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A small global village: the effects of collectivist, tight and Confucian cultures on the spread of COVID-19

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While previous studies have emphasised several important factors associated with the spread of COVID-19 and strategies to reduce transmission, few studies have focused on the social and cultural factors that may influence its spread. This study analyses the spread of COVID-19 from a cross-country/region cultural perspective and finds that countries and regions with a collectivistic, Confucian or tight (restrictive) culture experience a lower spread rate of COVID-19. The results are robust to controlling for several factors, including population, age structure, gross domestic product (GDP) per capita, previous SARS occurrence, smoking prevalence, and religion. A one standard deviation increase in the collectivism score is associated with a 1.38% reduction of the weekly growth rate of COVID-19 cases. More importantly, the effect of culture on the spread of COVID-19 becomes stronger during national or regional lockdowns. Corroborating these main results, supporting analyses find a significant effect of culture on national and regional COVID-19 death rates. These findings suggest that to manage the ongoing surges in COVID-19 outbreaks, governments should implement public health policies that emphasise the ideas of common interest, personal responsibility and strong cultural norms, and sense of community, as this pandemic has revealed that people all live together in a small global village.

Why did Korea, Japan & Taiwan have so few deaths? I see face-covering and the Confucian idea of common good as key. –Michael Levitt, the Nobel Prize Laureate (2020)

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Introduction

The COVID-19 pandemic has been an unprecedented shock to the world. However, the spread of COVID-19 has varied drastically between countries and regions. While previous studies have emphasised several important factors associated with the spread of COVID-19 (Chinazzi et al. 2020; Zhang et al. 2020; Koo et al. 2020; Li et al. 2022a) and strategies to reduce transmission (Prather et al. 2020; Fennelly, 2020; Weitz et al. 2020; Li et al. 2022b; Qiu et al. 2022), few studies have focused on the social and cultural factors that may influence the spread of COVID-19. In this study, we seek to address this gap by analysing the spread rate of COVID-19 from a cross-country cultural perspective.

As a fundamental part of an individual's thoughts, actions and interactions with others, culture influences behaviour, economic activities and social norms (Daniell, 2014). Members of a cultural group behave and socialise according to their shared values and beliefs (Guan et al. 2020). Certain governmental policies may also be a product of culture (Dizikes, 2020). So cultural differences may shape different regional attitudes and collective actions in response to the COVID-19 pandemic and further shape the regional differences in the severity of COVID-19 infections.[1] For example, in East Asia such as South Korea, Japan and China where the priority is given to obligations, duties and the collective welfare, people are more willing to tolerate personal inconvenience and wear masks during the pandemic (Lu et al. 2021). However, in the U.S where the priority is given to personal convenience and freedom, people are less willing to follow the social distancing rules and wear masks (Bazzi et al. 2021). People who value personal freedom would also be less likely to support lockdown policies and obey stay-at-home orders than people who value collective welfare. As a result, lockdown policies may fail to effectively slow the spread of COVID-19 when people are concerned with personal freedom. Therefore, it is of great theoretical and practical significance to explore the effects of cultural factors on the spread of COVID-19. In this study, we aim to address the following research questions:

(1) Do countries and regions with collectivistic, Confucian-oriented or tight (restrictive) cultures have a lower growth rate of COVID-19 cases than countries with individualistic, non-Confucian-oriented or loose cultures?

(2) Do the cultural effects become stronger during lockdowns?

We investigate the association between different national cultures and the prevalence of COVID-19 cases by conducting a comprehensive cross-country analysis. National culture refers to the shared psychological beliefs and collective practices that distinguish one nation or region from another (Hofstede, 1980). Cultures have many dimensions that are difficult to quantify. In this study, we first capture national culture using the Individualism Index from the Hofstede National Culture Measures to quantify collectivism vs individualism. We believe the collectivistic vs individualistic axis is the Hofstede cultural dimension most relevant to the COVID-19 global pandemic.[2] This dimension measures group integration as the degree of perceived obligation and dependence upon a broader group felt by individuals within a society (Hofstede, 1991, 2005). Collectivistic cultures emphasise the 'we' rather than the 'I' and so stress the common good over personal interest. They create 'in-groups' based on the tightly integrated relationships among families and close friends. As a result, mask usage was higher in more collectivistic countries during the COVID-19 pandemic (Lu et al. 2021). The importance of adhering to social norms and honouring the common good has also been demonstrated in the response to other collective crises such as global climate change (Murray et al. 2011; Douglas and Wildavsky, 1982; Shi, Visschers and Siegrist, 2015; Xue et al. 2016). Anecdotally, to reduce the spread rate of COVID-19 in the UK, the Scientific Advisory Group for Emergencies (SAGE) recommended that the UK government should promote a sense of collectivism: all messaging should reinforce a sense of community, that "we are all in this together" (SAGE, 2020).[3]

Next, we consider how the Confucian vs non-Confucian orientation of culture influences the spread rate of COVID-19. Collectivistic behaviours are an inherent component of Confucian culture in East Asia as Confucianism dictates that to achieve the ultimate objective of social harmony, one must place one's own interests and desires beneath the common good of the group. Confucianism emphasises the importance of collectivism and promotes shared social norms and virtues. We also consider a tight vs loose culture. The former has many strong norms and low tolerance for deviant behaviour, whereas the latter has weak social norms and high tolerance for deviant behaviour (Gelfand et al. 2011). Variations in cultural tightness and looseness reflect the strength of punishment and degree of permissiveness (Harrington and Gelfand, 2014) and are determined by distal ecological and historical factors, such as population density, resource scarcity, and disease and other environmental threats (Gelfand et al. 2011).

