightarrow Tot.Cov.}$, $\gamma_{Win.Temp.\rightarrow Tot.Cov.}$ and $\gamma_{Air.Pol.\rightarrow Tot.Cov.}$ are included from the start without any interactions, as *winter temperature* and *air pollution* are seen as completely independent from a population's *intelligence*. Further variables were integrated as mediators between intelligence and *Total-COVID* (Figure 1). Indirect effects of *intelligence* on *Total-COVID* were supposed along each variable associated with health, including vaccinations/c except health risk. In parallel, indirect effects of intelligence on those variables along *wealth* and *health expenditures* were added to reflect the Cognitive Capital theory (Rindermann, 2018). *Demographics* (age, urbanization and population density) is supposed to be a mediator between *wealth* and *health risk*, as higher wealth decreases mortality and thus affecting median ages and prevalences of diseases. Similarly, *health expenditures* were supposed to mediate the effect of *wealth* on the *health system quality*, which, in turn, is supposed to increase the capacities for *vaccinations* and *testing*. *Stringency* and *mobility changes* are supposed to mediate the effect of *intelligence* as both are results of rational thinking and appropriate reactions of a society to deal with a pandemic. Both variables are connected as more restrictions should decrease the mobility. *Total-COVID* is directly affected by *intelligence*, *wealth*, the *health system quality*, *vaccinations/c*, *stringency* and *mobility changes*, but also by *tests/c*, as higher test coverage could increase registered cases and deaths by sampling errors. All individual paths and their coefficients can be criticized. However, details of the model should not be considered too rigorously, as we were only interested in the general sum effect of intelligence relative to climate and air pollution.

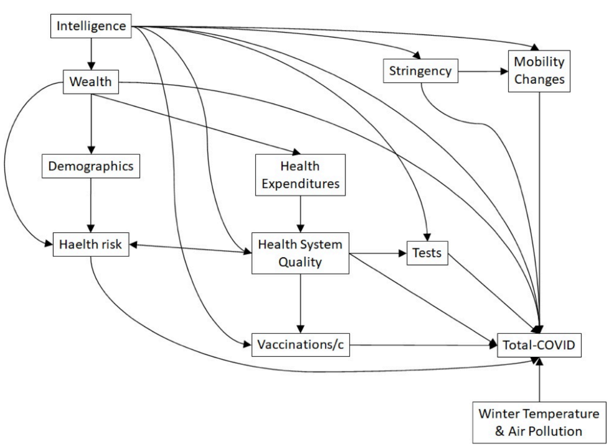

Figure 1. Theoretical model of direct and indirect effects of intelligence in the pandemic's impact, controlled for winter temperature and air pollution

We also plan to additionally test the validity of our findings by replacing the variable intelligence in the path model with the alternative measures by Lim et al. [44] and Angrist et al. [45]. We also replace intelligence with two education variables to check whether any effects found are not pure education effects. These are *education expenditures (% of GDP)* and *school life expectancy (primary to tertiary education)*, both derived from the CIA [48] from an older (2017) and a current version of that source. Numbers from the older and the current version were averaged or imputed to increase the number of observations.

All analyses were done (by David Becker) with R (version 4.0.0, R Foundation for Statistical Computing, 2020). For the KMO test the package Psych (version 2.1.6) was used. Multivariate regression analyses were done by using Lavaan-package version 0.6-7. The command "std.ov" was set to TRUE to standardize all observed variables before entering the analysis. Missing data were treated by Full Maximum Likelihood (command: missing = "FIML"; i.e. all given data were used) and the default model estimator Maximum Likelihood (command: estimator = "ML") was used. Factor scores were estimated by using the command lavPredict (method = "regression") from models ran with settings identical to those from multivariate regression analyses (above).

Table 1 provides an overview of all variables. Data files, R syntaxes (commands only) and R outputs (commands and results) can be found in the supplementary material. Files ending on "01" are for the full timespan, "0" is for 2000 only and "1" for 2021 only. Abbreviations of variables are also displayed in Table 1. Subsamples are named "DATAHEMAFFN" and "DATAHEMAFFS" for northern and southern countries, "DATASTACAPH" and "DATASTACAPL" for countries with high and low data quality, and "DATGDPSTDH" and "DATAGDPSTDL" for rich and poor countries. The supplementary material also includes data from Lim et al. (2018) (LIMHC3, LIMYL3, LIMHS3, LIMEA3, LIMLE3) and Angrist et al. (2021) (TWBHLO), used to check the validity of *National level of intelligence* (see 2.1.1).

3. Results

Intercorrelations within the six dependent Corona-variables (see Table 2) are usually positive. The mean correlations for 2020, 2020/21 and 2021 are $r = .53$ ($SD = .24$; $Min. = .17$; $Max. = .90$), .48 ($SD = .25$; $Min. = .05$; $Max. = .68$) and .41 ($SD = .32$; $Min. = -.06$; $Max. = .50$). Running KMO tests gives overall *MSAs* of .42 ($MSAI \geq .18$), .52 ($MSAI \geq .33$) and .43 ($MSAI \geq .04$), rather indicating unrelatedness between these six variables. However, theoretically related variables mostly show very strong correlations, as *hospitalizations/c* and *Intensive Care Unit treatments/c* ($r = .86$; .75; .78) or *registered deaths/c* and the *excess mortality rate* ($r = .90$.; .68; .47). As these two groups of variables are also mostly strong correlated, we repeated the KMO test with *hospitalizations/c*, *Intensive Care Unit treatments/c*, *registered deaths/c* and *excess mortality* only and gained much higher .72 ($MSAI \geq .66$), *MSAs* of .83 ($MSAI \geq .78$) and .60 ($MSAI \geq .52$), now indicating relatedness between these four variables. Heterogeneity is therefore also evident in the correlations between intelligence and Corona variables, which are neither uniform across Corona variables nor robust over time. However, the correlations are similar for *hospitalizations/c* and *Intensive Care Unit treatments/c* as well as for *registered cases* and *deaths/c*.

Factor scores for a *Total-COVID*-variable were generated via regression by using the four dependent variables with high measurement of sampling adequacy. For the full dataset, the goodness of model fits is mostly perfect with $CFI = 1.000$, $TLI = 1.001$, $RMSEA = .000$. Only *SRMR* is questionable with .158. *Total-COVID*-scores were generated for 184 countries. λ were high, with .87 ($R^2 = .76$) for *hospitalizations/c*, .95 ($R^2 = .90$) for *ICU treatments/c*, .91 ($R^2 = .91$) for *registered deaths/c* and .68 ($R^2 = .68$) for *excess mortality*. Fits are worse if 2020 data were used only but improved for 2021 data only ($CFI = .929$, 1.000; $TLI = .788$, 1.036; $RMSEA = .208$, .000; $SRMR = .433$, .111). λ and R^2 are similar, however much higher for 2020 compared to 2021 for *excess mortality* ($\lambda_{Hosp.} = .89$ and .89, $R^2_{Hosp.} = .79$ and .80; $\lambda_{ICU} = .91$ and .89, $R^2_{ICU} = .82$ and .80; $\lambda_{Reg.Dea.} = 96$ and .95, $R^2_{Reg.Dea.} = .93$ and .90; $\lambda_{Exc.Mort.} = .87$ and .42, $R^2_{Exc.Mort.} = .76$ and .18). Nevertheless, as the results from the KMO test (first paragraph) were satisfying also for 2021, we calculated *Total-COVID*-factor scores for this time period the same way as for 2020 and 2020/21.

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		Rep. rate	Hosp./c	ICU/c	R. cas./c	R. dea./c	Ex. mrt.	Intelligence
2020/21	Rep. rate		.18	.32	.28	.29	.14	.20
	Hosp./c	.348		.75	.41	.74	.60	−.40
	ICU/c	.131	<.001		.52	.79	.77	−.33
	R. cas./c	<.001	.026	.012		.66	.05	.41
	R. dea./c	<.001	<.001	<.001	<.001		.68	.28
	Ex. mrt.	.211	.001	<.001	.663	. <.001		−.37
	Intelligence	.017	.030	.122	<.001	.001	.001	
2020	Rep. rate		.48	.48	.20	.17	.20	−.18
	Hosp./c	.012		.86	.52	.82	.68	.04
	ICU/c	.032	<.001		.56	.83	.64	.17
	R. cas./c	.010	.007	.011		.35	.33	.19
	R. dea./c	.027	<.001	<.001	<.001		.90	.13
	Ex. mrt.	.070	<.001	.002	.002	<.001		−.19
	Intelligence	.037	.828	.465	.158	.128	.083	
2021	Rep. rate		−.04	−.06	.17	.08	.16	.13
	Hosp./c	.854		.78	.43	.87	.68	−.39
	ICU/c	.780	<.001		.50	.81	.70	−.34
	R. cas./c	.024	.021	.016		.63	−.01	.46
	R. dea./c	.290	<.001	<.001	<.001		.47	.29
	Ex. mrt.	.189	<.001	<.001	.906	<.001		−.60
	Intelligence	.125	.035	.113	<.001	<.001	<.001	

Table 2. Correlations (and in parentheses p-values) between intelligence and dependent variables for 2020/21, 2020 and 2021

Note. All countries included. Rep. rate: reproduction rate; Hosp./c: hospitalized patients with COVID per capita; ICU/c: intensive care unit admissions due to COVID per capita; R. cas./c: daily new registered cases of COVID per capita; R. dea./c: daily new registered deaths attributed to COVID per capita; Ex. mrt.: excess mortality.

Tables 3 through 8 summarize the statistical effects of intelligence on COVID measures for all 126 model runs (see tables R1 to R18 in the appendix for detailed model results). From 39 runs, no results were reported due to large proportions of missing values, especially for the dependent variables *hospitalizations/c* and *Intensive Care Units treatments/c*. Additionally 16 analyses must be assessed as doubtful due to excessive multicollinearity (generating $\beta < 1.00$). In the further course we will completely ignore all 55 model runs with missing or dubious results and focus on the 73 remaining runs (~58%) only. The criterion of $R^2 \geq .26$ is met in all those runs.

Samples	2020			2020/21			2021		
	ß	*S.E.*	R^2	*ß*	*S.E.*	R^2	*ß*	*S.E.*	R^2
All countries	−.53*	0.149	.31	−.01	0.150	.41	.29*	0.148	.27
North. Hemis.	−.54*	0.164	.33	−.05	0.176	.45	.35*	0.156	.34
South. Hemis.	n.r.	n.r.	n.r.	d.r.	d.r.	d.r.	d.r.	d.r.	d.r.
High Data Qual.	−.42*	0.162	.43	−.12	0.114	.62	.10	0.145	.37
Low Data Qual.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	d.r.	d.r.	d.r.
Rich	−.90*	0.280	.52	−.14	0.302	.63	−.78*	0.359	.39
Poor	−.33*	0.140	.37	−.02	0.155	.41	.24	0.140	.32

Table 3. Survey of effects of intelligence on reproduction ratein six samples per three time spans

Notes. β = standardized regression coefficients for *intelligence* controlled by 11 to 12 variables on *reproduction rate* (see tables R1 to R18 for detailed model information), *S.E.* = standard errors for *B* of *intelligence*, R^2 = explained variance in *reproduction* rate by all independent variables; n.r. = no results, d.r. = dubious results; * $p \leq .05$.

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Samples	2020			2020/21			2021		
	ß	*S.E.*	R^2	*ß*	*S.E.*	R^2	*ß*	*S.E.*	R^2
All countries	−.02	0.822	.89	d.r.	d.r.	d.r.	d.r.	d.r.	d.r.
North. Hemis.	.01	0.829	.91	d.r.	d.r.	d.r.	d.r.	d.r.	d.r.
South. Hemis.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
High Data Qual.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r,	n.r.	n.r.	n.r.
Low Data Qual.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
Rich	d.r.	d.r.	d.r.	−.23	0.514	.93	.20	0.415	.89
Poor	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.

Table 4. Survey of effects of intelligence on hospitalizations/c in six samples per three time spans

Notes. β = standardized regression coefficients for *intelligence* controlled by 11 to 12 variables on *hospitalized individuals/c* (see tables R1 to R18 for detailed model information), *S.E.* = standard errors for *B* of *intelligence*, R^2 = explained variance in *hospitalized individuals/c* by all independent variables; n.r. = no results, d.r. = dubious results; * $p \leq .05$.

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Samples	2020			2020/21			2021		
	ß	*S.E.*	R^2	*ß*	*S.E.*	R^2	*ß*	*S.E.*	R^2
All countries	d.r.	d.r.	d.r.	−.95	0.872	.84	−.38	0.913	.73
North. Hemis.	−.41	1.046	.94	−.96	0.884	.84	−.39	0.921	.75
South. Hemis.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
High Data Qual.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
Low Data Qual.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
Rich	d.r.	d.r.	d.r.	−.46	0.533	.88	−.21	0.599	.78
Poor	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.

Table 5. Survey of effects of intelligence on ICU treatments/c in six samples per three time spans

Notes. β = standardized regression coefficients for *intelligence* controlled by 11 to 12 variables on *ICU/capita* (see tables R1 to R18 for detailed model information), *S.E.* = standard errors for *B* of *intelligence*, R^2 = explained variance in *ICU/c* by all independent variables; n.r. = no results, d.r. = dubious results; * $p \leq .05$.

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Samples	2020			2020/21			2021		
	ß	*S.E.*	R^2	*ß*	*S.E.*	R^2	*ß*	*S.E.*	R^2
All countries	−.18	0.134	.28	−.17	0.110	.55	−.16	0.117	.50
North. Hemis.	−.24	0.147	.30	−.18	0.120	.53	−.17	0.127	.48
South. Hemis.	d.r.	d.r.	d.r.	n.r.	n.r.	n.r.	−.52*	0.217	.93
High Data Qual.	.22	0.151	.49	−.08	0.105	.69	−.15	0.124	.65
Low Data Qual.	n.r.	n.r.	n.r.	.06	0.126	.97	d.r.	d.r.	d.r.
Rich	d.r.	d.r.	d.r.	−.51	0.300	.43	−.35	0.278	.46
Poor	.19	0.142	.50	−.02	0.084	.71	−.01	0.097	.70

Table 6. Survey of effects of intelligence on registered cases/cin six samples per three time spans

Notes. β = standardized regression coefficients for *intelligence* controlled by 11 to 12 variables on *registered cases/capita* (see tables R1 to R18 for detailed model information), *S.E.* = standard errors for *B* of *intelligence*, R^2 = explained variance in *registered cases/c* by all independent variables; n.r. = no results, d.r. = dubious results; * $p \leq .05$.

Samples	2020			2020/21			2021		
	ß	S.E.	R^2	ß	S.E.	R^2	ß	S.E.	R^2
All countries	.11	0.152	.27	−.08	0.123	.30	−.14	0.123	.31
North. Hemis.	.16	0.159	.39	−.13	0.124	.40	−.13	0.125	.38
South. Hemis.	d.r.	d.r.	d.r.	−.01	1.568	.49	d.r.	d.r.	d.r.
High Data Qual.	.31	0.189	.32	.03	0.135	.37	−.04	0.132	.43
Low Data Qual.	n.r.	n.r.	n.r.	−.44	0.455	.51	d.r.	d.r.	d.r.
Rich	−.42	0.268	.49	.18	0.269	.51	.31	0.270	.45
Poor	.10	0.142	.27	−.02	0.106	.38	−.07	0.107	.42

Table 7. Survey of effects of intelligence on registered deaths/cin six samples per three time spans

Notes. β = standardized regression coefficients for *intelligence* controlled by 11 to 12 variables on *registered deaths/c* (see tables R1 to R18 for detailed model information), *S.E.* = standard errors for *B* of *intelligence*, R^2 = explained variance in *registered deaths/c* by all independent variables; n.r. = no results, d.r. = dubious results; * $p \leq .05$.

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Samples	2020			2020/21			2021		
	ß	*S.E.*	*R²*	*ß*	*S.E.*	*R²*	*ß*	*S.E.*	*R²*
All countries	−.22	0.276	.37	−.27	0.263	.31	−.40	0.326	.65
North. Hemis.	−.71*	0.242	.61	−.77*	0.275	.41	−.50*	0.342	.80
South. Hemis.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
High Data Qual.	.20	0.254	.53	.00	0.275	.44	.09	0.431	.80
Low Data Qual.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
Rich	−.06	0.280	.69	.04	0.280	.69	.21	0.323	.52
Poor	−.04	0.263	.65	−.18	0.303	.64	n.r.	n.r.	n.r.

Table 8. Survey of effects of intelligence on excess mortality in six samples per three time spans

Notes. β = standardized regression coefficients for *intelligence* controlled by 11 to 12 variables on *excess mortality rate* (see tables R1 to R18 for detailed model information), *S.E.* = standard errors for *B* of *intelligence*, R^2 = explained variance in *excess mortality rate* by all independent variables; n.r. = no results, d.r. = dubious results; * $p \leq .05$.

