Culture and COVID-19-related mortality: a cross-sectional study of 50 countries

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Abstract

Using a cross-sectional sample of 50 countries we investigate the influence of Hofstede's six-dimensions of culture on COVID-19 related mortality. A multivariable regression model was fitted that controls for health-related, economic- and policy-related variables that have been found to be associated with mortality. We included the percentage of population aged 65 and above, the prevalence of relevant comorbidities, and tobacco use as health-related variables. Economic variables were GDP, and the connectedness of a country. As policy variables, the Oxford Stringency Index as well as stringency speed, and the Global Health Security Index were used. We also describe the importance of the variables by means of a random forest model. The results suggest that individualistic societies are associated with lower COVID-19-related mortality rates. This finding contradicts previous studies that supported the popular narrative that collectivistic societies with an obedient population are better positioned to manage the pandemic.

Keywords COVID-19 · Policy response · Mortality · Culture · Random forest

Key messages

- Not the level of containment measures but the speed of implementation is associated with a reduction in mortality.
- Cultural Values influence COVID-19-related mortality as well. In particular, COVID 19-related mortality is lower in individualistic societies.

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Introduction

Few researchers have explored the influence of cultural values on health, although concepts of health differ across societies. A report of World Health Organization (WHO) highlights increasing appreciation for improving understanding of cultural factors that affect health-improving behaviors [1]. In 2014, the authors of a Lancet Commission on Culture and Health argued that "the systematic neglect of culture in health and health care is the single biggest barrier to the advancement of the highest standard of health worldwide" [2]. People respond to quality-of-life surveys based on cultural values, with far reaching consequences for health technology assessment and, subsequently, for valuing and pricing medical interventions [3]. The framework of culture also directs consumers' selection of healthy food and eating behavior [1]. A considerable steam of the literature about COVID-19 analyzes factors influencing the spread of infection and resulting mortality. As of 2021, COVID-19 claimed more than 25 million lives globally [4]. Most studies take clinical and socioeconomic variables into account to explain mortality but accord little attention to culture as an influencing factor. Among some notable exceptions is the study by Gokmen et al. [5] who build upon Hofstede's work on national culture. Hofstede's pioneering model consists of six dimensions that constitute cultural norms [6, 7]: Power distance, individualism, masculinity, uncertainty avoidance, long term orientation, and indulgence. In their empirical analysis Gokmen et al. reported significant and positive associations between COVID-19 incident rates in selected European countries' individualism and indulgence, and also reported that power distance was negatively related to COVID-19 incidence. Individualism in Hofstede's sense is a social preference for a "loosely-knit social framework in which individuals are expected to take care of only themselves and their immediate families" [8]. The authors interpreted the link between individualism and COVID-19 cases as the way that individualistic cultures feel less responsible for achieving collective goals such as the containment of a pandemic and, therefore, are less supportive towards policies that restrict individual rights even though the society at large might benefit from them. In individualistic countries, where privacy is highly valued [9] some containment measures such as contact tracking are difficult to achieve. In a more collectivistic societies, people are more willing to sacrifice personal freedom for the sake of collective benefits [10].

Gokmen et al. put forward similar argument for the impact of indulgence. Indulgence means "a society that allows relatively free gratification of basic and natural human drives related to enjoying life and having fun" [6]. The opposite of indulgent cultures are restraint societies with strict social norms [11]. There, the argument is that such societies more easily accept restrictions in daily life at the expense of quality of life. Power distance describes to what extent less powerful members of societies accept an unequal distribution of power. Here, the authors posit that societies with a high-power distance are less likely to follow orders by state authorities, thus containment measures are less effective.

Chen et al. conducted another study that empirically linked cultural variables with COVID-19 outcomes [12]. They found that individualistic cultures are slow

to respond to the COVID-19 pandemic and that higher speed implementation of containment measures leads to a lower COVID-19 related mortality. This result partly echoes the findings Cao et al. [13] who established a negative correlation between Hofstede's individualism dimension and both incidence and mortality rates.

Notwithstanding the substantial new insights that those studies provide, none of them controlled for clinical parameters that are known to be associated with COVID-19 related mortality. Clinical variables may be even more important in terms of effect size, thus their absence would result in an underspecified model. Omitted variables can lead to biased and inconsistent coefficient estimates. We offer a fresh look at the relationship between culture and COVID-19 related mortality while taking into consideration a set of variables associated with both COVID-19 incidence and mortality, such as age, obesity, and co-morbidities such as cancer, cardiovascular diseases, and high blood pressure [14–17]. Controlling for those factors allows for better specification of the model and might lead to different results.

Methods

Variables and data sources

We assembled a cross-sectional dataset of 50 countries starting at the beginning of the pandemic from 1 January 2020 through 27 April 2021.

The outcome variable in our model is the COVID-19 related mortality rate defined as the cumulative number of confirmed deaths per million population (taken from a publicly accessible data set assembled by the University of Oxford) [18]. We prefer the mortality rate over infection counts because a large proportion of infections with COVID-19 from non-risk individuals are mild and, therefore, measurement errors might occur regarding incidence. The availability and quality of testing varies markedly among countries. In contrast, data on death rates can be more easily and reliably collected.