Consistent with our expectations, we find that countries and regions with collectivistic, Confucian-oriented or tight cultures have a lower growth rate of COVID-19 cases than countries with individualistic, non-Confucian-oriented or loose cultures. This remains true after controlling for factors associated with an increase in COVID-19 cases, including national or regional population, age structure, gross domestic product (GDP) per capita, previous SARS occurrence, smoking prevalence and religion. For every one standard deviation increase in our collectivism score, the weekly growth rate of COVID-19 cases decreases by 1.38% in our sample. More importantly, we show that the cultural effect on slowing the spread of COVID-19 becomes stronger during national or regional lockdowns. For every one standard deviation increase in collectivism score, the weekly growth rate of COVID-19 cases decreases by 4.04% during lockdown period, and it decreases by 1.24% during non-lockdown periods. Our finding of a significant cultural effect on the reduction of COVID-19 death rates across the world corroborates these results.

Our study contributes to the existing literature in the following ways. First, prior studies show mixed results regarding the relationship between collectivism and COVID-19 cases. Webster et al. (2021) report that country-level collectivism has no significant relationship with COVID-19 cases after controlling for covariates. When only studying the United States, Webster et al. (2021) even find that state-level collectivism positively relates to both COVID-19 cases and higher deaths after controlling for all covariates except race. However, Jiang et al. (2022) and Maaravi et al. (2021) find opposite results and report that collectivistic societies have less COVID-19 cases than individualistic societies. Compared with Webster et al. (2021), Maaravi et al. (2021) and Jiang et al. (2022), we focus on the growth rate of COVID-19 cases, rather than the number of COVID-19 cases (the final outcome). We believe that it is worth exploring the growth rate of COVID-19 cases rather than the number of COVID-19 cases because (1) the spread of COVID-19 is dynamic and changes over time and (2) we can examine when cultures play a more important role in limiting the spread of COVID-19 by studying the growth rate. Our innovative perspective shows that countries and regions with collectivistic, tight and Confucian cultures experience a lower growth rate of COVID-19 cases. This can be attributed to the emphasis these countries place on the ideas of the common good and sense of community, as well as strong norms and low tolerance of deviant behaviour. Second, our study contributes to the literature by showing that the degree of

collectivistic orientation affects not only the spread of COVID-19, but also the outcome of lockdowns. We report that the effect of collectivistic cultures on the spread of COVID-19 becomes stronger during lockdowns, suggesting that lockdowns are more likely to succeed in slowing the spread of COVID-19 in countries and regions with collectivistic cultures. Therefore, our findings successfully explain why stringent government policies (e.g., lockdown policies) can effectively slow the spread of COVID-19 in East Asia where people share a strong commitment to collectives such as country, community and family, but only have limited effects on the spread of COVID-19 in Western Europe and North American where people endorse individualism and are independent. Third, our study has important practical implications. Our findings indicate that government policies that focus on collectivistic considerations, the concept of common interests, community awareness and a low tolerance for deviant behaviours may more successfully slow the spread of COVID-19, as people all live together in a small global village.

Overall, as one of the most fundamental influences upon individual's thinking, actions and interactions with other people, culture and social norms affect national and individual responses to the COVID-19 pandemic. Our study is particularly important considering that many modern scholars these days hesitate to attribute outcomes to culture (Dizikes, 2020).[4]

Data, sample and variables

To provide a comprehensive analysis of the cultural effects on COVID-19 spread rate, we obtain daily COVID-19 case data from the Our World in Data website and individualism scores from the Hofstede national culture website.[5, 6] We use Hofstede's cultural dimensions to measure national culture because Hofstede's cultural dimensions have been widely used in prior literature (Maaravi et al. 2021; Jiang et al. 2022). As some areas with reported COVID-19 cases do not have individualism scores, our sample includes 190 countries and regions with reported daily counts of COVID-19 cases from 22 January 2020 to 31 December 2020, with 55,184 country-day observations.[7] Two key variables are (i) COVID-19 weekly case growth rate (*CASE_GROWTH*) and (ii) the collectivistic culture measure based on the Hofstede individualism scores (*COLLECTIVISTIC*) indicating whether a country or region is primarily oriented toward a collectivistic or individualistic culture. The weekly case growth rate for a country i on a day t is calculated as follows:

$$CASE\_GROWTH_{i,t} = LN(1 + COVID\_CASES_{i,t}) - LN(1 + COVID\_CASES_{i,t-7}) \quad (1)$$

where i and t index economy and day, respectively. $COVID\_CASES_{i,t}$ and $COVID\_CASES_{i,t\text{-}7}$ represent the number of confirmed cases in economy i on days t and t-7, respectively. $LN(1 + COVID\_CASES_{i,t})$ is the natural logarithm of one plus $COVID\_CASES_{i,t}$ while $LN(1 + COVID\_CASES_{i,t\text{-}7})$ is the natural logarithm of one plus $COVID\_CASES_{i,t\text{-}7}$. With this definition, we obtain the growth of COVID-19 cases from a day in the prior week to the same day in the current week (e.g., from prior Sunday to current Sunday, from prior Monday to current Monday, etc.). This calculation mitigates the potential bias associated with case reporting differences over weekdays versus weekends in the US and other countries.