Within the 15 valid results for *reproduction rate*, there are 11 negative and 4 positive effects, or 8 negative and 1 positive within the 9 significant results ($p \leq .05$). Only in the subsample *Rich* there is a temporal robust negative effect of β_{20} = −.90 (*p* = .003), $\beta_{20|21}$ = −.14 (*p* = .682) and β_{21} = −.78 (*p* = .045). In all other subsamples, the operator changed from − to +. Thus, across five subsamples, there is a mean β_{20} of −.54 (*SD* = .19), a mean $\beta_{20|21}$ of −.07 (*SD* = .05) and a mean β_{21} of .04 (*SD* = .42). Only 4 results are valid for *hospitalizations/c*: two β_{20} with no effect, one $\beta_{20|21}$ with a negative effect and one β_{21} with a positive effect. The mean β across the 4 valid results is -.01 (*SD* = .15). Similarly, only 7 results are valid for *Intensive Care Unit treatments/c*: 2 for *all* countries, 3 for *northern* countries and another 2 for *rich* countries. Significance is gained by none of the effects, but operators are consistently negative across time and subsamples. The mean β across the 7 valid results is −.53 (*SD* = .27). There are 13 negative and 3 positive valid effects for *registered cases/c* with a mean β = −.14 (*SD* = .20). Robustness across our three time intervals was found for *all*, *northern* and *rich* countries[3], and a mean β_{20} = .00 (*SD* = .21), a mean $\beta_{20|21}$ = −.15 (*SD* = .18) and a mean β_{21} = −.23 (*SD* = .16). There are 17 valid results for *registered deaths/c*, but operators changed frequently, so the mean β is −.02 (*SD* = .20). There is no robustness in any (sub-)sample and the mean β_{20} is .05 (*SD* = .25), the mean $\beta_{20|21}$ is −.07 (*SD* = .18) and the mean β_{21} is −.01 (*SD* = .17). The 14 valid results for *excess mortality* showed 9 negative operators, 4 positive operators and a mean β of −.19 (*SD* = .30). Temporal robustness of negative effects is obtained for *all* and *northern* countries. In the latter case, significance is gained throughout with β_{20} = −.71 (*p* = .002) , $\beta_{20|21}$ = −.77 (*p* = .004) and β_{21} = −.50 (*p* = .033). The mean β_{20} is −.17 (*SD* = .30), the mean $\beta_{20|21}$ is −.24 (*SD* = .29) and the mean β_{21} is −.15 (*SD* = .31).

Summarizing all 73 valid results, there is a mean β of −.16 (*SD* = .30), a mean β_{20} of −.17 (*SD* = .32), a mean $\beta_{20|21}$ of −.20 (*SD* = .29) and a mean β_{21} is −.11 (*SD* = .29). Averaging β for (sub-)samples across time and dependent variables gives a mean of −.21 (*SD* = .28) for *all* countries, −.29 (SD = .34) for the *northern* hemisphere, −.27 (SD = .26) for the *southern* hemisphere, .01 (SD = .19) for countries with *high data quality*, −.19 (SD = .28) for countries with *low data quality*, −.21 (SD = .35) for *rich* countries and −.01 (SD = .15) for *poor* countries.

	Effect on *Total-COVID*	2020	2020/21	2021
a.	$\gamma_{Int.\rightarrow Tot.Cov.}$	.08	−.18	−.21
b.	$\gamma_{Int.\rightarrow Mob.Cha.\rightarrow Tot.Cov.}$	−.01	.01	.04
c.	$\gamma_{Int.\rightarrow Vacc.\rightarrow Tot.Cov.}$	excl.	.00	.00
d.	$\gamma_{Int.\rightarrow Wealth\rightarrow Tot.Cov.}$	.03	.06	−.05
e.	$\gamma_{Int.\rightarrow Hea.Qual.\rightarrow Tot.Cov.}$	−.10	.07	.18
f.	$\gamma_{Int.\rightarrow Hea.Qual.\rightarrow Vacc.\rightarrow Tot.Cov.}$	excl.	−.01	.00
g.	$\gamma_{Int.\rightarrow Wealth\rightarrow Hea.Exp.\rightarrow Hea.Qual.\rightarrow Tot.Cov.}$	−.01	.01	.03
h.	$\gamma_{Int.\rightarrow Wealth\rightarrow Hea.Exp.\rightarrow Hea.Qual.\rightarrow Vacc.\rightarrow Tot.Cov.}$	excl.	.00	.00
i.	$\gamma_{Int.\rightarrow Tests\rightarrow Tot.Cov.}$	−.01	−.01	.01
j.	$\gamma_{Int.\rightarrow Wealth\rightarrow Hea.Exp.\rightarrow Hea.Qual.\rightarrow Tests\rightarrow Tot.Cov.}$	.00	.00	.00
k.	$\gamma_{Int.\rightarrow String.\rightarrow Tot.Cov.}$	.11	.00	.05
l.	$\gamma_{Int.\rightarrow String.\rightarrow Mob.Cha.\rightarrow Tot.Cov.}$	−.07	.01	.02
m.	$\gamma_{Int.\rightarrow Hea.Qual.\rightarrow Hea.Con.\rightarrow Tot.Cov.}$	−.05	.02	.06
n.	$\gamma_{Int.\rightarrow Wealth\rightarrow Hea.Exp.\rightarrow Hea.Qual.\rightarrow Hea.Con.\rightarrow Tot.Cov.}$	−.01	.00	.01
o.	$\gamma_{Int.\rightarrow Wealth\rightarrow Demog.\rightarrow Hea.Con.\rightarrow Tot.Cov.}$	.00	.00	.00
p.	$\gamma_{Int.\rightarrow Wealth\rightarrow Hea.Con.\rightarrow Tot.Cov.}$	.00	.00	.00
I.	$Total\gamma_{Int\rightarrow Tot.Cov.}$	−.06	−.01	.14
II.	$Total\gamma_{Int\rightarrow BEHAVIOR\rightarrow Tot.Cov.}$	.03	.02	.11
III.	$Total\gamma_{Int\rightarrow ECONOMICS\rightarrow Tot.Cov.}$	.00	.08	−.01
IV.	$Total\gamma_{Int\rightarrow HEALTH\rightarrow Tot.Cov.}$	−.15	.09	.24
V.	$Total\gamma_{Int\rightarrow ECONOMICS+HEALTH\rightarrow Tot.Cov.}$	−.14	.17	.22
	Control: $Total\gamma_{Win.Temp.+Air.Pol.\rightarrow Tot.Cov.}$	−.37	−.52	−.26
	CFI	.776	.786	.798
	TLI	.655	.680	.697
	RMSEA	.166	.148	.144
	SRMR	.116	.100	.098
	R^2	.259	.258	.224

Table 9. Survey of direct and indirect effects of intelligence on Total-COVID in three time spans

Notes. γ = multiplied βs, Totalγ = summed γ (BEHAVIOR = b, k, l; ECONOMICS = d, g, h, j, n, o, p; HEALTH = c, e, f, m; excl. = variable *vaccinations/c* excluded in 2020 due to missing data.

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Table 9 shows results from path analyzes using the theoretical model from Figure 1 and *Total-COVID*-factor scores as dependent variables. Direct and indirect effects[4] of intelligence on *Total-COVID* from the three runs are summarized in the Table 9 (a-p). These effects where summed to a total effect along all paths (I.) and four partial total effects along a certain category of variables: (II.) BEHAVIOR by the indirect effects of *intelligence* with *mobility changes* and/or *stringency*; (III.) ECONOMICS by all indirect effects of *intelligence* along *wealth*; (IV.) HEALTH by all indirect effects of *intelligence* along *health expenditures*, *health system quality* and *vaccinations/c* but without *Wealth*; (V.) ECONOMICS+HEALTH as the sum of III. and IV. Fits indicate an insufficient model fit to the actual data structure, but at a similar level for all three time periods. R^2 are .26 for 2020 and 2020/21 and sufficient according to Cohen (1988, p. 80), but only .22 for 2021. On average, the models were able to explain around one quarter of the variance in *Total-COVID*.

A robust pattern of polarity reversal from 2020 to 2021 can be found for the direct (a.), the total (I.) and two of the partial total effects along HEALTH (IV.) and ECONOMICS+HEALTH (V.) variables. There is no such polarity reversal found for the partial total effect along BEHAVIOR (II.) but an increase, whereas the effect along ECONOMICS alone (III.) stayed below .10. In summary, even if there are similar R^2 across all three observed time spans, the effect pattern for *intelligence* became more or less completely inverted from 2020 to 2021. The strongest effect on *Total-COVID* is the combined total effect of *winter temperature* and *air pollution* ($\text{Total}\gamma_{2020}$ = -.37; $\text{Total}\gamma_{2020/21}$ = -.52; $\text{Total}\gamma_{2021}$ = -.26), whose direction is also robust over the time periods. The results are summarized in Figure 2.

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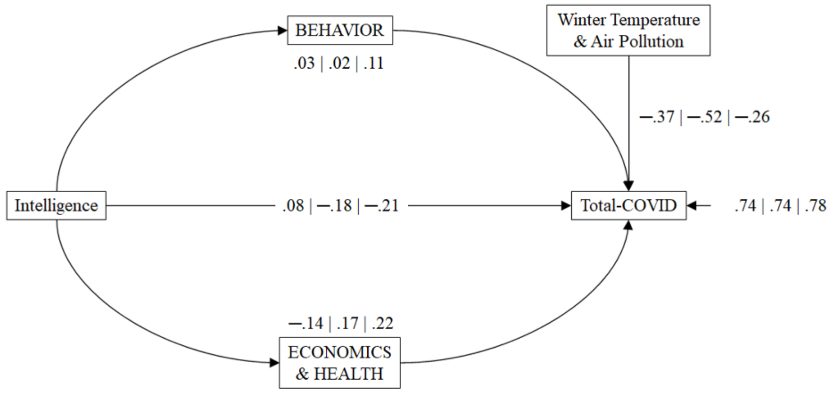

Figure 2. Summarized effects of intelligence on pandemic's impact along a direct and two indirect macro-paths along behavior (e.g., mobility) and economics (e.g., wealth) & health (e.g., vaccination, conditions). Numbers: left = 2020, center = 2020/21, right = 2021; residual variances for Total-COVID at the right.

The two alternative cognitive ability data sources and the two educational variables were also used to test the stability of the effects [44][45][48]. Beta-coefficients and explained variances of *Total-COVID* were rather similar in case of using alternative cognitive ability data. For example, with our data and measures the direct effect of *intelligence* was for the combined period 2020/21 on *Total-COVID* $\gamma_{\text{Int.}\rightarrow\text{Tot.Cov.}}$ = -.18, with the Lim measure (*Learning*) the effect was $\gamma_{\text{Int.}\rightarrow\text{Tot.Cov.}}$ = -.24 and with the Angrist measure (*Harmonized Learning Outcome*) $\gamma_{\text{Int.}\rightarrow\text{Tot.Cov.}}$ = -.20. In contrast, no or much weaker effects on *Total-COVID* were found when replacing *intelligence* with educational variables, in detail: for *Education Expenditures (% of GDP)* the effect was $\gamma_{\text{EE.}\rightarrow\text{Tot.Cov.}}$ = -.07 and for *School Life Expectancy (primary to tertiary education)* the effect was $\gamma_{\text{SLE.}\rightarrow\text{Tot.Cov.}}$ = .02. However, except for *Education Expenditures (% of GDP)*, there is the same polarity reversal in the direct and total effect on *Total-COVID* from 2020 to 2021 as shown in Table 9.

In summary, there is some evidence for a statistically reducing impact of cognitive ability (intelligence) on Corona for the long term, but which cannot be explained by behavior (e.g., mobility), health (e.g., vaccinations, health conditions) or economics (e.g., wealth). On the contrary: Along pandemic related behavior (mobility and government measures to combat the pandemic) and health (conditions, system, vaccination and testing), higher cognitive ability is indirectly associated with a more severely affectation by Corona.

Limitations: First, due to a high failure and error rate of the models no statements can be made about *hospitalizations/c* and *Intensive Care Unit treatments/c*. The models for *reproduction rate*, *registered cases/c* or *deaths/c* and *excess mortality* resulted mainly in negative effects, however, robustness was limited. The results suggest that there are two opposing effects of intelligence that cancel each other out.

4. Discussion

Our results provide preliminary evidence that, during the observed period, the intelligence of a population had a direct reducing effect on the impact of the pandemic which can hardly be explained by existing theories. Initially, we hypothesized a reducing impact of intelligence on Corona based on two causal effects:

Intelligence increases insight, knowledge and the ability to react in a rational way to new challenges. This at the individual and societal level (e.g., by social distancing or establishing rules for isolation of infected persons).

Intelligence helps to improve the environment being beneficial for avoiding risks and recovering health (e.g., better health system).

However, these two causal effects seem to do exactly the opposite and could, albeit in an unknown way, explain why societies with higher cognitive abilities are more strongly affected by the pandemic.

The second option might get some evidence from the direct reducing effect of cognitive ability and could possibly be explained as follows: Protecting oneself from diseases is to be rated as highly rational, but all measures against Corona may also have negative side effects. Lockdowns damage the economy, school closings will reduce in the long run economic growth, both leading to higher mortality rates. SARS-CoV-2 infection has no serious health consequences for the vast majority of people and especially for younger and healthy individuals, but the lockdowns certainly have negative consequences for everyone, for prosperity, quality of life, psychological well-being and physical health (e.g., due to less contact, less sports etc.). Individual considerations of pandemic risks on the one hand and economic constraints on the other can vary widely, being influenced, for example, by a person's age and health status and thus vulnerability to Corona or their current economic situation and activity. Thus, higher cognitive abilities produce disease-protective behavior only as long as it does not lead to damage in other ways, e.g. economically.

Overall, however, our results for the IQ-Corona relationship also show that intelligence does not appear to be a panacea for preventing or mitigating all disasters. Complex mechanisms, the difficulty of making reliable predictions and the increased vulnerability of societies due to changes in living conditions and demographics (age, urbanization and population density) caused by high levels of intelligence and wealth lead to a mixture of indirect and direct COVID decreasing and increasing effects of a population's cognitive ability level.

5. Conclusion

Previous findings showed a significant negative impact of IQ on the prevalence and severity of infectious diseases. Specifically, hygiene and health technologies, as well as rational behavior in dealing with health problems, were considered possible mediators. We were able to underpin these assumptions in the context of the Corona pandemic in some ways, however we also found positive effects mediated along wealth and country's level of development.

6. Limitations and suggestions

At the time of finishing this manuscript the SARS-CoV-2-pandemic was still going on. We already saw a change in the global pattern from the first to the second and third wave, for example an increasing impact in developing countries [61][62][63][64]. This is also reflected in our results and could be the reason for the low robustness over time. Further research should analyze the possible impact of intelligence on the Corona pandemic in further waves. Furthermore, it cannot be ruled out that, in addition to intelligence [65][66], genes may also be relevant for susceptibility to corona virus. Furthermore, in addition to the broad country level, a more focused regional level within a country is also important.

Statements & Declarations

Ethics approval: This study is a cross-national study at an aggregated level and thus did not involve human participants, their data or biological material. All data were taken from freely accessible databases. An ethics approval is therefore not considered necessary by the authors.

Consent to participate: As no individual data from human participants has been used for this study, no consent to participate was obtained.

Consent to publish: As no individual data from human participants has been used for this study, no consent to publish was obtained.

Availability of data and material: All data were taken from freely accessible databases (in order of appearance):

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- WHO. Weekly epidemiological update on COVID-19 - 29 June 2021. 2020. https://www.who.int/publications/m/item/weekly-epidemiological-update-on-covid-19---29-june-2021
- WHO. Scaling Up, Saving Lives - Task force for scaling up education and training for health workers, Global Health Workforce Alliance. 2008. https://www.who.int/workforcealliance/documents/Global_Health_FINAL_REPORT.pdf?ua=1
- Becker D. A corrigendum to V1.3.2 and a comment to V1.3.3. 2019. https://viewoniq.org/?p=134
- CantyMedia. Weatherbase. 2020. http://www.weatherbase.com/weather/countryall.php3
- WHO. Air pollution. 2020. https://www.who.int/health-topics/air-pollution#tab=tab_1
- CIA. The world fact book. 2020. https://www.cia.gov/library/publications/the-world-factbook
- Our World in Data. Coronavirus pandemic data explorer. 2021. https://ourworldindata.org/coronavirus-data-explorer?zoomToSelection=true&time=2020-03-01..latest&country=~IND&region=World&casesMetric=true&interval=smoothed&perCapita=true&smoothing=7&pickerMetric=population_density&pickerSort=asc
- WHO. Alcohol, recorded per capita (15+) consumption (in litres of pure alcohol), three-year average with 95%CI. 2020. https://www.who.int/data/gho/data/indicators/indicator-details/GHO/alcohol-recorded-per-capita-(15-)-consumption-(in-litres-of-pure-alcohol)-three-year-average-with-95-ci
- Cancer Atlas. Cancer deaths attributable to alcohol. 2020. https://canceratlas.cancer.org/data/map
- WHO. Global Health Observatory data repository. 2021. https://apps.who.int/gho/data/view.main.35300
- Google. The COVID-19 community mobility reports. 2021. https://www.google.com/covid19/mobility

The database for all calculations was included as supplementary material.