Explanatory variables of interest are the cultural dimensions of Hofstede. Hofstede distinguishes between human nature, culture, and personality. Universal human nature is innate and common to all human beings. Personality is specific to an individual and is both learned and inherited. Culture lies between human nature and personality and is specific to a group. Because its source is the social environment, culture it is learned rather than innate. Hofstede's original empirical research presented results of a value study of over 110,000 IBM employees from 40 countries, between 1967 and 1973. Hofstede used factor analysis to define four cultural dimensions based on this data set, after which several replication studies expanded to six dimensions. The latest published update of the database, in 2013, contains 57 countries [19]. Values for the six indices are available online [20]. According to Hofstede, the current six cultural dimensions are: the power distance index (PDI), individualism versus collectivism (IDV), masculinity versus femininity (MAS), the uncertainty avoidance index (UAI), long term versus short term orientation (LTO) and indulgence versus restraint (IVR). PDI describes

how a society deals with inequality, with a higher value associated with greater acceptance of inequality. High IDV scores indicate a preference for a loose society with a focus on the individual. The collective self-image here is defined more as "me" as opposed to "we." The MAS dimension attempts to enact a society between competitive and consensual values. UAI is concerned with a society's attitude toward an uncertain future. A high value in this dimension is associated with intolerance of deviant behavior, while a low value suggests a more relaxed attitude. High-LTO scores describe a society with a high focus on the future. Low values describe more traditional attitudes, with aversion to major change. The sixth dimension, IVR, places nations between free enjoyment and restraint [21]. Table 1 that was taken from Erlach and Eriksson [22] provides a summary of the six dimensions.

In his book 'Cultures and Organization' Hofstede et al. provide numerous examples to illustrate how health-related behavior is shaped by his cultural dimensions [23]. In a society characterized by higher acceptance of inequality (*high power distance*), doctor–patient interactions take less time, and there is less room for unexpected information. In cultures that score high on *individualism*, people tend to have a greater concern for their own health. Hofstede et al. also observed that *uncertainty avoiding* countries spend more healthcare resources on doctors and less on nurses; the opposite is true for uncertainty-accepting countries. Uncertainty avoiding cultures, therefore, delegate more tasks to those regarded as experts to minimize risks. Self-ratings of health negatively correlate with uncertainty -avoidance and positively with higher scores on indulgence. People from UA-countries tend to suffer more often from anxiety

Table 1 Dimensions of culture and their interpretation

Dimension	Interpretation
PDI-Power distance (high vs. low)	The degree to which less powerful members of a society accept and expect that power is distributed unequally
IDV-Individualism (vs. collectivism)	A preference for a loosely knit social framework in which individuals are expected to take care of themselves and their immediate families only
MAS-Masculinity (vs. femininity)	A preference in society for achievement, heroism, assertiveness, and material rewards for success
UAI-Uncertainty avoidance (high vs low)	The degree to which the members of a society feel uncomfortable with uncertain and ambiguous situations
LTO-long term orientation (vs short term orientation)	The degree to which members of the society are encouraged to thrift and take efforts in modern education as a way to prepare for the future
IVR-Indulgence (vs self-restraint)	The degree to which members of the society are allowed free gratification of basic and natural human drives related to enjoying life and having fun

Source: Erlach and Eriksson [22]

and subsequently from mental health problems. Doctors in uncertainty-avoiding countries also prescribe more medications than their peers in countries with low UAI scores.

Although the model and its simplification of culture to a few cultural dimensions is not without controversy, especially for multiethnic societies [24], it still represents an important tool for understanding culture in an international comparison as well as in a professional context [25].

We used several covariates in our analysis. We considered the prevalence of co-morbidities that might be associated with a severe course of the COVID disease we draw from the World Health Organization. This include the percentage of the population with obesity (Body Mass Iindex [BMI] above 30) [26] and hypertension [27]; WHO reported the latter to be a risk factor for severe disease aggravation [28]. From the same database we also include the percentage of the population that regularly uses tobacco products [29] because patients with a smoking history have a higher likelihood of developing a more severe disease course [30]. The prevalence of cancer, another relevant co-morbidity, we draw from the Global Health Data Exchange [31]. We also included the proportion of the total population over age 65 from the Worldbank database [32] because age is major risk factor for COVID-19 related mortality [33,34]. Finally, we used the proportion of the population between 20 and 79 with diabetes [35] because a recent meta-analysis suggested that diabetes is one major cause of COVID-19 related mortality [36].

Besides the clinical covariates we used the Gross Domestic Product (GDP) per capita as an economic performance indicator, assuming that people in higher resource countries have better access to health care and modern treatments. Values were in constant 2017 USD using purchasing power parities as exchange rates. Those data also come from the World Bank [37]. We used the Global Health Security Index, an attempt to quantify how prepared a country is to respond effectively to a pandemic outbreak [38]. Another variable we used to explain COVID-19 mortality included the connectedness of a country measured by the number of international arrivals [39]. We take these data from the World Bank [40].