Since people in collectivistic cultures are more likely to take COVID-19 prevention measures and sacrifice for the common good (Maaravi et al. 2021), we consider the role of collectivistic culture in limiting the spread of COVID-19. Collectivistic culture is measured as the reciprocal of the logarithm of the Hofstede individualism scores:

$$COLLECTIVISTIC = 1/[LN(INDIVIDUALISM)] \quad (2)$$

We provide collectivistic culture scores for all countries and regions in Appendix B. To conduct further empirical analysis, we also identify countries and regions that belong to the Confucian cultural circle as an additional measure of national culture. The Confucian philosophy of the common good emphasises the honour of collectivism and discourages individualism in interpersonal interactions in a society. According to Ye et al. (2012), the countries and regions within the 'Confucian cultural circle' are China, Hong Kong, Indonesia, Japan, South Korea, Malaysia, the Philippines, Singapore, Thailand and Vietnam. We create *CONFUCIAN*, a dummy variable that equals 1 for these ten countries and regions, and 0 for all other countries. We then use this dummy variable in the regression specification.

Numerous studies have investigated factors associated with the spread of COVID-19, including population (Kadi and Khelfaoui, 2020), age structure (Dowd et al. 2020; Esteve et al. 2020), gross domestic product (GDP) per capita (Gangemi et al. 2020), previous SARS occurrence (Petersen et al. 2020), smoking prevalence (Reddy et al. 2021; Patanavanich and Glantz, 2020) and religion (Quadri, 2020). Consistent with these findings, we include the following control variables in the regression equations: *LN(POPULATION), SMOKE, SARS, AGE65, LN(GDP), PROTESTANT, CATHOLIC* and *MUSLIM*. Also, the enforcement quality of policies may play an important role in effective pandemic response. We include *LN(LENIENT_ENFORCEMENT)* in the regression such that higher values indicate lenient or weaker enforcement of government policies. We obtain the religion data from La Porta et al. (1999). The definitions of these control variables and data sources are provided in the Appendix A.

Table 1 reports the descriptive statistics of the main variables used in the study. All of the continuous variables are winsorised at 1% and 99%. The mean (median) spread rate of COVID-19 *(CASE_GROWTH)* is 20.48% (7.32%) with a standard deviation of 35.76%. The maximum weekly growth rate is 207.16%. The average weekly growth rate of deaths is 13.97% with a median of 4.70%. The mean (median) score of *COLLECTISTIC* for the sample countries is 0.293 (0.279), with a minimum of 0.222 and maximum of 0.558. *CONFUCIAN_DUMMY* has a mean of 0.060 and median of 0, suggesting that ~1 in 16 countries or regions in our sample is classified as Confucian-circle. The mean (median) of *LN(POPULATION)* in the sample is 2.436 (2.388), ranging from 0.001 to 7.273 with a standard deviation of 1.509. The mean of *SARS* is 0.087, indicating that a small number of countries in the sample experienced SARS in 2003.[8] A mean of 8.88% of the population is aged over 65. As measured by *LN(GDP)*, the economic development of the sample countries varies significantly, ranging from 6.494 to 11.669 with a standard deviation of 1.196. *SMOKE* has an average of 21.39%, indicating that less than a quarter of the sample population are smokers. Finally, Protestants, Catholics and Muslims, respectively, account for 12.07%, 30.94% and 23.72% of the population.

Results

Effect of collectivistic culture on the spread of COVID-19. We conduct an ordinary least squares (OLS) regression analysis of the effect of collectivistic vs individualistic culture on the spread of COVID-19 after controlling for continent and month-level fixed effects. We regress the spread rate of COVID-19 (*CASE_GROWTH*) on the collectivism culture scores (*COLLECTIVISTIC*), where higher scores reflecting greater orientation toward a collectivistic culture. Consistent with our expectation, the higher the collectivism culture scores, the lower the COVID-19 spread

Table 1 Summary statistics.