Competing interests: The corresponding author (David Becker) confirms on behalf of all authors that there are no conflicts of interest.

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Author contributions: All authors contributed to the study significantly. Idea, monitoring, coordination and advice by Heiner Rindermann. Claudia Kiel was responsible for collecting and processing the data. David Becker did the analyzes and wrote the manuscript.

Footnotes

[1] One quote from Miles et al. (2020, p. 2) highlights the negative consequences of the prevailing lockdown response to the Corona pandemic: "There is a need to normalise how we view COVID-19 because its costs and risks are comparable to other health problems (such as cancer, heart problems, diabetes) where governments have made resource decisions for decades. ... Movement away from blanket restrictions that bring large, lasting and widespread costs and towards measures targeted specifically at groups most at risk is prudent." [67]

[2] Variables were given differently as per capita, per thousand capita or per million capita. Since this distinction is irrelevant for regression-based methods, we will only speak of "per capita" or "/c" in the following text and tables, except descriptive statistics.

[3] All coefficients were negative: β for „all" = −.18, −.16 and −.17, for „northern" = −.24, −.18 and −.17, for „rich" = (−1.17), −.51 and −.35.

[4] Multiplied β -coefficients along a concatenation of multiple direct paths (γ)

Appendix

Independent variables	2020		2020/21		2021	
	ß	R^2	ß	R^2	ß	R^2
Intelligence	.08	.259	−.18	.258	−.21	.224
	.03		.02		.11	
	−.14		.17		.22	
Learning	.03	.255	−.24	.248	−.19	.219
	.01		.00		.08	
	−.12		.14		.22	
Hrm. learn. out.	−.01	.252	−.20	.258	−.21	.222
	.04		.02		.10	
	−.09		.18		.22	
Ed. exp. %GDP	−.05	.271	−.07	.233	−.07	.181
	−.01		−.02		.01	
	−.01		.11		.03	
School life exp.	.11	.264	.02	.267	−.06	.214
	.08		.03		.10	
	−.10		.06		.12	

Table 10. Survey of direct and indirect effects of intelligence, alternative measurements and education system on Total-COVID compared

Notes. β = standardized regression coefficients for independent variables, upper value: direct effects, mid value: indirect along behavior (e.g., mobility), lower value: indirect along economics (e.g., wealth) and health (e.g., vaccination, conditions), controlled by 11 to 12 variables on *Total-COVID*, R^2 = explained variance in *Total-COVID* by all independent variables.

Tables

Table D1 Descriptive statistics for 2020/21 if all cases are included

doi.org/10.32388/YAEGXV

Variable	*N*	Mean	Median	*SD*	*LL*	*UL*
Statistical Capacity	141	65.18	67.25	15.36	24.38	92.81
GDP/c (PPP)	204	22043.63	13650.00	23969.02	700.00	139100.00
GDP/c (PPP) log	204	9.39	9.52	1.20	6.55	11.84
Intelligence	149	84.32	85.63	12.32	60.00	106.49
Winter temperature	205	13.89	18.20	11.29	−20.80	27.30
Air Pollution	183	1321.14	1117.00	915.64	144.00	4821.00
Demographics	178	0.00	0.05	0.73	-1.28	4.23
Health Risk	179	2.78	2.56	2.27	−0.76	8.51
Health Expand./c	185	1399.78	724.80	1707.42	32.00	10225.80
Health Sys. Qual.	200	−0.03	0.00	0.87	−2.31	1.96
Mobility Changes	133	−11.40	−12.13	9.53	−33.97	12.50
Tests/c	121	1.88	0.90	3.09	0.00	19.20
Vaccinations/c	192	9.59	5.11	11.70	0.00	58.38
Stringency Index	179	58.06	59.72	13.26	13.50	86.80
Reproduction rate	181	1.00	1.06	0.19	0.03	1.29
Hospitalizations/mc	29	179.14	152.52	115.25	19.73	462.40
ICU treatments/mc	23	27.19	27.24	12.87	4.89	50.15
Regist. cases/mc	189	72.16	36.23	83.77	0.02	384.40
Regist. deaths/mc	182	1.51	0.62	2.01	−0.05	16.18
Excess mortality	88	15.61	11.93	18.47	−12.82	137.21

Notes. upper section = independent or filter variables, lower section = dependent (COVID-) variables; n.d. = no data.

Table D2 Descriptive statistics for 2020/21 for countries from northern hemisphere only

Variable	*N*	Mean	Median	*SD*	*LL*	*UL*
Statistical capacity	105	65.65	67.78	15.63	24.38	91.24
GDP/c (PPP)	163	24646.01	15200.00	25586.94	700.00	139100.00
GDP/c (PPP) log	163	9.53	9.63	1.19	6.55	11.84
Intelligence	128	85.23	87.00	12.44	60.00	106.49
Winter temperature	164	12.75	16.70	12.07	−20.80	27.30
Air pollution	145	1362.23	1108.00	986.88	144.00	4821.00
Demographics	143	0.08	0.14	0.74	-1.28	4.23
Health risk	145	2.81	2.73	2.30	−0.76	8.51
Health expand./c	147	1581.51	923.80	1819.02	40.60	10225.80
Health sys. qual.	160	0.08	0.18	0.87	−2.31	1.96
Mobility changes	109	−10.94	−11.56	9.30	−33.97	12.50
Tests/c	101	2.16	1.03	3.30	0.02	19.20
Vaccinations/c	153	10.06	6.34	11.40	0.00	58.38
Stringency	143	58.75	60.34	12.75	13.50	86.80
Reproduction rate	147	1.00	1.06	0.17	0.03	1.19
Hospitalizations/mc	29	179.14	152.52	115.25	19.73	462.40
ICU treatments/mc	23	27.19	27.24	12.87	4.89	50.15
Regist. cases/mc	152	78.39	42.11	85.55	0.06	384.40
Regist. deaths/mc	147	1.49	0.75	1.67	−0.05	6.32
Excess mortality	77	13.59	11.51	10.76	−3.93	56.26

Notes. upper section = independent or filter variables, lower section = dependent (COVID-) variables; n.d. = no data.

Table D3 Descriptive statistics for 2020/21 for countries from southern hemisphere only

doi.org/10.32388/YAEGXV

Variable	*N*	Mean	Median	*SD*	*LL*	*UL*
Statistical capacity	36	63.82	62.84	14.46	40.46	92.81
GDP/c (PPP)	41	11697.56	7800.00	11036.03	700.00	50400.00
GDP/c (PPP) log	41	8.87	8.96	1.10	6.55	10.83
Intelligence	21	78.73	78.24	9.84	62.97	99.25
Winter temperature	41	18.45	19.20	5.34	6.90	25.80
Air pollution	38	1164.37	1211.00	538.67	151.00	2268.00
Demographics	35	-0.32	-0.21	0.54	-1.09	0.60
Health risk	34	2.68	2.33	2.12	−0.32	7.24
Health expand./c	38	696.78	328.25	878.00	32.00	4636.80
Health sys. qual.	40	−0.46	−0.59	0.70	−1.55	1.01
Mobility changes	24	−13.52	−13.10	10.24	−31.45	6.00
Tests/c	20	0.48	0.28	0.55	0.00	1.88
Vaccinations/c	39	7.74	2.64	12.67	0.01	53.75
Stringency	36	55.30	57.56	14.79	15.04	75.62
Reproduction rate	34	0.98	1.07	0.24	0.03	1.29
Hospitalizations/mc	0	n.d.	n.d.	n.d.	n.d.	n.d.
ICU treatments/mc	0	n.d.	n.d.	n.d.	n.d.	n.d.
Regist. cases/mc	37	46.54	11.05	70.44	0.02	280.45
Regist. deaths/mc	35	1.63	0.20	3.02	0.00	16.18
Excess mortality	11	29.79	23.28	41.08	−12.82	137.21

Notes. upper section = independent or filter variables, lower section = dependent (COVID-) variables; n.d. = no data.

Table D4 Descriptive statistics for 2020/21 for countries with high data quality only

doi.org/10.32388/YAEGXV

Variable	*N*	Mean	Median	*SD*	*LL*	*UL*
Statistical capacity	75	77.20	77.52	7.62	65.62	92.81
GDP/c (PPP)	74	12378.38	11700.00	8108.49	1200.00	29600.00
GDP/c (PPP) log	74	9.14	9.37	0.85	7.09	10.30
Intelligence	66	81.84	81.98	9.73	60.00	103.95
Winter temperature	75	12.51	16.20	11.52	−20.80	25.80
Air pollution	74	1355.09	1171.00	753.72	356.00	3929.00
Demographics	75	-0.13	-0.04	0.47	-1.28	0.66
Health risk	74	3.09	2.98	2.26	−0.50	8.51
Health expand./c	74	759.63	639.15	568.45	63.70	2214.00
Health sys. qual.	75	−0.10	−0.12	0.75	−1.65	1.82
Mobility changes	61	−14.64	−14.38	9.40	−33.97	11.42
Tests/c	60	0.82	0.45	1.10	0.02	6.96
Vaccinations/c	73	6.76	3.58	9.88	0.00	58.38
Stringency	72	60.76	62.71	13.73	13.50	86.80
Reproduction rate	75	1.02	1.07	0.17	0.03	1.16
Hospitalizations/mc	3	331.91	297.29	95.59	236.05	462.40
ICU treatments/mc	2	38.07	38.07	0.02	38.05	38.09
Regist. cases/mc	75	74.64	45.29	76.90	0.02	354.07
Regist. deaths/mc	75	1.81	0.82	2.40	0.00	16.18
Excess mortality	40	21.74	15.85	24.67	−12.82	137.21

Notes. upper section = independent or filter variables, lower section = dependent (COVID-) variables; n.d. = no data.

Table D5 Descriptive statistics for 2020/21 for countries with low data quality only

doi.org/10.32388/YAEGXV

Variable	*N*	Mean	Median	*SD*	*LL*	*UL*
Statistical capacity	66	51.53	54.05	9.36	24.38	64.03
GDP/c (PPP)	130	27545.38	18150.00	27940.54	700.00	139100.00
GDP/c (PPP) log	130	9.54	9.81	1.34	6.55	11.84
Intelligence	83	86.29	90.74	13.73	60.00	106.49
Winter temperature	130	14.69	19.25	11.08	−14.60	27.30
Air pollution	109	1298.09	1099.00	1010.24	144.00	4821.00
Demographics	103	0.10	0.14	0.85	-1.13	4.23
Health risk	105	2.57	2.33	2.25	−0.76	7.46
Health expand./c	111	1826.55	972.80	2046.47	32.00	10225.80
Health sys. qual.	125	0.02	0.22	0.93	−2.31	1.96
Mobility changes	72	−8.65	−8.44	8.73	−24.90	12.50
Tests/c	61	2.93	1.68	3.94	0.00	19.20
Vaccinations/c	119	11.32	8.34	12.38	0.01	53.75
Stringency	107	56.24	57.54	12.61	15.04	84.06
Reproduction rate	106	0.99	1.06	0.19	0.03	1.29
Hospitalizations/mc	26	161.51	147.34	103.71	19.73	439.98
ICU treatments/mc	21	26.16	26.50	13.00	4.89	50.15
Regist. cases/mc	114	70.53	27.30	87.96	0.06	384.40
Regist. deaths/mc	107	1.31	0.42	1.65	−0.05	6.32
Excess mortality	48	10.51	9.84	7.78	−3.04	37.03

Notes. upper section = independent or filter variables, lower section = dependent (COVID-) variables; n.d. = no data.

Table D6 Descriptive statistics for 2020/21 for rich countries only

Variable	*N*	Mean	Median	*SD*	*LL*	*UL*
Statistical capacity	16	74.58	80.23	16.34	35.14	92.81
GDP/c (PPP)	73	46736.99	39400.00	24360.35	22300.00	139100.00
GDP/c (PPP) log	73	10.65	10.58	0.43	10.01	11.84
Intelligence	62	93.75	95.82	7.54	76.49	106.49
Winter temperature	71	8.42	7.20	11.87	−18.00	26.70
Air pollution	58	620.28	397.00	527.31	144.00	3008.00
Demographics	62	0.62	0.54	0.71	-0.46	4.23
Health risk	61	3.84	3.91	1.91	−0.72	7.67
Health expand./c	59	3268.08	2693.60	1887.22	815.30	10225.80
Health sys. qual.	69	0.70	0.77	0.44	−0.43	1.83
Mobility changes	57	−11.75	−12.40	8.16	−33.97	5.12
Tests/c	50	3.57	2.23	4.06	0.06	19.20
Vaccinations/c	70	16.97	13.57	11.72	0.52	49.66
Stringency	64	57.39	58.42	11.00	23.15	75.70
Reproduction rate	61	1.02	1.07	0.16	0.26	1.19
Hospitalizations/mc	28	169.02	150.66	103.87	19.73	439.98
ICU treatments/mc	22	26.70	26.87	12.94	4.89	50.15
Regist. cases/mc	63	128.02	141.52	91.11	0.98	384.40
Regist. deaths/mc	62	2.23	2.13	1.73	0.02	6.27
Excess mortality	54	10.14	9.41	8.50	−12.82	37.03

Notes. upper section = independent or filter variables, lower section = dependent (COVID-) variables; n.d. = no data.

Table D7 Descriptive statistics for 2020/21 for poor countries only

doi.org/10.32388/YAEGXV

Variable	*N*	Mean	Median	*SD*	*LL*	*UL*
Statistical capacity	125	63.98	65.62	14.81	24.38	90.00
GDP/c (PPP)	131	8283.21	6900.00	5902.07	700.00	21800.00
GDP/c (PPP) log	131	8.70	8.84	0.88	6.55	9.99
Intelligence	87	77.60	78.79	10.53	60.00	103.95
Winter temperature	134	16.79	21.35	9.81	−20.80	27.30
Air pollution	125	1646.34	1469.00	874.48	407.00	4821.00
Demographics	116	-0.33	-0.36	0.47	-1.28	0.66
Health risk	118	2.24	1.88	2.25	−0.76	8.51
Health expand./c	126	524.94	370.80	461.32	32.00	1901.90
Health sys. qual.	131	−0.41	−0.40	0.79	−2.31	1.96
Mobility changes	76	−11.14	−11.71	10.43	−31.45	12.50
Tests/c	71	0.69	0.35	1.11	0.00	6.96
Vaccinations/c	122	5.35	1.69	9.36	0.00	58.38
Stringency	115	58.43	60.47	14.35	13.50	86.80
Reproduction rate	120	0.99	1.05	0.20	0.03	1.29
Hospitalizations/mc	1	462.40	462.40	0.00	462.40	462.40
ICU treatments/mc	1	38.09	38.09	0.00	38.09	38.09
Regist. cases/mc	126	44.22	10.93	63.51	0.02	354.07
Regist. deaths/mc	120	1.15	0.28	2.04	−0.05	16.18
Excess mortality	34	24.31	16.42	25.39	−3.93	137.21

Notes. upper section = independent or filter variables, lower section = dependent (COVID-) variables; n.d. = no data.

Table D8 Descriptive statistics for 2020 if all cases are included

doi.org/10.32388/YAEGXV

Variable	*N*	Mean	Median	*SD*	*LL*	*UL*
Statistical capacity	141	65.18	67.25	15.36	24.38	92.81
GDP/c (PPP)	204	22043.63	13650.00	23969.02	700.00	139100.00
GDP/c (PPP) log	204	9.39	9.52	1.20	6.55	11.84
Intelligence	149	84.32	85.63	12.32	60.00	106.49
Winter temperature	205	14.08	18.40	11.42	−20.80	27.70
Air pollution	183	1321.14	1117.00	915.64	144.00	4821.00
Demographics	178	0.00	0.05	0.73	-1.28	4.23
Health risk	179	2.78	2.56	2.27	−0.76	8.51
Health expand./c	185	1399.78	724.80	1707.42	32.00	10225.80
Health sys. qual.	200	−0.03	0.00	0.87	−2.31	1.96
Mobility changes	133	−17.77	−17.87	10.12	−40.37	5.38
Tests/c	106	0.45	0.22	0.59	0.00	3.12
Vaccinations/c	0	n.d.	n.d.	n.d.	n.d.	n.d.
Stringency	170	65.31	66.65	14.26	13.89	95.61
Reproduction rate	165	1.09	1.17	0.29	0.06	1.59
Hospitalizations/mc	26	68.45	37.64	67.05	2.17	233.34
ICU treatments/mc	20	15.11	10.42	11.51	2.88	44.35
Regist. cases/mc	183	14.81	4.90	27.98	0.01	271.15
Regist. deaths/mc	165	1.04	0.20	2.76	−1.25	23.41
Excess mortality	88	6.07	2.45	15.06	−12.52	84.55

Notes. upper section = independent or filter variables, lower section = dependent (COVID-) variables; n.d. = no data.