Finally, we included two variables to assess government measures of pandemic containment. First, we use the "COVID-19 government response tracker" stringency index [18]. This index consists of several subscores on restriction measures, and an overall index. We used the overall index in our analysis. It is intended to quantify the severity of national pandemic containment measures. We included only the overall index, the mean of the daily total index since the beginning of the pandemic, as a control variable. Second, we included the stringency speed index that relates to the time the government takes to impose containment measures. Researchers consider reaction speed to be more effective than the level of stringency. For example, one study suggests the elapsed time between the first death in a nation and the ban on public events as a significant factor [41]. The Stringency speed, taken from Chen et al., is calculated as the as the marginal rate of change of Stringency Index [12]. Table 2 provides a summary of the variables including data sources and motivation for inclusion.

Table 2 List of variables

Independent variable	Designation in model	Source	Year of measurement	Justification for variable selection
COVID 19 related mortality per 1 million population	Deaths_Mio	Oxford Covid-19 Government Response Tracker (OxCGRT) [18]	2020–2021	---
Percent of population with elevated blood pressure	Blood_Pressure	World health organization [27]	2015	Co-morbidities [15, 16]
Percent of population with BMI > 30	Obesity	World health organization [26]	2016	Co-morbidities [14]
Percent of population that regularly consume tobacco products	Tobacco_Use	World health organization [29]	2018	Personal risk factors [29]
GDP per capita (PPP) in constant 2017 USD	GDP_Capita	World bank [37]	2019	Financial resources [14, 17]
Annual foreign arrivals per million inhabitants	Arrivals_Mio	World bank [40]	2019	External risk factors [38]
Percent of population over 65 years of age	Population_65	World bank [32]	2019	Personal risk factors [15]
Percent of the population between 20 and 79 with diabetes	Diabetes	World bank [35]	2019	Co-morbidities [15]
Cancer cases per 100,000 inhabitants	Cancer	Global health data exchange [31]	2017	Co-morbidities [15]
Average daily Oxford Stringency Index from 01.01.2020 to 27.04.2021	Ox	Oxford Covid-19 Government Response Tracker (OxCGRT) [18]	2020–2021	Government response [46, 47]
Stringency speed	Speed	Chen et al. [12]	2020	Government response [12, 40]
Global Health Security overall index	GHS	Global health security index [38]	2019–2021	Robustness of health care system [46]
Power distance index	PDI	Hofstede [20]	2013	Culture
Individualism index	IDV	Hofstede [20]	2013	Culture
Uncertainty avoidance index	UAI	Hofstede [20]	2013	Culture
Masculinity index	MAS	Hofstede [20]	2013	Culture
Long term orientation	LTO	Hofstede [20]	2013	Culture
Indulgence index	IVR	Hofstede [20]	2013	Culture

Statistical analysis

We employed a multivariate regression model that examines the association of Hofstede's six cultural dimensions with the cumulative number of COVID-19 deaths in a country. We included the value a country achieves on each dimension as a single variable in the model. The model also included the control variables presented above. Absolute counts were divided by the number of millions of inhabitants to make them comparable; we kept relative values and indices unchanged. We then standardized all variables to zero mean and standard deviation of one using z-transformation. Correlations between individual variables were calculated and displayed in a correlation matrix. We then examined combinations of variables with the greatest correlation coefficients using an interaction plot to examine whether interaction effects between variables are present. We plotted regression curves with confidence bands to illustrate the examined associations. Model fitting was done as follows: we first ran the model with all variables and then applied backwards elimination using Akaike information criterion (AIC) and Baysian information criterion (BIC) as model fit criterion.

Because of the cross-sectional nature of our data, the sample size was small relative to the number of variables. This may cause an overfitting of the model resulting in uncertainties about both the statistical significance and magnitude of the estimates [42]. To deal with this kind of "small n large p problem" [43], we also employ a random forest model. Random forest models create randomly selected training datasets. Then, regression trees were constructed with a random subset of predictor variables [44]. We use a fivefold cross validated random forest model consisting of 100,000 trees that we used to train for prediction of mortality. Before training, we scale and center the data by subtracting the variable mean and dividing by the standard deviation. We reported standardized importance scores for each of the selected variables. We calculated this measure by averaging the difference between mean squared error before and after permutating each variable over all trees and normalizing by the standard deviation of the differences.

Results

Of the 57 countries in the Hofstede dataset, we censored seven due to missing data. The remaining country selection includes 50 culturally and geographically diverse nations, as shown in Fig. 1. We represent regional differences in deaths per million population using varied shades of colors.

Table 3 presents the descriptive statistics of the dataset before standardization.

Figure 2 displays a graphical illustration of the correlation matrix of the variables. It is evident that some of the independent variables are related, mostly strongly the power distance and individualism variables with correlation coefficient of − 0.74.