Variables	Mean	STD	Min	Median	Max	N
CASE_GROWTH (%)	20.478	35.764	0.000	7.320	207.160	55,129
DEATH_GROWTH (%)	13.972	24.245	0.000	4.696	141.838	46,945
LN(TIGHTNESS)	1.774	0.478	0.470	1.856	2.510	10,099
LN(INDIVIDUALISM)	3.510	0.568	1.792	3.584	4.511	29,963
COLLECTIVISTIC	0.293	0.055	0.222	0.279	0.558	29,963
CONFUCIAN	0.060	0.238	0.000	0.000	1.000	55,184
SARS	0.087	0.283	0.000	0.000	1.000	55,184
LN(POPULATION)	2.436	1.509	0.001	2.388	7.273	55,184
AGE65	8.877	6.288	1.144	6.614	27.049	52,194
SMOKE	21.391	9.566	1.000	21.700	45.950	41,853
LN(GDP)	9.291	1.196	6.494	9.481	11.669	52,814
LN(LENIENT_ENFORCEMENT)	3.645	0.851	0.401	3.887	4.615	54,604
PROTESTANT	12.068	20.476	0.000	2.200	97.800	51,670
CATHOLIC	30.942	35.850	0.000	12.100	97.300	51,670
MUSLIM	23.719	36.019	0.000	1.400	99.900	51,670
LOCKDOWN	0.097	0.296	0.000	0.000	1.000	54,551

rate for a country or region (Table 2). In particular, the coefficient of the key variable of interest, *COLLECTIVISTIC*, is negative and significant ($\beta = -9.394$, $t = -2.951$, $p = 0.003$) in a simple regression specification in Model (1). It remains negative and significant ($\beta = -25.094$, $t = -5.662$, $p < 0.001$) after we include a set of control variables in Model (2). The latter result indicates that for every one standard deviation increase in the collectivism score ($\sigma = 0.055$, Table 1), the weekly case growth rate decreases by 1.38% ($0.055 \times 25.094\% = 1.38\%$).

Regarding the control variables in the regression results (Table 2), we note some important findings relevant to the factors associated with the spread of COVID-19. Generally consistent with previous studies (Kadi and Khelfaoui, 2020; Dowd et al. 2020; Esteve et al. 2020; Gangemi et al. 2020; Petersen et al. 2020; Apicella et al. 2020; Kreps and Kriner, 2020; Bavel et al. 2020), we find that the COVID-19 spread rate is lower for countries or regions that experienced SARS in 2003 and have higher GDP per capita, more people older than 65 and more Protestants. Conversely, COVID-19 spread more rapidly in countries with larger populations, more smokers, less media influence on public affairs and more Muslims. Specifically, the coefficient of *SARS* is negative and significant ($\beta = -2.309$, $t = -4.381$, $p < 0.001$) and the COVID-19 spread rate decreases by a mean of 2.309% in countries or regions that experienced SARS. Furthermore, economic condition is negatively associated with COVID-19 spread rate, as indicated by a negative and significant coefficient of *LN(GDP)* ($\beta = -1.980$, $t = -8.172$, $p < 0.001$). Every one standard deviation increase of GDP per capita is associated with a 1.98% decrease in the COVID-19 spread rate.

The percentage of the population aged over 65 is another factor influencing the spread of COVID-19, as indicated by a negative and significant coefficient of *AGE65* ($\beta = -0.446$, $t = -7.571$, $p < 0.001$). This may be because elderly people tend to remain at home during a pandemic, resulting in a lower COVID-19 spread rate. Notably, there is a negative association between Protestant population size and COVID-19 spread rate but a positive association between Muslim population size and COVID-19 spread rate. This may be related to more suspensions of community gatherings among Protestants, which reduces transmission risk. Reddy et al. (2021) and Patanavanich and Glantz (2020) report that patients with a smoking history have a significantly increased risk of severe COVID-19. We also find a positive relationship between smoking prevalence and the spread of COVID-19. Furthermore, weaker government policy enforcement, as denoted by a higher value of *LN(LENIENT_ENFORCEMENT)*, is associated with a higher COVID-19 spread rate, as indicated by a positive and significant coefficient of *LN(LENIENT_ENFORCEMENT)* ($\beta = 4.851$, $t = 11.135$, $p < 0.001$).

Table 2 The effect of collectivistic culture on the spread of COVID-19.

Dependent variable: *CASE_GROWTH*

Variables	Model (1)	Model (2)
COLLECTIVISTIC	−9.394***	−25.094***
	(−2.951)	(−5.662)
SARS		−2.309***
		(−4.381)
LN(POPULATION)		1.171***
		(8.169)
AGE65		−0.446***
		(−7.571)
LN(GDP)		−1.980***
		(−8.172)
SMOKE		0.069***
		(2.859)
LN(LENIENT_ENFORCEMENT)		4.851***
		(11.135)
PROTESTANT		−0.050***
		(−4.544)
CATHOLIC		0.007
		(0.856)
MUSLIM		0.063***
		(8.470)
Continent FE	Control	Control
Month FE	Control	Control
Observations	29,928	25,016
R-squared	0.573	0.608

The *t*-values are reported in parentheses. The symbol of *** indicates the 1% significance level.

Notably, we obtain an R-squared of 0.573 in Model (1) when collectivistic culture is the only explanatory variable, implying that more than half of the variance in COVID-19 growth rates can be explained by levels of collectivism across the sampled countries or regions. After we include a set of control variables in Model (2), the R-squared increases to 0.608, illustrating that our regression models not only fit the data, but also provide evidence that collectivistic culture indeed has an important effect on the spread of COVID-19.