Table D9 Descriptive statistics for 2020 for countries from northern hemisphere only

doi.org/10.32388/YAEGXV

Variable	*N*	Mean	Median	*SD*	*LL*	*UL*
Statistical capacity	105	65.65	67.78	15.63	24.38	91.24
GDP/c (PPP)	163	24646.01	15200.00	25586.94	700.00	139100.00
GDP/c (PPP) log	163	9.53	9.63	1.19	6.55	11.84
Intelligence	128	85.23	87.00	12.44	60.00	106.49
Winter temperature	164	12.85	16.70	12.17	−20.80	27.70
Air pollution	145	1362.23	1108.00	986.88	144.00	4821.00
Demographics	143	0.08	0.14	0.74	-1.28	4.23
Health risk	145	2.81	2.73	2.30	−0.76	8.51
Health expand./c	147	1581.51	923.80	1819.02	40.60	10225.80
Health sys. qual.	160	0.08	0.18	0.87	−2.31	1.96
Mobility changes	109	−17.09	−17.67	9.81	−37.26	5.38
Tests/c	86	0.51	0.30	0.63	0.01	3.12
Vaccinations/c	0	n.d.	n.d.	n.d.	n.d.	n.d.
Stringency	137	65.51	67.07	14.20	18.97	95.61
Reproduction rate	136	1.09	1.17	0.28	0.06	1.59
Hospitalizations/mc	26	68.45	37.64	67.05	2.17	233.34
ICU treatments/mc	20	15.11	10.42	11.51	2.88	44.35
Regist. cases/mc	149	15.58	6.24	28.80	0.02	271.15
Regist. deaths/mc	137	0.86	0.24	1.82	−1.25	9.31
Excess mortality	77	4.13	1.92	10.06	−8.16	53.94

Notes. upper section = independent or filter variables, lower section = dependent (COVID-) variables; n.d. = no data.

Table D10 Descriptive statistics for 2020 for countries from southern hemisphere only

doi.org/10.32388/YAEGXV

Variable	*N*	Mean	Median	*SD*	*LL*	*UL*
Statistical capacity	36	63.82	62.84	14.46	40.46	92.81
GDP/c (PPP)	41	11697.56	7800.00	11036.03	700.00	50400.00
GDP/c (PPP) log	41	8.87	8.96	1.10	6.55	10.83
Intelligence	21	78.73	78.24	9.84	62.97	99.25
Winter temperature	41	18.97	19.40	5.53	6.90	26.70
Air pollution	38	1164.37	1211.00	538.67	151.00	2268.00
Demographics	35	-0.32	-0.21	0.54	-1.09	0.60
Health risk	34	2.68	2.33	2.12	−0.32	7.24
Health expand./c	38	696.78	328.25	878.00	32.00	4636.80
Health sys. qual.	40	−0.46	−0.59	0.70	−1.55	1.01
Mobility changes	24	−20.87	−18.36	10.88	−40.37	−1.26
Tests/c	20	0.17	0.06	0.27	0.00	0.98
Vaccinations/c	0	n.d.	n.d.	n.d.	n.d.	n.d.
Stringency	33	64.48	63.02	14.45	13.89	89.94
Reproduction rate	29	1.11	1.14	0.33	0.15	1.54
Hospitalizations/mc	0	n.d.	n.d.	n.d.	n.d.	n.d.
ICU treatments/mc	0	n.d.	n.d.	n.d.	n.d.	n.d.
Regist. cases/mc	34	11.45	1.76	23.76	0.01	113.30
Regist. deaths/mc	28	1.95	0.11	5.24	−0.07	23.41
Excess mortality	11	19.58	7.61	29.95	−12.52	84.55

Notes. upper section = independent or filter variables, lower section = dependent (COVID-) variables; n.d. = no data.

Table D11 Descriptive statistics for 2020 for countries with high data quality only

doi.org/10.32388/YAEGXV

Variable	*N*	Mean	Median	*SD*	*LL*	*UL*
Statistical capacity	75	77.20	77.52	7.62	65.62	92.81
GDP/c (PPP)	74	12378.38	11700.00	8108.49	1200.00	29600.00
GDP/c (PPP) log	74	9.14	9.37	0.85	7.09	10.30
Intelligence	66	81.84	81.98	9.73	60.00	103.95
Winter temperature	75	-0.13	-0.04	0.47	-1.28	0.66
Air pollution	74	1355.09	1171.00	753.72	356.00	3929.00
Demographics	75	56.69	58.50	20.52	16.60	95.50
Health risk	74	3.09	2.98	2.26	−0.50	8.51
Health expand./c	74	759.63	639.15	568.45	63.70	2214.00
Health sys. qual.	75	−0.10	−0.12	0.75	−1.65	1.82
Mobility changes	61	−21.58	−22.06	10.03	−40.37	3.33
Tests/c	51	0.21	0.12	0.25	0.01	1.21
Vaccinations/c	0	n.d.	n.d.	n.d.	n.d.	n.d.
Stringency	72	66.74	67.40	14.42	18.97	95.61
Reproduction rate	70	1.15	1.24	0.30	0.09	1.59
Hospitalizations/mc	3	44.03	39.07	13.01	31.17	61.85
ICU treatments/mc	2	6.77	6.77	2.61	4.16	9.38
Regist. cases/mc	75	12.81	5.33	20.14	0.02	113.30
Regist. deaths/mc	67	1.15	0.19	3.61	−0.94	23.41
Excess mortality	40	7.44	1.33	19.55	−12.52	84.55

Table D12 Descriptive statistics for 2020 for countries with low data quality only

Notes. upper section = independent or filter variables, lower section = dependent (COVID-) variables; n.d. = no data.

doi.org/10.32388/YAEGXV

Variable	*N*	Mean	Median	*SD*	*LL*	*UL*
Statistical capacity	66	51.53	54.05	9.36	24.38	64.03
GDP/c (PPP)	130	27545.38	18150.00	27940.54	700.00	139100.00
GDP/c (PPP) log	130	9.54	9.81	1.34	6.55	11.84
Intelligence	83	86.29	90.74	13.73	60.00	106.49
Winter temperature	130	14.91	19.65	11.23	−14.60	27.70
Air pollution	109	1298.09	1099.00	1010.24	144.00	4821.00
Demographics	103	0.10	0.14	0.85	-1.13	4.23
Health risk	105	2.57	2.33	2.25	−0.76	7.46
Health expand./c	111	1826.55	972.80	2046.47	32.00	10225.80
Health sys. qual.	125	0.02	0.22	0.93	−2.31	1.96
Mobility changes	72	−14.55	−15.23	9.02	−33.60	5.38
Tests/c	55	0.67	0.56	0.72	0.00	3.12
Vaccinations/c	0	n.d.	n.d.	n.d.	n.d.	n.d.
Stringency	98	64.25	64.03	14.04	13.89	89.69
Reproduction rate	95	1.04	1.11	0.28	0.06	1.54
Hospitalizations/mc	23	71.63	36.22	70.52	2.17	233.34
ICU treatments/mc	18	16.03	12.82	11.74	2.88	44.35
Regist. cases/mc	108	16.20	4.48	32.25	0.01	271.15
Regist. deaths/mc	98	0.97	0.24	1.97	−1.25	9.31
Excess mortality	48	4.92	2.62	9.73	−8.16	53.94

Notes. upper section = independent or filter variables, lower section = dependent (COVID-) variables; n.d. = no data.

Table D13 Descriptive statistics for 2020 for rich countries only

doi.org/10.32388/YAEGXV

Variable	*N*	Mean	Median	*SD*	*LL*	*UL*
Statistical capacity	16	74.58	80.23	16.34	35.14	92.81
GDP/c (PPP)	73	46736.99	39400.00	24360.35	22300.00	139100.00
GDP/c (PPP) log	73	10.65	10.58	0.43	10.01	11.84
Intelligence	62	93.75	95.82	7.54	76.49	106.49
Winter temperature	71	8.53	7.90	11.95	−18.00	26.70
Air pollution	58	620.28	397.00	527.31	144.00	3008.00
Demographics	62	0.62	0.54	0.71	-0.46	4.23
Health risk	61	3.84	3.91	1.91	−0.72	7.67
Health expand./c	59	3268.08	2693.60	1887.22	815.30	10225.80
Health sys. qual.	69	0.70	0.77	0.44	−0.43	1.83
Mobility changes	57	−16.46	−17.17	10.36	−37.26	5.38
Tests/c	48	0.82	0.67	0.68	0.02	3.12
Vaccinations/c	0	n.d.	n.d.	n.d.	n.d.	n.d.
Stringency	60	59.10	57.27	12.00	27.14	88.16
Reproduction rate	58	1.04	1.13	0.33	0.06	1.54
Hospitalizations/mc	25	69.62	36.22	68.12	2.17	233.34
ICU treatments/mc	19	15.68	10.51	11.53	2.88	44.35
Regist. cases/mc	63	27.58	13.21	40.95	0.12	271.15
Regist. deaths/mc	61	1.60	0.57	2.41	−1.25	9.31
Excess mortality	54	4.74	2.52	9.51	−12.52	53.94

Notes. upper section = independent or filter variables, lower section = dependent (COVID-) variables; n.d. = no data.

Table D14 Descriptive statistics for 2020 for poor countries only

Variable	*N*	Mean	Median	*SD*	*LL*	*UL*
Statistical capacity	125	63.98	65.62	14.81	24.38	90.00
GDP/c (PPP)	131	8283.21	6900.00	5902.07	700.00	21800.00
GDP/c (PPP) log	131	8.70	8.84	0.88	6.55	9.99
Intelligence	87	77.60	78.79	10.53	60.00	103.95
Winter temperature	134	17.02	21.40	9.95	−20.80	27.70
Air pollution	125	1646.34	1469.00	874.48	407.00	4821.00
Demographics	116	-0.33	-0.36	0.47	-1.28	0.66
Health risk	118	2.24	1.88	2.25	−0.76	8.51
Health expand./c	126	524.94	370.80	461.32	32.00	1901.90
Health sys. qual.	131	−0.41	−0.40	0.79	−2.31	1.96
Mobility changes	76	−18.76	−17.92	9.82	−40.37	3.33
Tests/c	58	0.14	0.06	0.19	0.00	0.99
Vaccinations/c	0	n.d.	n.d.	n.d.	n.d.	n.d.
Stringency	110	68.69	71.79	14.25	13.89	95.61
Reproduction rate	107	1.12	1.18	0.27	0.09	1.59
Hospitalizations/mc	1	39.07	39.07	0.00	39.07	39.07
ICU treatments/mc	1	4.16	4.16	0.00	4.16	4.16
Regist. cases/mc	120	8.10	2.44	13.52	0.01	73.93
Regist. deaths/mc	104	0.71	0.09	2.89	−0.94	23.41
Excess mortality	34	8.17	1.01	20.89	−8.16	84.55

Notes. upper section = independent or filter variables, lower section = dependent (COVID-) variables; n.d. = no data.

Table D15 Descriptive statistics for 2021 if all cases are included

doi.org/10.32388/YAEGXV

Variable	*N*	Mean	Median	*SD*	*LL*	*UL*
Statistical capacity	141	65.18	67.25	15.36	24.38	92.81
GDP/c (PPP)	204	22043.63	13650.00	23969.02	700.00	139100.00
GDP/c (PPP) log	204	9.39	9.52	1.20	6.55	11.84
Intelligence	149	84.32	85.63	12.32	60.00	106.49
Winter temperature	205	14.08	18.40	11.42	−20.80	27.70
Air pollution	183	1321.14	1117.00	915.64	144.00	4821.00
Demographics	178	0.00	0.05	0.73	-1.28	4.23
Health risk	179	2.78	2.56	2.27	−0.76	8.51
Health expand./c	185	1399.78	724.80	1707.42	32.00	10225.80
Health sys. qual.	200	−0.03	0.00	0.87	−2.31	1.96
Mobility changes	132	−10.25	−12.16	11.63	−38.42	35.72
Tests/c	119	3.27	1.15	6.85	0.00	45.52
Vaccinations/c	192	9.69	5.14	11.83	0.00	58.38
Stringency	179	56.76	59.54	16.46	8.78	86.91
Reproduction rate	181	0.95	0.97	0.20	0.00	1.29
Hospitalizations/mc	29	270.65	197.32	192.66	20.51	824.08
ICU treatments/mc	23	41.34	38.29	20.77	5.88	101.02
Regist. cases/mc	189	114.63	65.03	143.31	0.00	780.89
Regist. deaths/mc	182	2.10	0.78	2.85	0.00	17.87
Excess mortality	69	23.63	10.41	38.64	−9.41	241.95

Notes. upper section = independent or filter variables, lower section = dependent (COVID-) variables; n.d. = no data.

Table D16 Descriptive statistics for 2021 for countries from northern hemisphere only

doi.org/10.32388/YAEGXV

Variable	*N*	Mean	Median	*SD*	*LL*	*UL*
Statistical capacity	105	65.65	67.78	15.63	24.38	91.24
GDP/c (PPP)	163	24646.01	15200.00	25586.94	700.00	139100.00
GDP/c (PPP) log	163	9.53	9.63	1.19	6.55	11.84
Intelligence	128	85.23	87.00	12.44	60.00	106.49
Winter temperature	164	12.85	16.70	12.17	−20.80	27.70
Air pollution	145	1362.23	1108.00	986.88	144.00	4821.00
Demographics	143	0.08	0.14	0.74	-1.28	4.23
Health risk	145	2.81	2.73	2.30	−0.76	8.51
Health expand./c	147	1581.51	923.80	1819.02	40.60	10225.80
Health sys. qual.	160	0.08	0.18	0.87	−2.31	1.96
Mobility changes	108	−10.14	−11.98	11.79	−38.42	35.72
Tests/c	100	3.74	1.56	7.37	0.03	45.52
Vaccinations/c	153	10.18	6.34	11.54	0.00	58.38
Stringency	143	57.69	60.48	16.07	10.51	86.91
Reproduction rate	147	0.95	0.96	0.19	0.01	1.24
Hospitalizations/mc	29	270.65	197.32	192.66	20.51	824.08
ICU treatments/mc	23	41.34	38.29	20.77	5.88	101.02
Regist. cases/mc	152	120.01	76.73	137.02	0.00	641.27
Regist. deaths/mc	147	2.10	0.93	2.65	0.00	13.25
Excess mortality	61	17.72	9.68	27.29	−9.41	183.44

Notes. upper section = independent or filter variables, lower section = dependent (COVID-) variables; n.d. = no data.

Table D17 Descriptive statistics for 2021 for countries from southern hemisphere only

doi.org/10.32388/YAEGXV

Variable	*N*	Mean	Median	*SD*	*LL*	*UL*
Statistical capacity	36	63.82	62.84	14.46	40.46	92.81
GDP/c (PPP)	41	11697.56	7800.00	11036.03	700.00	50400.00
GDP/c (PPP) log	41	8.87	8.96	1.10	6.55	10.83
Intelligence	21	78.73	78.24	9.84	62.97	99.25
Winter temperature	41	18.97	19.40	5.53	6.90	26.70
Air pollution	38	1164.37	1211.00	538.67	151.00	2268.00
Demographics	35	-0.32	-0.21	0.54	-1.09	0.60
Health risk	34	2.68	2.33	2.12	−0.32	7.24
Health expand./c	38	696.78	328.25	878.00	32.00	4636.80
Health sys. qual.	40	−0.46	−0.59	0.70	−1.55	1.01
Mobility changes	24	−10.73	−12.89	10.88	−29.05	15.83
Tests/c	19	0.80	0.56	0.90	0.00	3.13
Vaccinations/c	39	7.77	2.64	12.71	0.01	53.75
Stringency	36	53.08	56.18	17.42	8.78	80.25
Reproduction rate	34	0.96	1.04	0.24	0.00	1.29
Hospitalizations/mc	0	n.d.	n.d.	n.d.	n.d.	n.d.
ICU treatments/mc	0	n.d.	n.d.	n.d.	n.d.	n.d.
Regist. cases/mc	37	92.52	22.18	164.84	0.00	780.89
Regist. deaths/mc	35	2.13	0.32	3.58	0.00	17.87
Excess mortality	8	68.66	56.01	70.01	3.51	241.95

Notes. upper section = independent or filter variables, lower section = dependent (COVID-) variables; n.d. = no data.