The results of the full multivariable model appear in the first panel of Table 4.

The result of the complete regression model reaches an adjusted R-squared of 0.37. The model is highly significant according to the F-test result. After performing
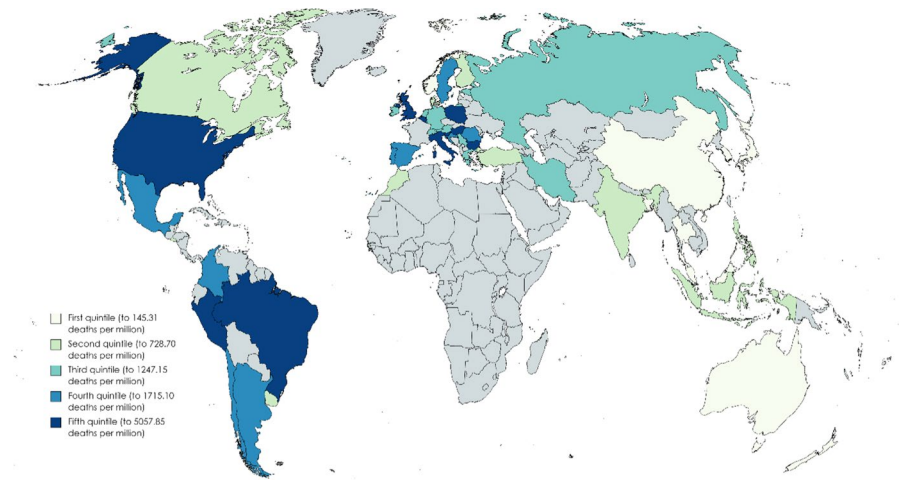
Fig. 1 Map of countries included in the analysis. Shading corresponds to quantiles of deaths per million inhabitants

Table 3 Descriptive Statistics before z transformation

Variable	Min	Max	Median	Std. deviation
Deaths_Mio	2.3	5057.9	967.9	946.3
Blood_Pressure	11.0	32.4	20.5	5.0
Obesity	3.4	37.3	24.35	8.5
Tobacco_Use	7.9	44.7	23.5	8.3
GDP_Capita	4753.7	114,323.4	32,932.5	23,486.8
Arrivals_Mio	1981.0	14,756,238.0	701,256.6	2,392,364.0
Population_65	5.2	28.0	16.1	5.8
Diabetes	3.2	16.7	6.8	2.5
Cancer	100.2	1278.5	316.2	202.0
Ox	34.2	72.6	54.8	8.6
Speed	0.09	1.52	0.31	0.25
GHS	35.0	83.5	58.0	11.3
PDI	11.0	104.0	62.0	21.4
IDV	13.0	91.0	43.5	23.6
UAI	8.0	112.0	70.0	23.9
MAS	5.0	95.0	49.5	19.1
LTO	13.0	100.0	46.5	22.3
IVR	16.0	97.0	48.5	20.2
PDI:IDV	605.0	4875.0	2328.5	911.8

a Breusch-Pagan test, the null hypothesis of homoscedasticity of the data cannot be rejected.

According to our results, prevalence of cancer and the share of the population older than 65 years are significantly associated with the COVID-19 related death
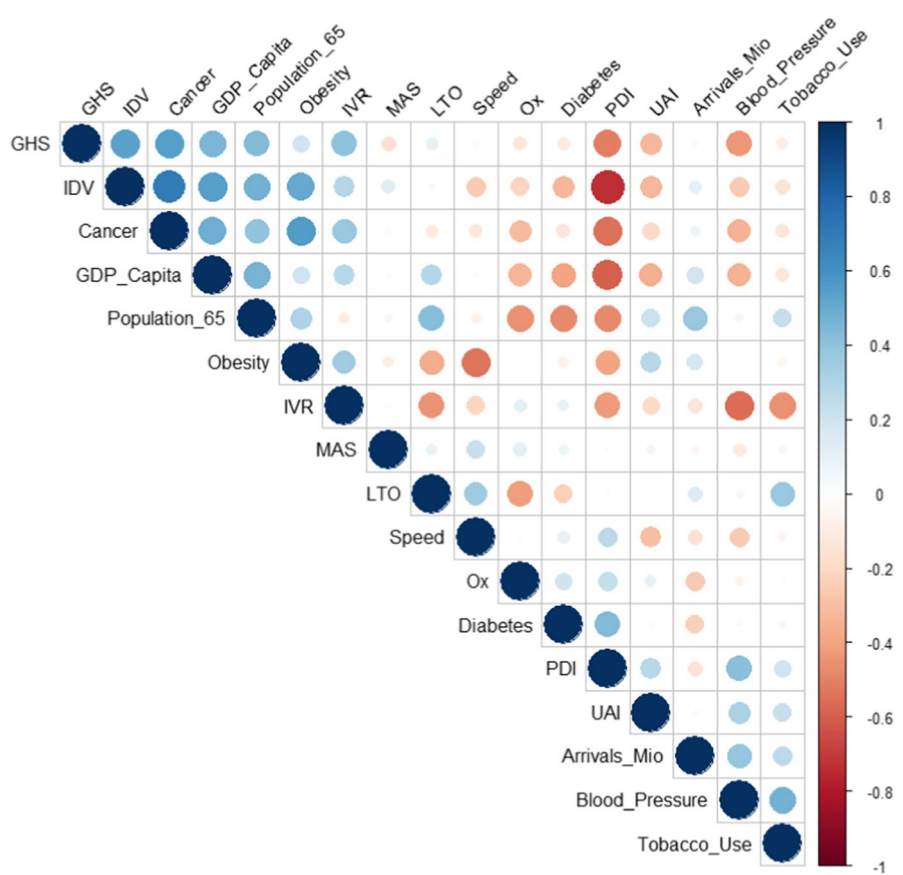
Fig. 2 Correlation matrix