Table 3 The effect of Confucian culture on the spread of COVID-19.

Dependent variable: *CASE_GROWTH*

Variables	Model (1)	Model (2)
CONFUCIAN	−6.291***	−7.598***
	(−13.479)	(−12.665)
SARS		−0.338
		(−0.728)
LN(POPULATION)		1.115***
		(11.011)
AGE65		−0.205***
		(−4.551)
LN(GDP)		−1.203***
		(−7.118)
SMOKE		0.157***
		(8.787)
LN(LENIENT_ENFORCEMENT)		1.819***
		(6.777)
PROTESTANT		−0.001
		(−0.111)
CATHOLIC		0.024***
		(4.500)
MUSLIM		0.023***
		(4.497)
Continent FE	Control	Control
Month FE	Control	Control
Observations	55,129	39,801
R-squared	0.544	0.594

The *t*-values are reported in parentheses. The symbol of *** indicates the 1% significance level.

Table 4 The collectivistic cultural effect on COVID-19 spread rate during lockdown vs non-lockdown periods.

Dependent variable: *CASE_GROWTH*

Variables	Model (1) Lockdown	Model (2) Non-Lockdown	Coefficient Difference (1) - (2)
COLLECTIVISTIC	−73.454***	−22.512***	−50.941***
	(−4.201)	(−4.658)	
SARS	−8.399***	−0.432	−7.967***
	(−5.125)	(−0.708)	
LN(POPULATION)	1.671***	0.739***	0.932
	(2.715)	(4.979)	
AGE65	−3.486***	0.010	−3.496***
	(−13.575)	(0.166)	
LN(GDP)	−1.497	−2.272***	0.776
	(−1.312)	(−9.288)	
SMOKE	0.092	0.122***	−0.030
	(0.873)	(4.412)	
LN(LENIENT_ENFORCEMENT)	26.403***	2.080***	24.323***
	(12.930)	(4.509)	
PROTESTANT	−0.277***	0.000	−0.277***
	(−5.718)	(0.004)	
CATHOLIC	−0.205***	0.037***	−0.242***
	(−7.548)	(4.577)	
MUSLIM	0.052	0.076***	−0.024
	(1.636)	(10.078)	
Continent FE	Control	Control	
Month FE	Control	Control	
Observations	3,394	20,989	
R-squared	0.634	0.587	

The *t*-values are reported in parentheses. The symbol of *** indicates the 1% significance level.

Overall, collectivistic-oriented cultures are associated with a lower COVID-19 spread rate (Table 2). In addition, the results indicate that prior experience of SARS, higher GDP per capita, larger population aged over 65 and more Protestants are associated with a lower spread rate of COVID-19. In contrast, COVID-19 cases spread more rapidly in countries and regions with larger populations, weaker media and more Catholics or Muslims.

Effect of Confucian culture on COVID-19 spread. The Confucian philosophy of common good emphasises the honour of collectivism and discourages individualism in interpersonal interactions in society. Following Ye et al. (2012), we identify countries and religions that belong to the Confucian cultural circle, including China, Hong Kong, Indonesia, Japan, South Korea, Malaysia, the Philippines, Singapore, Thailand and Vietnam. We then create *CONFUCIAN*, a dummy variable that equals 1 for these ten countries and regions and 0 for all other countries, for use in the regression specification.

As shown in Table 3, the coefficient of the key variable of interest, *CONFUCIAN*, is negative and significant ($p < 0.001$) in Models (1) and (2), implying that the countries and regions in the Confucian cultural circle generally experience a lower COVID-19 spread rate than other countries. The result in Model (2) ($\beta = -7.598$, $t = -12.665$, $p < 0.001$) indicates that the weekly case growth rate in the Confucian cultural circles is on average (mean), 7.598% lower than in other countries. Similarly, we find that the COVID-19 spread rate tends to be lower in wealthy countries and countries with more people aged over 65, as indicated by negative and significant coefficients ($p < 0.001$) of *AGE65* and *LN(GDP)*. COVID-19 cases tend to spread more rapidly in countries that have more population, more smokers, and more Catholics or Muslims. COVID-19 also spreads more rapidly when the enforcement of policies is more lenient. Again, we obtain higher R-squared values of 0.543 and 0.594 in Models (1) and (2), showing that our regression models not only fit the data, but also provide strong evidence for the important effect of Confucian culture on the spread of COVID-19.

Do lockdowns work? The COVID-19 pandemic has led governments across the world to implement unprecedented interventions and closure policies in an attempt to contain the virus. Governments have closed schools and workplaces, cancelled public events, restricted gathering, closed public transportation, issued stay-at-home orders, and restricted internal movements and international travel. Some countries have imposed lockdowns that restrict movement as short-term solutions to save lives (Brodeur et al. 2021).[9] Like any policy intervention, the effects of these responses are highly contingent on local political, social and cultural contexts (Hale et al. 2020). Nonetheless, several studies (e.g., Atalan, 2020) have reported that lockdowns play an important role in preventing the spread of COVID-19. Given our results showing that countries and regions with a collectivistic or Confucian culture have a lower spread rate of COVID-19, a natural question follows: would this cultural effect on the spread of COVID-19 become stronger during a national or regional lockdown?