Table D18 Descriptive statistics for 2021 for countries with high data quality only

doi.org/10.32388/YAEGXV

Variable	*N*	Mean	Median	*SD*	*LL*	*UL*
Statistical capacity	75	77.20	77.52	7.62	65.62	92.81
GDP/c (PPP)	74	12378.38	11700.00	8108.49	1200.00	29600.00
GDP/c (PPP) log	74	9.14	9.37	0.85	7.09	10.30
Intelligence	66	81.84	81.98	9.73	60.00	103.95
Winter temperature	75	12.64	16.20	11.61	−20.80	26.70
Air pollution	74	1355.09	1171.00	753.72	356.00	3929.00
Demographics	75	-0.13	-0.04	0.47	-1.28	0.66
Health risk	74	3.09	2.98	2.26	−0.50	8.51
Health expand./c	74	759.63	639.15	568.45	63.70	2214.00
Health sys. qual.	75	−0.10	−0.12	0.75	−1.65	1.82
Mobility changes	61	−12.09	−13.94	10.39	−29.54	27.70
Tests/c	59	1.15	0.74	1.26	0.05	6.96
Vaccinations/c	73	6.81	3.58	9.92	0.00	58.38
Stringency	72	58.94	60.98	16.85	8.78	86.91
Reproduction rate	75	0.95	0.99	0.21	0.00	1.24
Hospitalizations/mc	3	562.00	496.33	192.85	365.59	824.08
ICU treatments/mc	2	64.55	64.55	7.62	56.93	72.18
Regist. cases/mc	75	119.45	76.65	140.48	0.00	780.89
Regist. deaths/mc	75	2.51	1.24	3.15	0.00	17.87
Excess mortality	26	38.26	25.66	47.03	−4.29	241.95

Notes. upper section = independent or filter variables, lower section = dependent (COVID-) variables; n.d. = no data.

Table D19 Descriptive statistics for 2021 for countries with low data quality only

Variable	*N*	Mean	Median	*SD*	*LL*	*UL*
Statistical capacity	66	51.53	54.05	9.36	24.38	64.03
GDP/c (PPP)	130	27545.38	18150.00	27940.54	700.00	139100.00
GDP/c (PPP) log	130	9.54	9.81	1.34	6.55	11.84
Intelligence	83	86.29	90.74	13.73	60.00	106.49
Winter temperature	130	14.91	19.65	11.23	−14.60	27.70
Air pollution	109	1298.09	1099.00	1010.24	144.00	4821.00
Demographics	103	0.10	0.14	0.85	-1.13	4.23
Health risk	105	2.57	2.33	2.25	−0.76	7.46
Health expand./c	111	1826.55	972.80	2046.47	32.00	10225.80
Health sys. qual.	125	0.02	0.22	0.93	−2.31	1.96
Mobility changes	71	−8.67	−11.09	12.39	−38.42	35.72
Tests/c	60	5.35	2.32	9.09	0.00	45.52
Vaccinations/c	119	11.46	8.50	12.53	0.01	53.75
Stringency	107	55.30	57.29	16.02	16.91	86.10
Reproduction rate	106	0.95	0.97	0.19	0.01	1.29
Hospitalizations/mc	26	237.03	187.39	161.82	20.51	650.49
ICU treatments/mc	21	39.13	36.48	20.26	5.88	101.02
Regist. cases/mc	114	111.46	36.67	145.06	0.00	641.27
Regist. deaths/mc	107	1.82	0.59	2.59	0.00	13.25
Excess mortality	43	14.78	8.03	29.16	−9.41	183.44

Notes. upper section = independent or filter variables, lower section = dependent (COVID-) variables; n.d. = no data.

Table D20 Descriptive statistics for 2021 for rich countries only

doi.org/10.32388/YAEGXV

Variable	*N*	Mean	Median	*SD*	*LL*	*UL*
Statistical capacity	16	74.58	80.23	16.34	35.14	92.81
GDP/c (PPP)	73	46736.99	39400.00	24360.35	22300.00	139100.00
GDP/c (PPP) log	73	10.65	10.58	0.43	10.01	11.84
Intelligence	62	93.75	95.82	7.54	76.49	106.49
Winter temperature	71	8.53	7.90	11.95	−18.00	26.70
Air pollution	58	620.28	397.00	527.31	144.00	3008.00
Demographics	62	0.62	0.54	0.71	-0.46	4.23
Health risk	61	3.84	3.91	1.91	−0.72	7.67
Health expand./c	59	3268.08	2693.60	1887.22	815.30	10225.80
Health sys. qual.	69	0.70	0.77	0.44	-0.43	1.83
Mobility changes	56	−14.11	−12.89	6.35	−31.30	−4.17
Tests/c	49	6.59	3.13	9.62	0.15	45.52
Vaccinations/c	70	17.24	13.97	11.88	0.52	51.42
Stringency	64	61.60	64.06	12.79	23.15	82.76
Reproduction rate	61	0.97	0.96	0.11	0.63	1.21
Hospitalizations/mc	28	250.88	193.60	164.67	20.51	650.49
ICU treatments/mc	22	39.94	37.38	20.14	5.88	101.02
Regist. cases/mc	63	203.74	199.61	165.96	0.44	780.89
Regist. deaths/mc	62	3.10	2.85	2.91	0.00	13.25
Excess mortality	47	11.10	8.21	12.73	−9.41	56.40

Notes. upper section = independent or filter variables, lower section = dependent (COVID-) variables; n.d. = no data.

Table D21 Descriptive statistics for 2021 for poor countries only

doi.org/10.32388/YAEGXV

Variable	*N*	Mean	Median	*SD*	*LL*	*UL*
Statistical capacity	125	63.98	65.62	14.81	24.38	90.00
GDP/c (PPP)	131	8283.21	6900.00	5902.07	700.00	21800.00
GDP/c (PPP) log	131	8.70	8.84	0.88	6.55	9.99
Intelligence	87	77.60	78.79	10.53	60.00	103.95
Winter temperature	134	17.02	21.40	9.95	−20.80	27.70
Air pollution	125	1646.34	1469.00	874.48	407.00	4821.00
Demographics	116	-0.33	-0.36	0.47	-1.28	0.66
Health risk	118	2.24	1.88	2.25	−0.76	8.51
Health expand./c	126	524.94	370.80	461.32	32.00	1901.90
Health sys. qual.	131	−0.41	−0.40	0.79	−2.31	1.96
Mobility changes	76	−7.40	−11.46	13.65	−38.42	35.72
Tests/c	70	0.95	0.53	1.36	0.00	7.11
Vaccinations/c	122	5.36	1.69	9.36	0.00	58.38
Stringency	115	54.07	55.73	17.61	8.78	86.91
Reproduction rate	120	0.94	0.99	0.24	0.00	1.29
Hospitalizations/mc	1	824.08	824.08	0.00	824.08	824.08
ICU treatments/mc	1	72.18	72.18	0.00	72.18	72.18
Regist. cases/mc	126	70.07	14.96	105.26	0.00	641.27
Regist. deaths/mc	120	1.59	0.44	2.68	0.00	17.87
Excess mortality	22	50.40	28.05	57.30	−4.29	241.95

Notes. upper section = independent or filter variables, lower section = dependent (COVID-) variables; n.d. = no data.

Table R1 Results from regression analyses of 12 predictors on reproduction rate for 2020/21

Parameter	All countries		North. Hemisphere		South. Hemisphere	
	β	*S.E.*	β	*S.E.*	β	*S.E.*
Intelligence	−.006	0.150	−.047	0.176	−.589*	0.276
Winter temperature	−.108	0.108	−.149	0.136	.170	0.174
Air pollution	.063	0.105	.013	0.137	−.366	0.225
Wealth	−.171	0.165	.018	0.199	−.909*	0.419
Demographics	.271*	0.138	.287	0.152	1.069*	0.504
Health risk	.105	0.086	.221*	0.107	.133	0.122
Health expand./c	.189	0.105	.163	0.114	−1.514*	0.443
Health sys. qual.	.001	0.137	−.250	0.152	1.179*	0.401
Mobility changes	.120	0.117	.216	0.157	.161	0.211
CoV-2-Tests/c	.002	0.185	.039	0.182	2.472*	0.654
Vaccinations/c	−.228*	0.105	−.261*	0.104	−2.587*	0.831
Stringency	.551*	0.077	.545*	0.084	.267	0.221
N	207		166	(21%)	41	(19%)
R^2	.406		.454		.912	

Notes. n.r. = no results, italic = dubious results; * $p \leq .05$.

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High Data Qual.		Low Data Qual.		Rich		Poor	
β	S.E.	β	S.E.	β	S.E.	β	S.E.
−.117	0.114	−1.372	n.r.	−.136	0.302	−.018	0.155
−.022	0.135	−1.283	n.r.	−.401*	0.200	−.041	0.125
.228	0.118	−.279*	0.028	−.033	0.220	.148	0.118
−.028	0.185	−.014	n.r.	−.145	0.199	−.017	0.161
.266	0.185	1.419*	0.282	.414*	0.210	.085	0.171
−.044	0.102	−.514	n.r.	.014	0.171	.088	0.092
.323*	0.146	−.376	n.r.	.197	0.158	.165	0.150
.029	0.199	−.722*	0.310	.082	0.130	.064	0.191
.154	0.133	−1.207*	0.262	.131	0.171	.073	0.160
−.185	0.178	−2.189	n.r.	−.039	0.217	−.193	0.250
−.391*	0.110	.217	n.r.	−.014	0.121	−.259	0.155
.650*	0.103	1.001*	0.121	.608*	0.115	.538*	0.105
75	(36%)	66	(31%)	73	(35%)	131	(63)
.616		.933		.626		.406	

Table R2 Results from regression analyses of 12 predictors on hospitalized individuals/c for 2020/21

doi.org/10.32388/YAEGXV

Parameter	All countries		North. Hemisphere		South. Hemisphere	
	β	*S.E.*	β	*S.E.*	β	*S.E.*
Intelligence	−.238	0.707	−.246	0.710	n.r.	n.r.
Winter temperature	−.076	0.384	−.095	0.408	n.r.	n.r.
Air pollution	1.167*	0.597	1.217*	0.644	n.r.	n.r.
Wealth	−.134	0.776	−.142	0.765	n.r.	n.r.
Demographics	.437	0.427	.452	0.435	n.r.	n.r.
Health risk	.275	0.331	.270	0.338	n.r.	n.r.
Health expand./c	−.026	0.158	−.026	0.168	n.r.	n.r.
Health sys. qual.	.508*	0.356	.494	0.356	n.r.	n.r.
Mobility changes	−.251	0.221	−.262	0.220	n.r.	n.r.
CoV-2-Tests/c	−.091	0.079	−.099	0.084	n.r.	n.r.
Vaccinations/c	−.042	0.165	−.045	0.160	n.r.	n.r.
Stringency	.090	0.265	.060	0.259	n.r.	n.r.
N	207		166	(21%)	41	(19%)
R^2	.872		.878		n.r.	

Notes. n.r. = no results, italic = dubious results; * $p \leq .05$.

High Data Qual.		Low Data Qual.		Rich		Poor	
β	*S.E.*	β	*S.E.*	β	*S.E.*	β	*S.E.*
n.r.	n.r.	n.r.	n.r.	−.232	0.514	n.r.	n.r.
n.r.	n.r.	n.r.	n.r.	.010	0.432	n.r.	n.r.
n.r.	n.r.	n.r.	n.r.	.776*	0.481	n.r.	n.r.
n.r.	n.r.	n.r.	n.r.	−.142	0.307	n.r.	n.r.
n.r.	n.r.	n.r.	n.r.	.330	0.483	n.r.	n.r.
n.r.	n.r.	n.r.	n.r.	−.018	0.332	n.r.	n.r.
n.r.	n.r.	n.r.	n.r.	.073	0.206	n.r.	n.r.
n.r.	n.r.	n.r.	n.r.	.179	0.196	n.r.	n.r.
n.r.	n.r.	n.r.	n.r.	−.273*	0.252	n.r.	n.r.
n.r.	n.r.	n.r.	n.r.	−.070	0.115	n.r.	n.r.
n.r.	n.r.	n.r.	n.r.	−.083	0.182	n.r.	n.r.
n.r.	n.r.	n.r.	n.r.	−.076	0.303	n.r.	n.r.
75	(36%)	66	(31%)	73	(35%)	131	(63)
n.r,		n.r.		.934		n.r.	

Table R3 Results from regression analyses of 12 predictors on ICU/c for 2020/21

Parameter	All countries		North. Hemisphere		South. Hemisphere	
	β	*S.E.*	β	*S.E.*	β	*S.E.*
Intelligence	−.954	0.872	−.964	0.884	n.r.	n.r.
Winter temperature	−.153	0.479	−.153	0.513	n.r.	n.r.
Air pollution	−.259	0.934	−.243	1.008	n.r.	n.r.
Wealth	−.803	0.945	−.778	0.939	n.r.	n.r.
Demographics	.773	0.597	.774	0.614	n.r.	n.r.
Health risk	.484	0.466	.447	0.474	n.r.	n.r.
Health expand./c	.332*	0.195	.355*	0.209	n.r.	n.r.
Health sys. qual.	.220	0.514	.281	0.515	n.r.	n.r.
Mobility changes	−.609*	0.303	−.586*	0.301	n.r.	n.r.
CoV-2-Tests/c	−.024	0.131	−.040	0.138	n.r.	n.r.
Vaccinations/c	−.120	0.197	−.111	0.193	n.r.	n.r.
Stringency	−.329	0.367	−.316	0.356	n.r.	n.r.
N	207		166	(21%)	41	(19%)
R^2	.839		.844		n.r.	

Notes. n.r. = no results, italic = dubious results; * $p \leq .05$.

High Data Qual.		Low Data Qual.		Rich		Poor	
β	*S.E.*	β	*S.E.*	β	*S.E.*	β	*S.E.*
.109	n.r.	n.r.	n.r.	−.455	0.533	n.r.	n.r.
.401	13.480	n.r.	n.r.	.057	0.523	n.r.	n.r.
.356	n.r.	n.r.	n.r.	.454	0.729	n.r.	n.r.
−.357	14.355	n.r.	n.r.	−.266	0.325	n.r.	n.r.
.206	27.509	n.r.	n.r.	.760*	0.563	n.r.	n.r.
.046	n.r.	n.r.	n.r.	.211	0.404	n.r.	n.r.
.251	n.r.	n.r.	n.r.	.387*	0.214	n.r.	n.r.
.165	28.029	n.r.	n.r.	.206	0.252	n.r.	n.r.
.450	n.r.	n.r.	n.r.	−.498*	0.260	n.r.	n.r.
.046	n.r.	n.r.	n.r.	−.094	0.162	n.r.	n.r.
−.325	n.r.	n.r.	n.r.	−.125	0.191	n.r.	n.r.
−.457	10.959	n.r.	n.r.	−.322	0.306	n.r.	n.r.
75	(36%)	66	(31%)	73	(35%)	131	(63)
1.000		n.r.		.876		n.r.	

Table R4 Results from regression analyses of 12 predictors on registered cases/c for 2020/21

Parameter	All countries		North. Hemisphere		South. Hemisphere	
	β	*S.E.*	β	*S.E.*	β	*S.E.*
Intelligence	−.167	0.110	−.179	0.120	*−.074*	n.r.
Winter temperature	−.259*	0.089	−.263*	0.106	*−.030*	n.r.
Air pollution	−.053	0.087	−.112	0.108	*−.015*	n.r.
Wealth	−.027	0.131	.051	0.155	*.033*	*0.243*
Demographics	.144	0.111	.074	0.122	*.129*	n.r.
Health risk	.173*	0.070	.260*	0.088	*−.050*	*0.105*
Health expand./c	.100	0.089	.136	0.099	*−.253*	n.r.
Health sys. qual.	.066	0.117	−.033	0.133	*.138*	n.r.
Mobility changes	−.185*	0.081	−.140	0.096	*−.210*	n.r.
CoV-2-Tests/c	.241*	0.074	.234*	0.081	*.267*	n.r.
Vaccinations/c	.215*	0.074	.131	0.081	*.507*	n.r.
Stringency	.047	0.067	.042	0.076	*.138*	n.r.
N	207		166	(21%)	*41*	(19%)
R^2	.548		.532		n.r.	

Notes. n.r. = no results, italic = dubious results; * $p \leq .05$.