rate. The coefficient for cancer is 0.55 with a 95% CI of (0.02, 1.09). An increase of one standard deviation in the cancer prevalence rates relates to decrease of mortality by 0.55 standard deviations. The coefficient for the share of the population aged 65 and above is 0.62 (95%CI 0.04, 1.21). The stringency index is positively associated with mortality (95%CI 0.38, 1.09) while stringency speed (95%CI − 1.07, − 0.27) and tobacco use (95%CI − 0.72, − 0.07) exhibit a significant negative correlation with mortality. Among the cultural dimensions, long term orientation (95% 0.12 ,0.99) is positively and individualism negatively (95% − 4.19, 0.08) associated with mortality. The significance level for the latter is 94.11%. The effect of individualism is moderated by power distance in that it is associated with a higher mortality rate in countries characterized by a high power distance index. The coefficient of the interaction term takes the value 0.92 indicating a large effect size. Conversely, individualism is negatively related to the mortality rate when power distance is low. The significance level of this interaction effect, however, is 86%, thereby slightly below conventional levels. The interaction plot in Fig. 3 graphically illustrates the

Table 4 Regression results

Variable	Model 1 (full set of variables)			Model 2 (best fit according to BIC and AIC)		
	Coefficient	95% Confidence Interval	P-value	Coefficient	95% Confidence Interval	P-value
Intercept	7.201e−17	−0.22823, 0.22823	1.0000	−1.263e−16	−0.22170, 0.22170	1.0000
Blood_Pressure	−0.01761	−0.46045, 0.42523	0.9359	–	–	–
Obesity	0.34556	−0.10717, 0.79829	0.1297	0.36525	0.03019, 0.70032	0.0334 *
Tobacco_Use	−0.39649	−0.71923, −0.07375	0.0177*	−0.26854	−0.53691, −0.00017	0.0499 *
GDP_Capita	−0.22286	−0.60802, 0.16231	0.2470	–	–	–
Arrivals_Mio	0.10468	−0.19764, 0.40699	0.4853	–	–	–
Population_65	0.62132	−0.62176, 0.02709	0.0383*	0.34187	0.01421, 0.66953	0.0413 *
Diabetes	−0.06390	−0.62176, 0.02709	0.6718	–	–	–
PDI	−0.86733	−0.62176, 0.02709	0.2229	–	–	–
IDV	−2.05362	−4.18933, 0.08209	0.0589	−0.32442	−0.62176, −0.02709	0.0332 *
MAS	0.18246	−0.10998, 0.47490	0.2127	–	–	–
UAI	−0.51959	−1.18500, 0.14582	0.1214	–	–	–
LTO	0.55535	0.12227, 0.98842	0.0136*	0.40617	0.06079, 0.75154	0.0223 *
IVR	−0.02171	−0.42979, 0.38636	0.9143	–	–	–
Ox	0.73359	0.37867, 1.08852	0.0002***	0.54701	0.27758, 0.81644	0.0002 ***
Cancer	0.55339	0.01933, 1.08745	0.0427*	–	–	–
GHS	−0.16195	−0.58243, 0.25853	0.4381	–	–	–
Speed	−0.67202	−1.07333, −0.27072	0.0018**	−0.40542	−0.68493, −0.12592	0.0055 **
PDI_IDV	0.92150	−0.31695, 2.15995	0.1393	–	–	–
	Multiple R-squared: 0.6039; Adjusted R-squared: 0.3739; F-statistic: 2.625, p=0.00885			Multiple R-squared: 0.4828; Adjusted R-squared: 0.3966; F-statistic: 5.601, p=0.00013		