To answer this question, we first collect lockdown start and end dates from Wikipedia for the countries or regions that implemented these restrictive policies during our sample period. We then divide the sample into two subsamples, 'lockdown period' and 'non-lockdown period', based on the lockdown dates and conduct regression analysis for each subsample. Table 4 compares the effect of collectivistic culture on the spread of COVID-19 during lockdown and non-lockdown periods. The

Table 5 The Confucian cultural effect on COVID-19 spread rate during lockdown vs non-lockdown periods.

Dependent variable: *CASE_GROWTH*

Variables	Model (1) Lockdown	Model (2) Non-Lockdown	Coefficient Difference (1) - (2)
CONFUCIAN	−26.169***	−7.841***	−18.328***
	(−10.290)	(−11.429)	
SARS	−12.885***	1.309**	−14.194***
	(−8.703)	(2.484)	
LN(POPULATION)	4.314***	0.716***	3.598***
	(10.114)	(6.870)	
AGE65	−1.509***	0.055	−1.565***
	(−7.821)	(1.169)	
LN(GDP)	2.971***	−1.741***	4.712***
	(3.471)	(−10.188)	
SMOKE	0.080	0.192***	−0.112
	(0.967)	(10.093)	
LN(LENIENT_ENFORCEMENT)	6.129***	0.950***	5.179***
	(4.646)	(3.441)	
PROTESTANT	−0.266***	0.021***	−0.286***
	(−7.055)	(2.727)	
CATHOLIC	−0.010	0.031***	−0.041*
	(−0.485)	(5.613)	
MUSLIM	−0.041	0.020***	−0.061*
	(−1.543)	(3.890)	
Continent FE	Control	Control	
Month FE	Control	Control	
Observations	4,433	34,735	
R-squared	0.612	0.572	

The *t*-values are reported in parentheses. The symbols of ***, ** and * respectively indicate the 1%, 5% and 10% significance levels.

Table 6 The effect of cultural tightness on the spread of COVID-19.

Dependent variable: *CASE_GROWTH*

Variables	Model (1)	Model (2)
LN(TIGHTNESS)	−4.300***	−6.864***
	(−6.708)	(−7.117)
SARS		−4.437***
		(−5.764)
LN(POPULATION)		1.635***
		(4.890)
AGE65		−0.363***
		(−3.538)
LN(GDP)		−0.344
		(−0.436)
SMOKE		−0.262***
		(−3.727)
LN(LENIENT_ENFORCEMENT)		9.238***
		(11.081)
PROTESTANT		−0.108***
		(−5.681)
CATHOLIC		−0.014
		(−0.987)
MUSLIM		0.126***
		(7.612)
Continent FE	Control	Control
Month FE	Control	Control
Observations	10,095	9472
R-squared	0.657	0.679

The *t*-values are reported in parentheses. The symbol of *** respectively indicates the 1% significance level.

estimated coefficient of *COLLECTIVISTIC* is more negative and highly significant ($\beta = -73.454$, $t = -4.201$, $p < 0.001$) in the lockdown period subsample than in the non-lockdown period subsample (coefficient of $\beta = -22.512$ ($t = -4.658$, $p < 0.001$)). A χ^2 test shows that the difference between estimated coefficients of *COLLECTIVISTIC* is significantly different from 0 between the two subsamples ($p = 0.008$). This result indicates that the negative effect of a collectivism-oriented culture on the COVID-19 spread rate more than triples during lockdown periods compared to non-lockdown periods. For every one standard deviation increase in our collectivism score ($\sigma = 0.055$, Table 1), the weekly growth rate of COVID-19 cases decreases by 4.04% ($0.055 \times 73.454\% = 4.04\%$) during lockdown periods, whereas it decreases by 1.24% ($0.055 \times 22.512\% = 1.24\%$) during non-lockdown periods.

We similarly find that when using *CONFUCIAN* as an independent variable, it has a coefficient of -26.169 ($t = -10.290$, $p < 0.001$) and -7.841 ($t = -11.429$, $p < 0.001$) for the lockdown and non-lockdown subsamples, respectively (Table 5). The difference between the estimated coefficients of *CONFUCIAN* is -18.328, which significantly differs from 0 ($p < 0.001$). Overall, the results in Tables 4 and 5 support our hypothesis that the cultural effect on the spread of COVID-19 is stronger during national or regional lockdowns.

Corroborating evidence from the effect of cultural tightness vs looseness. First proposed by Gelfand et al. (2011) and Harrington and Gelfand (2014), cultural tightness-looseness is another important dimension of a country's culture. It measures the degree to which cultures adhere to social norms and tolerate deviance. Tight cultures are restrictive and take strict disciplinary actions against the violation of norms, while loose cultures have relaxed social norms and high tolerance for deviant behaviours. People who grow up in a tight culture that strictly enforces rules do not typically support individualistic thinking or behaviour, while those who grow up in a loose culture have more freedom regarding their behaviour and beliefs. As tight culture facilitates more effective coordination of people to survive threats and natural disasters (Gelfand et al. 2011; Harrington and Gelfand, 2014) and is associated with increased government control and constraints in daily life (Chua et al. 2019), we expect a lower COVID-19 spread rate in countries and regions that are more oriented toward cultural tightness.