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High Data Qual.		Low Data Qual.		Rich		Poor	
β	S.E.	β	S.E.	β	S.E.	β	S.E.
−.082	0.105	.057	0.126	−.508	0.300	−.023	0.084
.108	0.128	−.485*	0.120	−.422*	0.208	−.164*	0.084
.013	0.110	.151*	0.066	−.281	0.227	−.030	0.080
−.500*	0.166	−.144	0.102	−.024	0.193	−.241*	0.120
.322	0.172	.082	0.124	.175	0.200	.259*	0.122
.047	0.092	−.001	0.090	.340*	0.163	.039	0.070
.618*	0.135	.284*	0.080	.125	0.179	.553*	0.106
.228	0.171	−.090	0.126	−.065	0.149	−.158	0.127
−.145	0.146	−.041	0.100	−.146	0.172	−.208*	0.100
.328	0.101	.774*	0.140	.206	0.132	.367*	0.079
.067	0.092	.438*	0.150	.284*	0.131	−.056	0.086
.019	0.116	−.101	0.072	.016	0.135	.023	0.084
75	(36%)	66	(31%)	73	(35%)	131	(63)
.687		.966		.433		.712	

Table R5 Results from regression analyses of 12 predictors on registered deaths/c for 2020/21

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Parameter	All countries		North. Hemisphere		South. Hemisphere	
	β	*S.E.*	β	*S.E.*	β	*S.E.*
Intelligence	−.081	0.123	−.127	0.124	−.007	1.568
Winter temperature	−.387*	0.106	−.338*	0.115	−.132	0.998
Air pollution	−.177	0.098	−.238*	0.113	−.287	0.348
Wealth	−.018	0.155	−.002	0.168	.210	0.328
Demographics	.080	0.115	−.021	0.117	.091	3.237
Health risk	.040	0.083	.237*	0.095	−.172	0.210
Health expand./c	.006	0.107	.112	0.109	−.370	5.663
Health sys. qual.	.001	0.140	.021	0.146	−.069	5.271
Mobility changes	−.269*	0.087	−.126	0.097	−.425	0.691
CoV-2-Tests/c	.049	0.087	.053	0.086	−.068	7.659
Vaccinations/c	−.004	0.090	−.024	0.091	.112	7.294
Stringency	.049	0.075	.037	0.082	.208	0.380
N	207		166	(21%)	41	(19%)
R^2	.300		.400		.488	

Notes. n.r. = no results, italic = dubious results; * $p \leq .05$.

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High Data Qual.		Low Data Qual.		Rich		Poor	
β	*S.E.*	β	*S.E.*	β	*S.E.*	β	*S.E.*
.026	0.135	−.435	0.455	.180	0.269	−.019	0.106
−.338*	0.172	−.800	0.559	−.296	0.196	−.347*	0.112
−.023	0.144	−.057	0.158	−.123	0.203	−.099	0.102
−.185	0.230	−.175	0.314	−.252	0.178	.052	0.153
.498*	0.235	.457	0.488	−.040	0.171	.254	0.154
−.209	0.123	.024	0.261	.329*	0.151	−.124	0.088
.347	0.181	.205	0.236	.198	0.168	.334*	0.143
−.239	0.233	.053	0.363	.025	0.139	−.282	0.169
−.235	0.160	−.586	0.464	−.373*	0.151	−.252*	0.108
−.062	0.128	−.653	0.830	.030	0.116	−.029	0.109
−.101	0.114	.356	0.631	.235*	0.121	−.168	0.117
−.025	0.129	.123	0.246	.250*	0.121	−.048	0.094
75	(36%)	66	(31%)	73	(35%)	131	(63)
.371		.505		.508		.379	

Table R6 Results from regression analyses of 12 predictors on excess mortality rate for 2020/21

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Parameter	All countries		North. Hemisphere		South. Hemisphere	
	β	*S.E.*	β	*S.E.*	β	*S.E.*
Intelligence	−.272	0.263	−.766*	0.275	.138	0.559
Winter temperature	−.423*	0.156	−.443*	0.176	.057	0.193
Air pollution	−.214	0.228	−.194	0.265	−.226	n.r.
Wealth	.065	0.304	.260	0.309	.710	n.r.
Demographics	.117	0.148	.111	0.158	.110	1.035
Health risk	−.194	0.127	.020	0.146	−.292*	0.194
Health expand./c	−.138	0.140	−.139	0.150	−.223	2.030
Health sys. qual.	−.328	0.217	−.106	0.243	−.203	1.986
Mobility changes	−.401*	0.155	−.529*	0.182	−.426	n.r.
CoV-2-Tests/c	.005	0.097	−.024	0.107	−.064	2.736
Vaccinations/c	−.156	0.126	.054	0.147	−.104	2.567
Stringency	.039	0.124	−.256	0.141	.262	n.r.
N	207		166	(21%)	41	(19%)
R^2	.313		.413		.999	

Notes. n.r. = no results, italic = dubious results; * $p \leq .05$.

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High Data Qual.		Low Data Qual.		Rich		Poor	
β	S.E.	β	S.E.	β	S.E.	β	S.E.
−.002	0.275	−.088	n.r.	.042	0.280	−.176	0.303
−.698*	0.211	.217	n.r.	−.510*	0.203	−.492*	0.214
.101	0.286	−.160	n.r.	.582*	0.276	.174	0.323
.201	0.380	.098	n.r.	.047	0.202	.364	0.566
.549	0.354	.192	n.r.	.171	0.197	.281	0.395
−.452*	0.175	.408	n.r.	.072	0.162	−.395*	0.187
.020	0.299	.326	n.r.	.105	0.178	.239	0.348
−.779*	0.348	−.152	n.r.	−.122	0.146	−.415	0.341
−.328	0.211	−.260	n.r.	−.449*	0.154	−.614*	0.284
−.147	0.128	.072	n.r.	.087	0.132	−.059	0.129
−.251	0.158	.064	n.r.	−.077	0.127	−.089	0.253
−.068	0.179	.026	n.r.	.255*	0.134	−.176	0.197
75	(36%)	66	(31%)	73	(35%)	131	(63)
.435		1.000		.689		.637	

Table R7 Results from regression analyses of 11 predictors on reproduction rate for 2020

Parameter	All countries		North. Hemisphere		South. Hemisphere	
	β	*S.E.*	β	*S.E.*	β	*S.E.*
Intelligence	−.531*	0.149	−.535*	0.164	−.952	n.r.
Winter temperature	−.555*	0.121	−.630*	0.137	.323	n.r.
Air pollution	.117	0.105	.198	0.124	−.004	n.r.
Wealth	−.196	0.188	−.233	0.230	−1.834	n.r.
Demographics	.429*	0.179	.424*	0.187	1.066	n.r.
Health risk	−.037	0.097	−.073	0.115	.448	n.r.
Health expand./c	.206	0.114	.228	0.122	2.670	n.r.
Health sys. qual.	−.047	0.185	.028	0.204	−1.569	n.r.
Mobility changes	−.382*	0.108	−.462*	0.122	−1.444	n.r.
CoV-2-Tests/c	−.054	0.155	−.032	0.163	−1.176	n.r.
Stringency	−.016	0.090	−.093	0.100	−.424	n.r.
N	207		166	(21%)	41	(19%)
R^2	.308		.326		1.000	

Notes. n.r. = no results, italic = dubious results; * $p \leq .05$.

High Data Qual.		Low Data Qual.		Rich		Poor	
β	*S.E.*	β	*S.E.*	β	*S.E.*	β	*S.E.*
−.420*	0.162	n.r.	n.r.	−.896*	0.280	−.327*	0.140
−.118	0.225	n.r.	n.r.	−.914*	0.215	−.223	0.132
.272	0.144	n.r.	n.r.	−.158	0.203	.227*	0.115
−.175	0.246	n.r.	n.r.	.052	0.227	.088	0.182
.418	0.237	n.r.	n.r.	.686*	0.231	.188	0.193
−.149	0.132	n.r.	n.r.	.252	0.160	−.152	0.112
.112	0.183	n.r.	n.r.	.232	0.186	.072	0.167
−.002	0.243	n.r.	n.r.	−.043	0.163	.051	0.230
−.341*	0.165	n.r.	n.r.	−.308	0.178	−.442*	0.130
.374	0.253	n.r.	n.r.	−.141	0.192	.051	0.238
.006	0.121	n.r.	n.r.	−.120	0.176	−.013	0.118
75	(36%)	66	(31%)	73	(35%)	131	(63)
.430		n.r.		.519		.369	

Table R8 Results from regression analyses of 11 predictors on hospitalized individuals/c for 2020

Parameter	All countries		North. Hemisphere		South. Hemisphere	
	β	*S.E.*	β	*S.E.*	β	*S.E.*
Intelligence	−.021	0.822	.014	0.829	−.952	n.r.
Winter temperature	.297	0.574	.274	0.564	.323	n.r.
Air pollution	.121	0.836	.111	0.919	−.004	n.r.
Wealth	−.168	2.979	−.089	3.524	−1.834	n.r.
Demographics	.943	0.971	.973	1.185	1.066	n.r.
Health risk	.111	0.422	.112	0.473	.448	n.r.
Health expand./c	.283	0.743	.253	0.969	2.670	n.r.
Health sys. qual.	−.084	0.530	−.108	0.532	−1.569	n.r.
Mobility changes	−.399*	0.187	−.365*	0.172	−1.444	n.r.
CoV-2-Tests/c	−.153	0.590	−.225	0.674	−1.176	n.r.
Stringency	−.285	0.360	−.251	0.364	−.424	n.r.
N	207		166	(21%)	41	(19%)
R^2	.885		.912		n.r.	

Notes. n.r. = no results, italic = dubious results; * $p \leq .05$.

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High Data Qual.		Low Data Qual.		Rich		Poor	
β	*S.E.*	β	*S.E.*	β	*S.E.*	β	*S.E.*
n.r.	n.r.	n.r.	n.r.	*−.175*	*0.473*	n.r.	n.r.
n.r.	n.r.	n.r.	n.r.	*.155*	*0.375*	n.r.	n.r.
n.r.	n.r.	n.r.	n.r.	*.257*	*0.464*	n.r.	n.r.
n.r.	n.r.	n.r.	n.r.	*.262*	*0.355*	n.r.	n.r.
n.r.	n.r.	n.r.	n.r.	*1.068**	*0.436*	n.r.	n.r.
n.r.	n.r.	n.r.	n.r.	*.147*	*0.227*	n.r.	n.r.
n.r.	n.r.	n.r.	n.r.	*.023*	*0.371*	n.r.	n.r.
n.r.	n.r.	n.r.	n.r.	*−.080*	*0.179*	n.r.	n.r.
n.r.	n.r.	n.r.	n.r.	*−.349**	*0.142*	n.r.	n.r.
n.r.	n.r.	n.r.	n.r.	*−.427**	*0.169*	n.r.	n.r.
n.r.	n.r.	n.r.	n.r.	*−.241**	*0.294*	n.r.	n.r.
75	(36%)	66	(31%)	73	(35%)	131	(63)
n.r.		n.r.		*.980*		n.r.	

Table R9 Results from regression analyses of 11 predictors on ICU/c for 2020

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Parameter	All countries		North. Hemisphere		South. Hemisphere	
	β	***S.E.***	**β**	***S.E.***	**β**	***S.E.***
Intelligence	*−.487*	*1.031*	−.411	1.046	−.952	n.r.
Winter temperature	*.197*	*0.518*	.214	0.529	.323	n.r.
Air pollution	*−.148*	*1.142*	−.083	1.324	−.004	n.r.
Wealth	*−.146*	*2.111*	−.033	2.142	−1.834	n.r.
Demographics	*1.034**	*0.745*	.996*	0.796	1.066	n.r.
Health risk	*.332*	*0.595*	.300	0.649	.448	n.r.
Health expand./c	*.513*	*0.626*	.474	0.711	2.670	n.r.
Health sys. qual.	*−.480*	*0.543*	−.421	0.525	−1.569	n.r.
Mobility changes	*−.203*	*0.200*	−.192*	0.192	−1.444	n.r.
CoV-2-Tests/c	*−.210*	*0.396*	−.256	0.400	−1.176	n.r.
Stringency	*−.215*	*0.481*	−.205	0.481	−.424	n.r.
N	*207*		166	(21%)	41	(19%)
R^2	*.918*		.936		n.r.	

Notes. n.r. = no results, italic = dubious results; * $p \leq .05$.

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High Data Qual.		Low Data Qual.		Rich		Poor	
β	*S.E.*	β	*S.E.*	β	*S.E.*	β	*S.E.*
−.156	n.r.	n.r.	n.r.	*−.127*	*0.409*	n.r.	n.r.
−.513	9.147	n.r.	n.r.	*.155**	*0.213*	n.r.	n.r.
−.472	7.358	n.r.	n.r.	*.162*	*0.354*	n.r.	n.r.
.459	n.r.	n.r.	n.r.	*.211**	*0.200*	n.r.	n.r.
−.301	n.r.	n.r.	n.r.	*1.054**	*0.251*	n.r.	n.r.
−.089	6.262	n.r.	n.r.	*.350**	*0.179*	n.r.	n.r.
−.362	19.327	n.r.	n.r.	*.181**	*0.232*	n.r.	n.r.
−.246	13.385	n.r.	n.r.	*−.116**	*0.110*	n.r.	n.r.
−.532	7.653	n.r.	n.r.	*−.197**	*0.110*	n.r.	n.r.
.457	12.659	n.r.	n.r.	*−.411**	*0.110*	n.r.	n.r.
.357	n.r.	n.r.	n.r.	*−.161*	*0.300*	n.r.	n.r.
75	(36%)	66	(31%)	73	(35%)	131	(63)
1.000		n.r.		*.995*		n.r.	

Table R10 Results from regression analyses of 11 predictors on registered cases/c for 2020

Parameter	All countries		North. Hemisphere		South. Hemisphere	
	β	*S.E.*	β	*S.E.*	β	*S.E.*
Intelligence	−.175	0.134	−.238	0.147	_−.111_	_0.166_
Winter temperature	−.153	0.109	−.117	0.128	_−.482*_	_0.099_
Air pollution	.096	0.102	.162	0.122	_−1.004*_	_0.150_
Wealth	.373*	0.160	.520*	0.193	_.746*_	_0.200_
Demographics	.023	0.138	.023	0.147	_−.528*_	_0.274_
Health risk	−.074	0.087	−.088	0.107	_.255*_	_0.069_
Health expand./c	.146	0.113	.162	0.121	_−2.139*_	_0.155_
Health sys. qual.	−.135	0.154	−.100	0.175	_−.394*_	_0.162_
Mobility changes	−.164	0.097	−.032	0.116	_−1.235*_	_0.110_
CoV-2-Tests/c	.248*	0.101	.226	0.115	_1.607*_	_0.145_
Stringency	−.022	0.085	.081	0.097	_−.923*_	_0.085_
N	207		166	(21%)	_41_	(19%)
R^2	.276		.304		_.970_	

Notes. n.r. = no results, italic = dubious results; * $p \leq .05$.

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High Data Qual.		Low Data Qual.		Rich		Poor	
β	S.E.	β	S.E.	β	S.E.	β	S.E.
.216	0.151	n.r.	n.r.	−1.170*	0.244	.193	0.142
−.182	0.173	n.r.	n.r.	−.486*	0.201	−.256*	0.117
−.051	0.132	n.r.	n.r.	−.627*	0.185	−.016	0.103
−.529*	0.218	n.r.	n.r.	.952*	0.199	−.220	0.170
.373	0.218	n.r.	n.r.	.559*	0.229	.425*	0.178
−.147	0.119	n.r.	n.r.	.346*	0.142	−.210*	0.100
.435*	0.170	n.r.	n.r.	−.346	0.174	−.043	0.155
−.448*	0.221	n.r.	n.r.	−.298	0.153	−.317	0.196
−.503*	0.151	n.r.	n.r.	.111	0.157	−.449*	0.122
.546*	0.148	n.r.	n.r.	−.411*	0.145	.509*	0.125
−.166	0.122	n.r.	n.r.	.085	0.145	−.197	0.110
75	(36%)	66	(31%)	73	(35%)	131	(63)
.487		n.r.		.537		.497	

Table R11 Results from regression analyses of 11 predictors on registered deaths/c for 2020

doi.org/10.32388/YAEGXV

Parameter	All countries		North. Hemisphere		South. Hemisphere	
	β	*S.E.*	β	*S.E.*	β	*S.E.*
Intelligence	.110	0.152	.161	0.159	*−.497*	*0.459*
Winter temperature	−.297*	0.123	−.231	0.130	*.427*	*0.243*
Air pollution	−.150	0.104	−.145	0.118	*−.682**	*0.310*
Wealth	−.101	0.175	−.250	0.199	*.474*	*0.428*
Demographics	.019	0.145	−.091	0.153	*−.178*	*0.572*
Health risk	−.159	0.097	−.075	0.106	*−.593**	*0.157*
Health expand./c	.271*	0.115	.591*	0.115	*−.956*	*0.661*
Health sys. qual.	−.274	0.169	−.224	0.178	*−.165*	*0.515*
Mobility changes	−.503*	0.101	−.439*	0.109	*−1.073**	*0.272*
CoV-2-Tests/c	−.057	0.103	−.003	0.124	*.825*	*0.616*
Stringency	−.270*	0.088	−.287*	0.091	*−.873**	*0.248*
N	207		166	(21%)	*41*	(19%)
R^2	.268		.393		*.760*	

Notes. n.r. = no results, italic = dubious results; * $p \leq .05$.