Significance: *** 0.001; ** 0.01; * 0.05; . 0.1
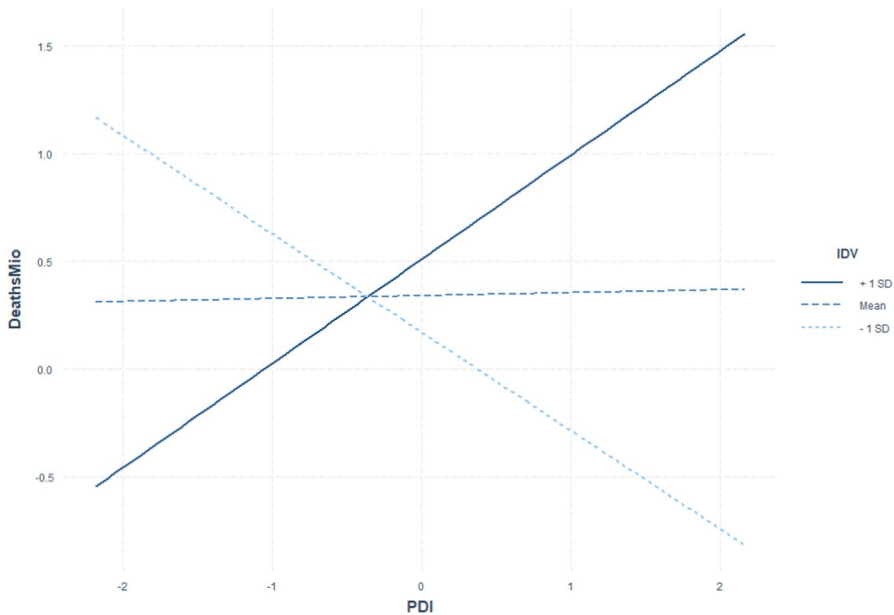
Fig. 3 Interaction plot between individidualism and power distance on deaths per million population

relationship between individualism and mortality, contingent on power distance. We did not detect other interaction effects.

The results of the fitted model using backwards elimination appear in the second panel of Table 4. The fitted model improved upon the full model in terms overall significance according to the F statistic. In this model the coefficients of prevalence of obesity (95%CI 0.03, 0.70), of the share of people above 65 (95%CI 0.01, 0.67), and of the stringency index (95%CI 0.28, 0.82) are positively related to mortality while stringency speed (95%CI − 0.68, − 0.13) and tobacco use (95%CI − 0.54, − 0.00) exhibit a negative association. Among Hofstede's dimensions, we find a negative association between individualism and mortality; it is the opposite for long term orientation. Figure 4 displays the regression curves with 95% confidence bands. The magnitude of the cultural variables suggest that an increase of the individualism score of 1 (one standard deviation) is related to a decrease of mortality by 0.32 standard deviations (95% CI − 0.62, − 0.03). The respective coefficient for long term orientation is 0.41 (95% CI 0.06, 0.75).

Figure 5 provides the relative importance of the selected variables by means of the random forest variable importance plot; the scores are between 0 and 100. We observed the highest importance weights for speed and tobacco use. Among the cultural variables, uncertainty avoidance and the interaction between individualism and power distance is most important, followed by individualism. Although interaction effects are usually uncovered by random forest models and do not need to be explicitly included in the model, simulation studies showed that variable importance measures are unable to detect interactions [45]. For that reason we report the importance score both with and without the interaction term.
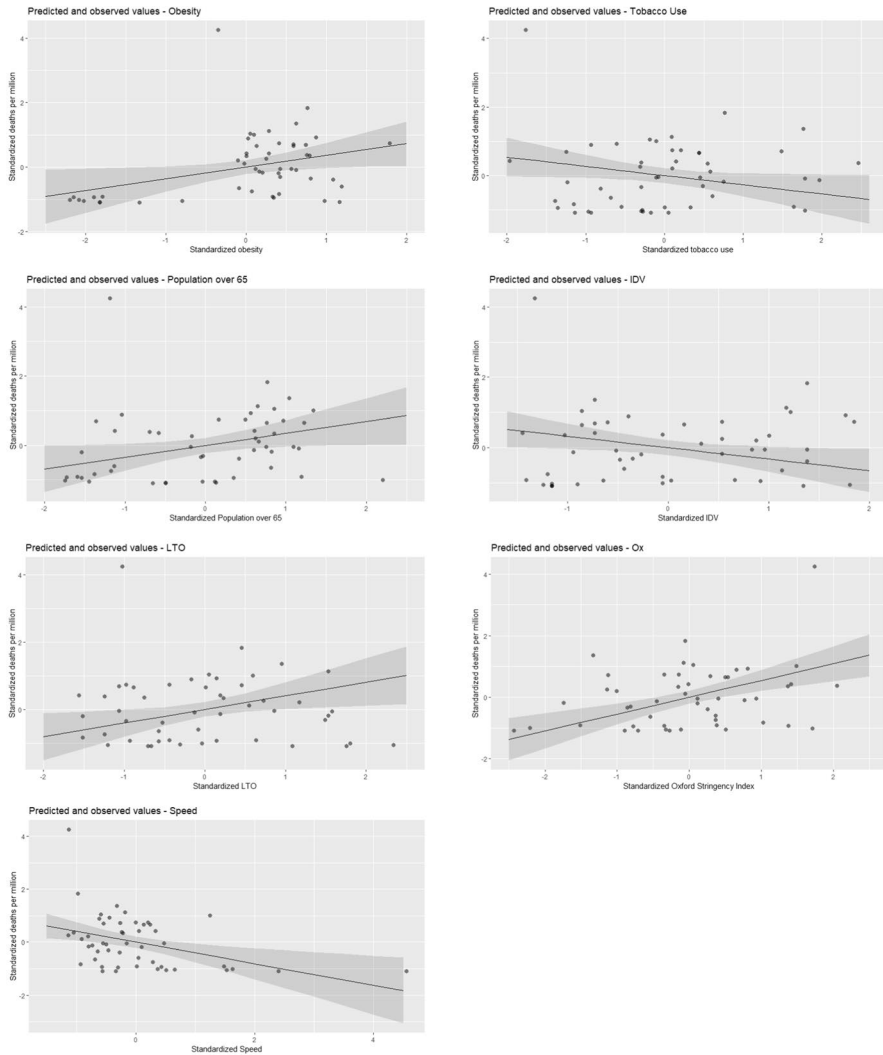
Fig. 4 Regression curves with confidence bands