We obtain the original cultural tightness scores for 31 countries from Gelfand et al. (2011) and merge these with the COVID-19 data, resulting in 10,095 observations in the final sample. We use *LN(TIGHTNESS)* in the regression analysis, which has a mean (median) of 1.774 (1.856) with a standard deviation of 0.478. The minimum and maximum are, respectively, 0.470 and 2.510. We provide cultural tightness scores for all countries/regions in Appendix C. Consistent with previous research (Harrington and Gelfand, 2014), the Pearson's correlation coefficient between tight score and the collectivistic culture index for this merged sample is 0.380 ($p = 0.042$), indicating a moderate correlation between these two measures of cultures.[10] We then regress COVID-19 spread rate (*CASE_GROWTH*) on the cultural tightness scores *LN(TIGHTNESS)* and control variables (Table 6). Consistent with our expectation, *LN(TIGHTNESS)* has a negative and significant coefficient ($p < 0.001$) in Models (1) and (2), showing that countries and regions with tight cultures generally experience a lower spread rate of COVID-19 than countries with loose cultures. The effects of the control variables are generally consistent with those revealed in previous models (Table 6).

Cultural effect on COVID-19 death rate. Overall, our findings indicate that countries or regions with collectivistic, Confucian or

Table 7 Cultural effects on COVID-19 death rate.

Dependent variable: *DEATH_GROWTH*

Variables	Model (1)	Model (2)	Model (3)
COLLECTIVISTIC	−28.309***		
	(−8.433)		
CONFUCIAN		−11.596***	
		(−23.172)	
LN(TIGHTNESS)			−3.806***
			(−5.505)
SARS	−4.494***	−1.764***	−5.000***
	(−11.128)	(−4.789)	(−8.894)
LN(POPULATION)	1.250***	1.366***	1.358***
	(11.347)	(16.870)	(5.594)
AGE65	−0.667***	−0.286***	−0.615***
	(−14.787)	(−7.894)	(−8.303)
LN(GDP)	−1.493***	−0.413***	−1.844***
	(−7.798)	(−3.053)	(−3.212)
SMOKE	0.010	0.161***	−0.172***
	(0.531)	(11.160)	(−3.383)
LN(LENIENT_ENFORCEMENT)	3.595***	0.314	9.828***
	(10.335)	(1.389)	(16.308)
PROTESTANT	−0.097***	−0.016***	−0.103***
	(−11.288)	(−2.627)	(−7.369)
CATHOLIC	−0.045***	0.004	−0.026**
	(−7.100)	(0.802)	(−2.484)
MUSLIM	0.023***	−0.028***	0.075***
	(3.989)	(−6.445)	(6.317)
Continent FE	Control	Control	Control
Month FE	Control	Control	Control
Observations	22,632	35,069	8708
R-squared	0.567	0.507	0.697

The *t*-values are reported in parentheses. The symbols of *** and ** respectively indicate the 1% and 5% significance levels.

tight cultures tend to have lower spread rates of COVID-19. We subsequently expect that analogous cultural effects also occur with respect to COVID-19 related deaths. To examine the potential cultural effect on the COVID-19 death rate (*DEATH_GROWTH*) during the sample period, we define *DEATH_GROWTH* as $LN(1+COVID\_DEATHS_{i,t})$ – $LN(1+COVID\_DEATHS_{i,t-7})$, where $COVID\_DEATHS_{i,t}$ and $COVID\_DEATHS_{i,t-7}$ are the numbers of confirmed COVID-19 deaths on day t and day t-7, respectively. We use *DEATH_GROWTH* as the dependent variable and conduct a regression analysis including the same control variables as in previous analyses. As shown in Table 7, the coefficients for *COLLECTIVISTIC*, *CONFUCIAN* and *LN(TIGHTNESS)* are all negative and significant ($p < 0.001$) across three regression specifications, implying that countries or regions with collectivistic, Confucian or tight cultures tend to have lower COVID-19 death rates.[11]

Discussion and conclusions

Conclusions. The COVID-19 pandemic has presented unprecedented challenges and greatly altered both normal life and economic activities (Zhang et al. 2022). In collectivistic societies, people usually prioritize group-oriented concerns over their personal interests and conveniences such as freedom and privacy (Chen et al. 2021). As a result, people in collectivistic cultures are more likely to sacrifice their personal interests for the group's needs and goals (Maaravi et al. 2021). For example, people in collectivistic cultures are more willing to tolerate personal inconvenience and wear masks during the pandemic (Lu et al. 2021). On the other hand, compared with individualistic societies, collectivistic societies have stronger social norms and encounter fewer difficulties during the pandemic (Bavel et al. 2020). Governments in countries with collectivistic cultures tend to react more quickly than those in countries with individualistic cultures (Chen et al. 2021). Therefore, collectivistic societies are more likely to experience a lower spread rate of COVID-19 than individualistic societies.