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High Data Qual.		Low Data Qual.		Rich		Poor	
β	*S.E.*	β	*S.E.*	β	*S.E.*	β	*S.E.*
.314	0.189	−.013	n.r.	−.418	0.268	.101	0.142
−.465*	0.226	.043	0.124	−.572*	0.214	−.195	0.143
−.165	0.150	.142	0.076	−.495*	0.207	−.082	0.115
−.038	0.264	−.041	0.217	−.071	0.220	.033	0.188
.135	0.251	.117	n.r.	.328	0.273	.182	0.196
−.262	0.139	−.128	0.191	.212	0.159	−.298*	0.117
−.116	0.196	−.053	0.140	.459*	0.188	−.042	0.176
−.405	0.261	.190	0.161	−.289	0.169	−.124	0.213
−.599*	0.175	−.234	0.218	−.543*	0.155	−.422*	0.129
−.055	0.167	.163	n.r.	−.203	0.196	−.170	0.137
−.360*	0.127	.065	0.121	−.058	0.161	−.364*	0.115
75	(36%)	66	(31%)	73	(35%)	131	(63)
.317		.223		.491		.267	

Table R12 Results from regression analyses of 11 predictors on excess mortality rate for 2020

Parameter	All countries		North. Hemisphere		South. Hemisphere	
	β	*S.E.*	β	*S.E.*	β	*S.E.*
Intelligence	−.220	0.276	−.705*	0.242	−.852	n.r.
Winter temperature	−.321*	0.161	−.247	0.169	.379	n.r.
Air pollution	−.152	0.240	.178	0.267	−1.201	n.r.
Wealth	−.192	0.303	.190	0.282	−.305	n.r.
Demographics	.043	0.178	.110	0.181	−.450	n.r.
Health risk	−.194	0.125	−.046	0.133	−.367	n.r.
Health expand./c	.100	0.136	.235*	0.123	−.133	n.r.
Health sys. qual.	−.103	0.227	.127	0.217	−.191	n.r.
Mobility changes	−.663*	0.133	−.594*	0.128	−1.121	n.r.
CoV-2-Tests/c	.029	0.152	.047	0.177	.395	n.r.
Stringency	−.506*	0.116	−.657*	0.101	−1.051	n.r.
N	207		166	(21%)	41	(19%)
R^2	.372		.614		1.000	

Notes. n.r. = no results, italic = dubious results; * $p \leq .05$.

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High Data Qual.		Low Data Qual.		Rich		Poor	
β	S.E.	β	S.E.	β	S.E.	β	S.E.
.201	0.254	.087	n.r.	−.059	0.280	−.042	0.263
−.594*	0.228	−.096	n.r.	−.318	0.220	−.287	0.183
−.088	0.261	.005	n.r.	−.874*	0.230	−.038	0.257
−.082	0.363	−.013	n.r.	.348	0.208	.103	0.508
−.076	0.338	−.043	n.r.	.298	0.293	−.233	0.352
−.427*	0.176	−.035	n.r.	.291*	0.139	−.438*	0.177
−.085	0.274	−.019	n.r.	−.162	0.177	.155	0.314
−.192	0.332	.090	n.r.	−.366*	0.158	.320	0.319
−.715*	0.209	−.024	n.r.	−.266	0.177	−.647*	0.179
−.123	0.160	−.051	n.r.	−.311	0.213	−.196	0.156
−.580*	0.131	.078	n.r.	.157	0.181	−.559*	0.131
75	(36%)	66	(31%)	73	(35%)	131	(63)
.528		.055		.686		.651	

Table R13 Results from regression analyses of 12 predictors on reproduction rate for 2021

Parameter	All countries		North. Hemisphere		South. Hemisphere	
	β	*S.E.*	β	*S.E.*	β	*S.E.*
Intelligence	.290*	0.148	.352*	0.156	*.624*	*3.285*
Winter temperature	.165	0.109	.144	0.125	*−.067*	*0.237*
Air pollution	.091	0.117	.118	0.139	*.496*	*3.854*
Wealth	.113	0.180	.329	0.203	*.269*	*4.262*
Demographics	.025	0.172	−.018	0.182	*−.452*	*5.952*
Health risk	.071	0.093	.217*	0.109	*−.278*	*1.513*
Health expand./c	−.041	0.114	−.072	0.120	*−.077*	*3.506*
Health sys. qual.	−.070	0.152	−.343*	0.167	*.468*	*0.741*
Mobility changes	.179	0.108	.196	0.116	*.383*	*1.449*
CoV-2-Tests/c	−.249	0.169	−.236	0.170	*−1.368*	*8.668*
Vaccinations/c	−.068	0.109	−.135	0.107	*1.935*	*14.113*
Stringency	.444*	0.087	.452*	0.091	*.231*	*0.734*
N	207		166	(21%)	*41*	(19%)
R^2	.271		.340		*.585*	

Notes. n.r. = no results, italic = dubious results; * $p \leq .05$.

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High Data Qual.		Low Data Qual.		Rich		Poor	
β	*S.E.*	β	*S.E.*	β	*S.E.*	β	*S.E.*
.101	0.145	*1.014*	*0.542*	−.778*	0.359	.242	0.140
.224	0.156	*1.720**	*0.709*	−.050	0.231	.134	0.120
.121	0.186	*−.129*	*0.207*	−.279	0.265	.008	0.134
−.016	0.234	*−.023*	*0.454*	−.038	0.229	−.047	0.187
.190	0.246	*−.757*	*0.420*	.509*	0.234	.131	0.184
.070	0.125	*.909**	*0.440*	−.037	0.206	.056	0.098
−.056	0.180	*−.089*	*0.267*	.096	0.214	−.093	0.160
−.219	0.261	*.802*	*0.574*	.002	0.181	−.226	0.193
.012	0.149	*1.113**	*0.449*	.462*	0.168	.142	0.133
.350	0.301	*3.297**	*1.263*	−.066	0.199	.439	0.273
−.121	0.194	*−2.690**	*0.999*	−.388*	0.162	−.235	0.187
.426*	0.166	*−.659*	*0.522*	.314*	0.161	.349*	0.163
75	(36%)	66	*(31%)*	73	(35%)	131	(63)
.367		.693		.386		.323	

Table R14 Results from regression analyses of 12 predictors on hospitalized individuals/c for 2021

Parameter	All countries		North. Hemisphere		South. Hemisphere	
	β	*S.E.*	β	*S.E.*	β	*S.E.*
Intelligence	*−.113*	*0.561*	*−.114*	*0.580*	n.r.	n.r.
Winter temperature	*−.155*	*0.302*	*−.149*	*0.329*	n.r.	n.r.
Air pollution	*1.043**	*0.495*	*1.102**	*0.541*	n.r.	n.r.
Wealth	*−.174*	*0.568*	*−.176*	*0.575*	n.r.	n.r.
Demographics	*.229*	*0.361*	*.264*	*0.382*	n.r.	n.r.
Health risk	*.405**	*0.262*	*.379**	*0.274*	n.r.	n.r.
Health expand./c	*−.077*	*0.123*	*−.070*	*0.133*	n.r.	n.r.
Health sys. qual.	*.135*	*0.284*	*.116*	*0.293*	n.r.	n.r.
Mobility changes	*−.139*	*0.240*	*−.166*	*0.258*	n.r.	n.r.
CoV-2-Tests/c	*−.073*	*0.054*	*−.071*	*0.060*	n.r.	n.r.
Vaccinations/c	*−.052*	*0.128*	*−.040*	*0.128*	n.r.	n.r.
Stringency	*.217*	*0.165*	*.190*	*0.167*	n.r.	n.r.
N	*207*		*166*	*(21%)*	41	(19%)
R^2	*.927*		*.934*		n.r.	

Notes. n.r. = no results, italic = dubious results; * $p \leq .05$.

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High Data Qual.		Low Data Qual.		Rich		Poor	
β	*S.E.*	β	*S.E.*	β	*S.E.*	β	*S.E.*
−.419	45.167	n.r.	n.r.	.200	0.415	n.r.	n.r.
−.285	n.r.	n.r.	n.r.	.073	0.337	n.r.	n.r.
.704	n.r.	n.r.	n.r.	.879*	0.383	n.r.	n.r.
−.137	n.r.	n.r.	n.r.	−.134	0.227	n.r.	n.r.
.460	27.113	n.r.	n.r.	.062	0.424	n.r.	n.r.
.092	n.r.	n.r.	n.r.	.277	0.250	n.r.	n.r.
.093	n.r.	n.r.	n.r.	−.081	0.159	n.r.	n.r.
.217	n.r.	n.r.	n.r.	.087	0.160	n.r.	n.r.
−.138	n.r.	n.r.	n.r.	−.093	0.183	n.r.	n.r.
−.036	n.r.	n.r.	n.r.	−.132	0.085	n.r.	n.r.
−.778	n.r.	n.r.	n.r.	−.116	0.144	n.r.	n.r.
.152	23.268	n.r.	n.r.	.176	0.172	n.r.	n.r.
75	(36%)	66	(31%)	73	(35%)	131	(63)
1.000		n.r.		.889		n.r.	

Table R15 Results from regression analyses of 12 predictors on ICU/c for 2021

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Parameter	All countries		North. Hemisphere		South. Hemisphere	
	β	*S.E.*	β	*S.E.*	β	*S.E.*
Intelligence	−.379	0.913	−.386	0.921	n.r.	n.r.
Winter temperature	−.030	0.496	−.039	0.527	n.r.	n.r.
Air pollution	.421	0.975	.419	1.050	n.r.	n.r.
Wealth	−.181	0.880	−.152	0.871	n.r.	n.r.
Demographics	.226	0.712	.242	0.727	n.r.	n.r.
Health risk	.682	0.476	.676	0.483	n.r.	n.r.
Health expand./c	.031	0.194	.033	0.206	n.r.	n.r.
Health sys. qual.	.486	0.522	.473	0.524	n.r.	n.r.
Mobility changes	−.401	0.500	−.398	0.510	n.r.	n.r.
CoV-2-Tests/c	−.119	0.111	−.125	0.120	n.r.	n.r.
Vaccinations/c	−.162	0.198	−.158	0.193	n.r.	n.r.
Stringency	−.001	0.328	−.004	0.322	n.r.	n.r.
N	207		166	(21%)	41	(19%)
R^2	.726		.747		n.r.	

Notes. n.r. = no results, italic = dubious results; * $p \leq .05$.

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High Data Qual.		Low Data Qual.		Rich		Poor	
β	*S.E.*	β	*S.E.*	β	*S.E.*	β	*S.E.*
.148	25.712	n.r.	n.r.	−.208	0.599	n.r.	n.r.
.389	11.962	n.r.	n.r.	−.015	0.561	n.r.	n.r.
.376	n.r.	n.r.	n.r.	.595	0.806	n.r.	n.r.
−.348	n.r.	n.r.	n.r.	−.055	0.322	n.r.	n.r.
.275	34.836	n.r.	n.r.	.416	0.708	n.r.	n.r.
.105	n.r.	n.r.	n.r.	.504	0.439	n.r.	n.r.
.325	9.834	n.r.	n.r.	.062	0.224	n.r.	n.r.
.230	23.620	n.r.	n.r.	.251	0.271	n.r.	n.r.
.447	n.r.	n.r.	n.r.	−.263	0.297	n.r.	n.r.
.267	12.308	n.r.	n.r.	−.186	0.153	n.r.	n.r.
−.373	n.r.	n.r.	n.r.	−.157	0.206	n.r.	n.r.
−.606	9.065	n.r.	n.r.	−.057	0.278	n.r.	n.r.
75	(36%)	66	(31%)	73	(35%)	131	(63)
1.000		n.r.		.782		N:R:	

Table R16 Results from regression analyses of 12 predictors on registered cases/c
for 2021

doi.org/10.32388/YAEGXV

Parameter	All countries		North. Hemisphere		South. Hemisphere	
	β	*S.E.*	β	*S.E.*	β	*S.E.*
Intelligence	−.158	0.117	−.170	0.127	−.521*	0.217
Winter temperature	−.133	0.090	−.158	0.104	−.076	0.103
Air pollution	−.040	0.091	−.102	0.113	−.305	0.207
Wealth	−.014	0.132	.069	0.156	−.220	0.324
Demographics	.127	0.113	.056	0.124	.619	0.434
Health risk	.174*	0.073	.305*	0.092	−.042	0.133
Health expand./c	−.006	0.092	.043	0.102	−.440	0.318
Health sys. qual.	.077	0.122	−.040	0.137	.270	0.220
Mobility changes	−.128	0.084	−.089	0.093	.119	0.140
CoV-2-Tests/c	.149	0.075	.145	0.078	.966	0.637
Vaccinations/c	.370*	0.371	.243*	0.239	−.130	1.057
Stringency	.091	0.069	.095	0.079	.077	0.121
N	207		166	(21%)	41	(19%)
R^2	.502		.484		.925	

Notes. n.r. = no results, italic = dubious results; * $p \leq .05$.

High Data Qual.		Low Data Qual.		Rich		Poor	
β	*S.E.*	β	*S.E.*	β	*S.E.*	β	*S.E.*
−.146	0.124	*.425**	*0.065*	−.351	0.278	−.013	0.097
.250*	0.122	*.224**	*0.037*	−.257	0.195	−.067	0.083
.101	0.134	*−.009*	*0.015*	−.171	0.214	−.026	0.083
−.479*	0.176	*−.145*	*0.119*	−.121	0.184	−.221	0.120
.298	0.188	*.123**	*0.030*	.158	0.191	.231	0.124
.055	0.092	*.424**	*0.039*	.288	0.161	.040	0.070
.549*	0.137	*.363**	*0.063*	.012	0.176	.616*	0.106
.298	0.187	*−.553**	*0.111*	−.002	0.147	−.247	0.132
−.181	0.147	*.371**	*0.067*	−.207	0.150	−.149	0.097
.254	0.143	*1.562**	*0.228*	.117	0.134	.423*	0.094
.247*	0.123	*−.349*	*0.222*	.450*	0.133	−.028	0.092
.008	0.100	*−.235**	*0.084*	−.011	0.134	.037	0.082
75	(36%)	66	(31%)	73	(35%)	131	(63)
.649		*1.000*		.457		.703	

Table R17 Results from regression analyses of 12 predictors on registered deaths/c for 2021

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Parameter	All countries		North. Hemisphere		South. Hemisphere	
	β	*S.E.*	β	*S.E.*	β	*S.E.*
Intelligence	−.135	0.123	−.130	0.125	*−.438*	*0.501*
Winter temperature	−.318*	0.101	−.260*	0.112	*−.374**	*0.167*
Air pollution	−.130	0.100	−.168	0.118	*−.476*	*0.431*
Wealth	−.017	0.151	.001	0.169	*−.564*	*0.450*
Demographics	.148	0.122	.031	0.128	*2.108**	*0.647*
Health risk	.080	0.083	.291*	0.098	*−.261*	*0.201*
Health expand./c	−.179	0.104	−.115	0.109	*−1.594**	*0.366*
Health sys. qual.	.104	0.139	.090	0.150	*−.237*	*0.275*
Mobility changes	−.139	0.085	−.046	0.094	*−.068*	*0.260*
CoV-2-Tests/c	.113	0.080	.120	0.081	*3.984**	*0.659*
Vaccinations/c	−.004	0.088	−.023	0.091	*−4.094**	*1.049*
Stringency	.129	0.077	.086	0.084	*.755**	*0.226*
N	207		166	(21%)	*41*	(19%)
R^2	.306		.375		.759	

Notes. n.r. = no results, italic = dubious results; * $p \leq .05$.

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High Data Qual.		Low Data Qual.		Rich		Poor	
β	*S.E.*	β	*S.E.*	β	*S.E.*	β	*S.E.*
−.041	0.132	*−.320*	*0.389*	.313	0.270	−.069	0.107
−.192	0.149	*−1.103*	*0.589*	−.169	0.192	−.305*	0.105
.070	0.152	*−.020*	*0.151*	.122	0.207	−.058	0.102
−.377	0.219	*−.107*	*0.265*	−.219	0.179	−.024	0.147
.586*	0.228	*.604*	*0.385*	−.050	0.175	.307*	0.148
−.173	0.117	*−.064*	*0.278*	.171	0.155	−.042	0.084
.478*	0.169	*.513**	*0.205*	−.108	0.173	.440*	0.138
−.026	0.223	*−.445*	*0.374*	.087	0.143	−.273	0.166
−.142	0.146	*−.394*	*0.306*	−.231	0.139	−.202	0.104
−.135	0.140	*−1.718*	*1.198*	.059	0.116	−.019	0.126
−.026	0.120	*1.616*	*1.599*	.243	0.132	−.173	0.125
.063	0.117	*.110*	*0.195*	.203	0.132	.005	0.095
75	(36%)	*66*	*(31%)*	73	(35%)	131	(63)
.425		.697		.451		.424	

Table R18 Results from regression analyses of 12 predictors on excess mortality rate for 2021

Parameter	All countries		North. Hemisphere		South. Hemisphere	
	β	*S.E.*	β	*S.E.*	β	*S.E.*
Intelligence	−.401	0.326	−.501*	0.342	n.d.	n.d.
Winter temperature	−.020	0.168	.106	0.181	n.d.	n.d.
Air pollution	−.088	0.292	−.185	0.356	n.d.	n.d.
Wealth	−.192	0.293	−.077	0.290	n.d.	n.d.
Demographics	.088	0.148	.002	0.163	n.d.	n.d.
Health risk	−.178	0.132	−.015	0.148	n.d.	n.d.
Health expand./c	−.037	0.130	−.022	0.136	n.d.	n.d.
Health sys. qual.	−.343	0.255	−.242	0.271	n.d.	n.d.
Mobility changes	−.085	0.188	.288	0.227	n.d.	n.d.
CoV-2-Tests/c	.062	0.080	.108	0.087	n.d.	n.d.
Vaccinations/c	−.070	0.129	−.069	0.124	n.d.	n.d.
Stringency	.097	0.132	−.073	0.140	n.d.	n.d.
N	207		166	(21%)	41	(19%)
R^2	.646		.799		n.d.	