Comparing results from the regression analysis with those from the random forest analysis stringency, speed was the most important variable in both analytic approaches. The coefficient for this variable was − 0.67 (95% CI − 1.07, − 0.27). It also has the highest importance score. The stringency variable itself was also important, although in an unexpected way: higher stringency was correlated with higher mortality. Relevant cultural variables in the regression model include individualism and long-term orientation; it was individualism and uncertainty avoidance in the random forest model.
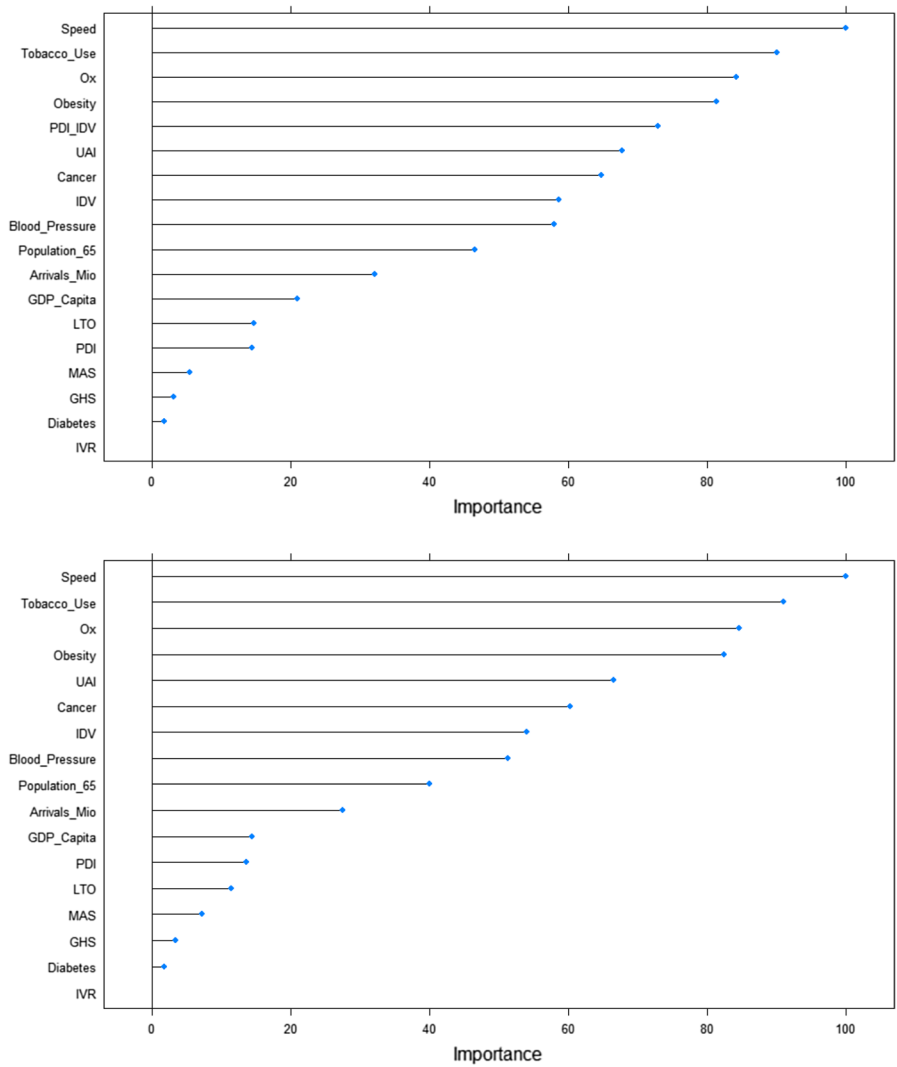
Fig. 5 Variable importance plots. Upper plot includes interaction term (PDI_IDV) between power distance and individualism

Discussion

The results partly mirror those of previous studies. In particular, the influence of obesity and age on death rates is supported by the model. The speed of implementation of containment measures are associated with lower mortality, as has been reported in previous studies [46, 47]. In the random forest model analysis, of all variables stringency speed had the most impact. This observation is supported by a recent study from the United Kingdom (UK). According to estimates, earlier

introduction of containment measures by only one week would have resulted in a 74% reduction of the number of confirmed COVID-19 cases [48]. Somewhat surprisingly, the average level of the stringency index was positively correlated with mortality; this is at odds with most of the literature [33, 49, 50]. Our results could be due to reverse causality (for example, if mortality drives the Stringency Index and not the opposite way) that would lead to a biased parameter estimate. Controlling for this so called simultaneity bias would require the use of instruments. Using instrumental variables and other methods to control for endogeneity, Bjørnskov [51] found no evidence of reversed causality and concluded that stringency measures had no effect, or even a positive one on mortality [51]. He used the discretionary power of governments as the instrument variable because policy responses are stronger in countries where the constitution allows for strong political responses irrespective of the pandemic situation [52]. For this reason, the instrument is correlated with the stringency index but not with mortality. We observed a positive relationship between stringency and mortality when people substituted gatherings in restaurants with private meetings at home where they pay less attention to hygiene and distance keeping. A recent, yet not peer reviewed meta-analysis concluded, that lockdowns have had little to no public health effects [53]. And, a recent study did not find evidence that COVID-19-related deaths trigger interventions, which would cause reverse causality issues. Instead, the study showed that governments are more likely to follow the policies of nearby countries, and this led to badly timed lookdowns implemented either too early or too late [54].

Unexpectedly, tobacco use was correlated with a lower COVID 19 related mortality in our study. A growing body of literature reported similar findings. A large population-based study conducted in the UK found the risk of ICU admission to be 88% lower in heavy smokers compared with non-smokers [55]. A recent French study also reported a protective effect of smoking [56]. The authors offered a potential explanation, that smoking may increase the gene expression of the angiotensin converting enzyme (ACE) 2; scientists consider it to be a potential source of protection against severe forms of COVID-19 disease [57].

Turning to the culture variables, we find that individualism is negatively related with mortality and moderated by power distance. Specifically, lower scores on the individualism dimension (higher degree of collectivism) are related to higher death counts in presence of low values in power distance, and vice versa. While this interaction effect is statistically not significant in the regression model, it is an important driver of mortality in the random forest analysis. This means that individualism is associated with lower mortality in the presence of low power distance scores. Power distance reflects decision making of authorities in a persuasive vis a vis an autocratic style. It also mirrors the degree to which a society values 'critical thinking'. Thus, individualism, combined with critical thinking, is linked to low COVID-19 related mortality. This finding contradicts the popular narrative that autocratic societies such as China are better positioned to manage the COVID 19 pandemic. The UK based *Daily Mail* newspaper recently reported that "China was able to get a quicker grip on the virus, because people are more obedient and follow the rules" [58]. The Journal of Chinese Political Science published an article about China's containment policies in which the author coined the term 'Authoritarian Advantage'

[59] and a recent public health research paper argued that "China's response to COVID-19 exemplifies the unique strengths of authoritarian institutions in public health crisis management" [60]. Our results indicate instead that individualism accompanies personal responsibility, and a critical attitude towards authority does not necessarily constitute an obstacle to management of a pandemic. While the fitted regression model does not include the interaction term the individualism variable remains negatively and significantly related to mortality. This result is supported by the importance plot of the random forest model and contrasts with results from Gokmen and colleagues [5]. We therefore challenge their finding that "individualistic societies could have a characteristic that accelerates the spread of the outbreak as these societies do not support the practices that restrain individual interests in favor of collective interests." Hofstede himself mentioned that in individualistic cultures people have a greater concern for their own health. In the context of COVID 19 it may be in the self-interest of individualistic people to reduce the number of contacts even without an explicit order by the authorities.

We also observe that long term orientation shows a significant positive influence on mortality. According to Hofstede, pragmatic societies score high in this dimension as they strive to prepare for the future. Traditional societies that value time-honored norms have relatively low scores. And in low scoring countries there is more focus on short-term and quick results. This mindset may have helped to manage the pandemic more effectively, especially considering the observed importance of stringency speed.

Limitations

The aggregate nature of ecological studies does not allow us to make interferences about the individual level [61]. The aggregate level of our data also makes the small sample size so small that it may lead to overfitting of the model. That, in turn, causes uncertainty about parameter estimates. We tried to deal with this problem by performing a non-parametric random forest exercise. Although the variable importance rankings are less prone to overfitting issues, this methodology does not allow us to test hypotheses for causal relationships.

Conclusion

Our results suggest that cultural dimensions matter for COVID-19 related mortality. After controlling for major clinical and policy variables, we observe that in individualistic societies COVID 19-related mortality is lower; put differently, higher death rates are associated with collectivistic societies. We conclude, therefore, that collectivism and obedience are not necessary prerequisites for effective management of this pandemic as previous studies suggested. We also conclude that there is no universal blueprint for COVID-19 containment measures and to improve outcomes policy-makers need to tailor country-specific approaches that build on local cultural circumstances.

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