Notes. n.r. = no results, italic = dubious results; * $p \leq .05$.

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High Data Qual.		Low Data Qual.		Rich		Poor	
β	S.E.	β	S.E.	β	S.E.	β	S.E.
.088	0.431	−.396	n.r.	.210	0.323	−.439	n.r.
−.539*	0.294	.250	n.r.	−.116	0.238	−.384*	0.238
−.485	0.560	.108	n.r.	.663*	0.324	.547*	0.389
−.085	0.423	−.022	n.r.	.129	0.246	.133	0.465
.564*	0.375	.042	n.r.	−.002	0.220	.140	0.393
−.321*	0.190	−.182	n.r.	.176	0.205	.176*	0.024
−.209	0.366	−.178	n.r.	−.192	0.213	.227*	0.194
−.557	0.447	−.297	n.r.	−.180	0.171	−.774*	0.510
−.344	0.294	.078	n.r.	−.272	0.194	−.660*	0.201
−.362	0.344	−.124	n.r.	.160	0.125	−.756	n.r
.073	0.350	−.094	n.r.	.248	0.163	.291*	0.671
.250	0.219	−.089	n.r.	−.042	0.168	.338*	0.101
75	(36%)	66	(31%)	73	(35%)	131	(63)
.796		1.000		.524		.998	

References

1. a, b, c Gorbalenya AE, Baker SC, Baric RS, de Groot RJ, Drosten Ch, Gulyaeva AA, ... & Ziebuh J. *The species severe acute respiratory syndrome related coronavirus: classifying 2019-nCoV and naming it SARS-CoV-2. Nat. Microbiol. 2020; 5, 536–544. https://doi.org/10.1038/s41564-020-0695-z*
2. a, b *WHO. Weekly epidemiological update on COVID-19 - 29 June 2021. 2020. https://www.who.int/publications/m/item/weekly-epidemiological-update-on-covid-19---29-june-2021*
3. ^ *WHO. Scaling Up, Saving Lives - Task force for scaling up education and training for health workers, Global Health Workforce Alliance. 2008. https://www.who.int/workforcealliance/documents/Global_Health_FINAL_REPORT.pdf?ua=1*
4. ^ *Lynn R, & Becker D. The intelligence of nations. Ulster Institute for Social Research. 2019.*
5. ^ *Kodila-Tedika O, & Asongu SA. Genetic distance and cognitive human capital: A cross-national investigation. J. Bioeconomics. 2016; 18, 33–51. https://doi.org/10.1007/s10818-015-9210-7*
6. ^ *Reeve CI. Expanding the g-nexus: Further evidence regarding the relations among IQ, religiosity, and national health outcomes. Intelligence. 2009; 37(5), 495–505. https://doi.org/10.1016/j.intell.2009.06.003*
7. ^ *Rindermann H, & Meisenberg G. Relevance of education, intelligence, and knowledge at the national level for non-economic welfare: The case of HIV and AIDS. Intelligence. 2009; 37(2), 383–395. https://doi.org/10.1016/J.INTELL.2007.02.002*
8. ^ *Rushton JP, & Templer DI. National differences in intelligence, crime, income and skin color. Intelligence. 2009; 37(4), 341–346. https://doi.org/10.1016/j.intell.2009.04.003*
9. ^ *Woodley MA, Rindermann H, Bell E, Stratford J, & Piffer D. The relationship between Microcephalin, ASPM and intelligence: A reconsideration. Intelligence. 2014; 44, 51–63. https://doi.org/10.1016/j.intell.2014.02.011*
10. ^ *Daniele V, & Ostuni N. The burden of disease and the IQ of nations. Learn Individ Differ. 2013; 28, 109–118. https://doi.org/10.1016/j.lindif.2013.09.015*
11. ^ *Cui J, LiF, & Shi Z-L. Origin and evolution of pathogenic coronaviruses. Nat. Rev. Microbiol. 2019; 17, 181–192. https://doi.org/10.1038/s41579-018-0118-9*
12. ^ *RKI (Robert Koch Institut). SARS-Epidemie im Jahr 2003 (Teil 1) [SARS epidemic in 2003 (part 1)]. Epidemiologisches Bulletin, 8, 61–65.*
13. ^ *Enserink M. SARS: Chronology of the epidemic. Science. 2004; 339(6125), 1266–1271. https://doi.org/10.1126/science.339.6125.1266*
14. ^ *Hanlon P, Chadwick F, Shah A, Wood R, Minton J, McCartney G, ... & McAllister DA. COVID-19 – exploring the implications of long-term condition type and extent of multimorbidity on years of life lost: A modelling study. Wellcome Open Research. 2020; 5(75). https://doi.org/10.12688/wellcomeopenres.15849.1*
15. ^ *World Heart Federation. COVID-19 and CVD individuals with pre-existing medical conditions, such as heart disease, are at higher risk. 2020. www.world-heart-federation.org/covid-19-and-cvd*
16. ^ *Mai F, Del Pinto R, & Ferri C. COVID-19 and cardiovascular diseases. J. Cardiol. 2020; 76, 453–458. https://doi.org/10.1016/j.jjcc.2020.07.013*
17. ^ *Mehra MR, Desai SS, Kuy SR, Henry TD, & Patel AM. Cardiovascular disease, drug therapy, and mortality in Covid-19. NEJM. 2020; 382, e102. https://doi.org/10.1056/NEJMoa2007621*
18. ^ *Patanavanich R, & Glantz StA. Smoking is associated with COVID-19 progression: A meta-analysis. medRxiv preprint. 2020. https://doi.org/10.1101/2020.04.13.20063669*
19. ^ *Singh SK, Jain R, & Singh S. Vitamin D deficiency in patients with diabetes and COVID- 19 infection. Diabetes and Metabolic Syndrome. Diabetes Metab Syndr. 2020; 14, 1033–1035. https://doi.org/10.1016/j.dsx.2020.06.071*
20. a, b *Ilie PC, Stefanescu S, & Smith L. The role of vitamin D in the prevention of coronavirus disease 2019 infection and mortality. Aging Clin. Exp. Res. 2020. https://doi.org/10.1007/s40520-020-01570-8*
21. ^ *Katz J, Yue S, & Xue W. Increased risk for COVID-19 in patients with vitamin D deficiency. Nutrition. 2021; 84, 111106. https://doi.org/10.1016/j.nut.2020.111106*
22. ^ *McCartney DM, O'Shea PM, Faul JL, Healy MJ, Byrne G, Griffin TP, ... & Kenny RA. Vitamin D and SARS-CoV-2 infection-evolution of evidence supporting clinical practice and policy development: A position statement from the Covit-D Consortium. Ir J Med Sci. 2021; 190(3), 1253–1265. https://doi.org/10.1007/s11845-020-02427-9*
23. ^ *Barbosa C, Cowell AJ, & Dowd WN. Alcohol consumption in response to the COVID-19 pandemic in the United States. Journal of Addiction Medicine. 2020. https://doi.org/10.1097/ADM.0000000000000767*
24. ^ *Tung NTh, Cheng P-Ch, Chi K-H, Hsiao TCh, Jones TJ, BéruBé K, ... & Chuang H-Ch. Particulate matter and SARS-CoV-2: A possible model of COVID-19 transmission. Sci Total Environ. 2020; 750, 141532. https://doi.org/10.1016/j.scitotenv.2020.141532.*
25. ^ *Ogen Y. Assessing nitrogen dioxide (NO2) levels as a contributing factor to coronavirus (COVID-19) fatality. Sci Total Environ. 2020; 726, 138605. https://doi.org/10.1016/j.scitotenv.2020.138605*
26. ^ *Copiello S, & Grillenzoni C. The spread of 2019-nCoV in China was primarily driven by population density. Comment on "association between short-term exposure to air pollution and COVID-19 infection: evidence from China" by Zhu et al. Sci Total Environ. 2020; 744, 141028. https://doi.org/10.1016/j.scitotenv.2020.141028*
27. ^ *Eppig Ch, Fincher CL, & Thornhill R. Parasite prevalence and the worldwide distribution of cognitive ability. Proc Royal Soc B. 2010; 277, 3801–3808. https://doi.org/10.1098/rspb.2010.0973*
28. ^ *Lowen AC, & Steel J. Roles of humidity and temperature in shaping Influenza seasonality. J Virol. 2014; 88(14), 7692–7695. https://doi.org/10.1128/JVI.03544-13*
29. ^ *Lynn R, & Meisenberg G. Race differences in deaths from Coronavirus in England and Wales: Demographics, poverty, pre-existing conditions, or intelligence? Mankind Q. 2020; 60(4), 511–524. https://doi.org/10.46469/mq.2020.60.4.4*
30. ^ *Rindermann H, Falkenhayn L, & Baumeister AEE. Cognitive ability and epistemic rationality: A study in Nigeria and Germany. Intelligence. 2014; 47, 23–33. https://doi.org/0.1016/j.intell.2014.08.006*
31. ^ *Ioannidis JPA. Infection fatality rate of COVID-19 inferred from seroprevalence data. Bulletin of the World Health Organization: Research. 2020. https://doi.org/10.1101/2020.05.13.20101253*

32. ^Hanushek EA, & Woessmann L. The economic impacts of learning losses. 2020; OECD.
33. ^Raffelhüschen B. Verhältnismäßigkeit in der Pandemie: Geht das? [Appropriateness during the pandemic: Is this possible?]. 2020; Universität Freiburg.
34. ^Rindermann H. The coronavirus and its social consequences. 2020. The Unz Review. www.unz.com/article/the-coronavirus-and-its-social-consequences
35. ^Czeisler MÉ, Lane RI, Petrosky E, Wiley JF, Christensen A, Njai R, ... Rajaratnam SMW. Mental health, substance use, and suicidal ideation during the COVID-19 pandemic—United States, June 24–30, 2020. MMWR. 2020; 69(32), 1049–1057.
36. ^Schröder M. The effect of the Covid-19 pandemic on human well-being. 2020. www.martin-schroeder.de/2020/06/05/the-effect-of-the-covid-19-pandemic-on-human-well-being
37. ^Jones G. Hive mind: How your nation's IQ matters so much more than your own. 2016. Stanford University Press.
38. ^Rindermann H. Cognitive capitalism: Human capital and the wellbeing of nations. 2018. Cambridge University Press.
39. ^Deary IJ. Intelligence. Annu Rev Psychol. 2012; 63, 453–482. https://doi.org/10.1146/annurev-psych-120710-100353
40. ^Gottfredson L. Intelligence: Is it the epidemiologists' elusive „fundamental cause" of social class inequalities in health? J Pers Soc Psychol. 2004; 86(1), 174–199. https://doi.org/10.1037/0022-3514.86.1.174
41. ^Becker D. A corrigendum to V1.3.2 and a comment to V1.3.3. 2019. https://viewoniq.org/?p=134
42. ^Rindermann H & Baumeister AEE. Validating the interpretations of PISA and TIMSS tasks: A rating study. Int J Test. 2015; 15(1), 1–22. https://doi.org/10.1080/15305058.2014.966911
43. ^The European Human Behaviour and Evolution Association Committee. EHBEA Statement on National IQ Datasets. 2020. https://ehbea2020.com/wp-content/uploads/2020/07/EHBEA_IQ_statement.pdf
44. a, b, c, dLim SS, Updike RL, Kaldjian AS, Barber RM, Cowling K, York H, ... Murray CJL. Measuring human capital: A systematic analysis of 195 countries and territories, 1990–2016. Lancet. 2018; 392(10154), 1217–1234. https://doi.org/10.1016/S0140-6736(18)31941-X
45. a, b, c, dAngrist N, Djankov S, Goldberg PK, & Patrinos HA. Measuring human capital using global learning data. Nature. 2021; 592, 403–408. https://doi.org/10.1038/s41586-021-03323-7
46. ^CantyMedia. Weatherbase. 2020. http://www.weatherbase.com/weather/countryall.php3
47. ^WHO. Air pollution. 2020. https://www.who.int/health-topics/air-pollution#tab=tab_1
48. a, b, c, d, e, fCIA. The world fact book. 2020. www.cia.gov/library/publications/the-world-factbook
49. a, b, cOur World in Data. Coronavirus pandemic data explorer. 2021. https://ourworldindata.org/coronavirus-data-explorer?zoomToSelection=true&time=2020-03-01..latest&country=~IND®ion=World&casesMetric=true&interval=smoothed&perCapita=true&smoothing=7&pickerMetric=population_density&pickerSort=asc
50. ^WHO. Alcohol, recorded per capita (15+) consumption (in litres of pure alcohol), three-year average with 95%CI. 2020. https://www.who.int/data/gho/data/indicators/indicator-details/GHO/alcohol-recorded-per-capita-(15-)-consumption-(in-litres-of-pure-alcohol)-three-year-average-with-95-ci
51. ^Cancer Atlas. Cancer deaths attributable to alcohol. 2020. https://canceratlas.cancer.org/data/map
52. ^WHO. Global Health Observatory data repository. 2021. https://apps.who.int/gho/data/view.main.35300
53. ^Google. The COVID-19 community mobility reports. 2021. www.google.com/covid19/mobility
54. ^Armstrong SJ. Significance tests harm progress in forecasting. Int J Forecast. 2007; 23, 321–327. https://doi.org/10.1016/j.ijforecast.2007.03.004
55. ^Cohen J. The earth is round (p <.05). Am Psychol. 1994; 49(12), 997¬–1003.
56. ^Gigerenzer G. Mindless statistics. Int J Soc Econ. 2004; 33, 587–606. https://doi.org/10.1016/j.socec.2004.09.033
57. ^Hunter JE. Needed: A ban on the significance test. Psychol Sci. 1997; 8(1), 3–7.
58. ^Wasserstein RL, Schirm AL, & Lazar NA. Moving to a world beyond "p < 0.05". Am Stat. 2019; 73(1), 1–19. https://doi.org/10.1080/00031305.2019.1583913
59. ^World Bank. Data on statistical capacity. 2020. https://datatopics.worldbank.org/statisticalcapacity
60. ^Cohen J. Statistical power analysis for the behavioral sciences - Second Edition. 1988, Lawrence Erlbaum Associates.
61. ^Africa Center for Strategic Studies. Analyzing Africa's Second Wave of COVID-19. 2021. https://africacenter.org/spotlight/analyzing-africas-second-wave-of-covid-19
62. ^Carletti M, & Pancrazi R. Geographic negative correlation of estimated incidence between first and second waves of Coronavirus Disease 2019 (COVID-19) in Italy. Mathematics. 2021; 9(2), 133. https://doi.org/10.3390/math9020133
63. ^Iftimie S, López-Azcona AF, Vallverdú I, Hernàndez-Flix S, de Febrer G, Parra S, ... & REUSCOVID Study Group. First and second waves of coronavirus disease-19: A comparative study in hospitalized patients in Reus, Spain. medRxiv, 2020.12.10.20246959. https://doi.org/10.1101/2020.12.10.20246959
64. ^Shim E, Tariq A, & Chowell G. Spatial variability in reproduction number and doubling time across two waves of the COVID-19 pandemic in South Korea, February to July, 2020. Int J Infect Dis. 2020; 102, 1–9. https://doi.org/10.1016/j.ijid.2020.10.007.
65. ^Becker D, & Rindermann H. The relationship between cross-national genetic distances and IQ-differences. Pers Individ. 2016; 98, 300–310. https://doi.org/10.1016/j.paid.2016.03.050
66. ^Rindermann H, Becker D, & Coyle ThR. Survey of expert opinion on intelligence: Causes of international differences in cognitive ability tests. Front Psychol. 2016; 7 (399), 1–9. https://doi.org/10.3389/fpsyg.2016.00399
67. ^Miles DK, Stedman M, & Heald AH. "Stay at Home, Protect the National Health Service, Save Lives": A cost benefit analysis of the lockdown in the United Kingdom. Int J Clin. 2020; e13674. https://doi.org/ 10.1111/ijcp.13674

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