In this study, we investigate the spread of COVID-19 cases by considering cultures across different countries and regions of the world. Our findings are consistent with our expectations. After controlling for factors at the national level, including population, age structure, gross domestic product (GDP) per capita, previous SARS occurrence, smoking prevalence and religion, we find that countries and regions with cultures that emphasise collectivism rather than individualism experience a lower spread rate of COVID-19. Considering the effects of Confucian culture and cultural tightness-looseness on the spread rate of COVID-19, we find that countries and regions in the Confucian cultural circle or those with tight cultures generally experience lower COVID-19 spread rates. Examining the cultural effect on COVID-19 death rate corroborates these results. Overall, our results are not consistent with Webster et al. (2021), but consistent with Jiang et al. (2022) and Maaravi et al. (2021), both of which report that collectivistic societies have fewer COVID-19 cases than individualistic societies. Compared with Maaravi et al. (2021) and Jiang et al. (2022), our study further reports that the effect of collectivistic cultures on the spread of COVID-19 becomes stronger during national or regional lockdowns. Therefore, our study contributes to the literature by showing that the degree of collectivistic orientation affects not only the spread of COVID-19, but also the outcome of lockdowns.

Implications. Our study has important practical implications for controlling the spread of infectious diseases. First, in light of the significant cultural effects on the global spread of COVID-19 identified in this study, we recommend that governments implement policies that emphasise the ideas of the common interest, personal responsibility and strong norms, and the sense that we all live in a global community. Second, since the effectiveness of lockdown policies depends on the degree of collectivistic orientation, we recommend that governments highlight the collective benefits from lockdowns and the importance of adhering to social norms before implementing lockdown policies, especially in Western Europe and North America where people endorse individualism. Third, considering that the world is becoming more and more interconnected, we recommend that governments in different countries and regions collaborate on solving the collective crises like COVID-19 pandemic, as people all live together in a small global village.

Finally, our recommendations may still hold for future similar infectious diseases. Besides, our study does not suggest that collectivism outperforms individualism in any conditions. Vaccines may be more important than cultural factors in the later stage of COVID-19 pandemic.

Limitations and future research. First, in our study, we use regression models to estimate the effects of cultural factors on the spread of COVID-19. However, regression models fail to show the COVID-19 spread process in the real world and may ignore some important factors. Existing literature (e.g., Li et al. 2022b) has shown that higher-order interactions have significant impacts on the epidemic spreading. For example, the collective behaviour in higher-order networks often leads to "super spreading events" during the pandemic (Althouse et al. 2020). So it is necessary for researchers to study the impact of higher-order networks on the spread process. Furthermore, WHO has reported that different variants have emerged and been identified in many countries.

Variants suppress each other through competitive behaviour which may influence the pandemic transmission dynamics. Li et al. (2022a) present a competing spread model for two simplicial irreversible epidemics on higher-order networks to show the spread process of two epidemics. However, there is a lack of systematic research on epidemiological immunization strategies on higher-order networks. Considering the importance of higher-order interactions, we argue that future research could examine the influence of higher-order interactions on the spread process.

Second, in our study, each country/region has a fixed collectivistic culture score. However, cultures are actually dynamic and changing all the time. For example, people in collectivistic cultures may be unwilling to support lockdown policies after they have been locked down for several months. We may need to find a balance between freedom and constraint.

Third, our study only examines the effects of collectivist, tight and Confucian cultures on the spread of COVID-19. However, cultures are complex and have different dimensions, other cultural dimensions may be also important. Future research could examine how other cultural dimensions affect the spread of COVID-19.

Data availability

The datasets generated and analyzed during the current study are available from the corresponding auther upon reasonable request.

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Notes

1 According to Orbann (2020), 'We are both biological and cultural beings, so when a disease spreads through large parts of the world's population, we can cope with that in both biological and cultural ways… Every major pandemic in human history has been exacerbated by cultural behaviour in one way or another.' (https://www.futurity.org/covid-19-culture-history-2318752/). Accessed on 19 Aug 2020.

2 Hofstede's cultural dimensions include individualism-collectivism, uncertainty avoidance, power distance, masculinity-femininity and long-term orientation. In 2010, Hofstede added a sixth dimension, indulgence versus self-restraint.

3 The report further states that this will avoid increasing tensions between different groups (including between responding agencies and the public), promote social norms around behaviours, and lead to self-policing within communities around important behaviours. See the report "SPI-B return on risk of public disorder", conducted by the UK Scientific Advisory Group for Emergencies (SAGE), Ministry of Justice, Home Office (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/873736/08-spi-b-return-on-risk-of-public-disorder.pdf), Accessed on 19 Aug 2020.

4 MIT political scientist Cahppell Lawson, who moderated the event 'When Culture Clashes with COVID-19' on 25 June 2020, adds that 'The basic question related to culture is…how do thoese beliefs and norms affect what different countries did in response to the emergence of the SARS-CoV-2 virus?' Source: https://news.mit.edu/2020/when-culture-clashes-covid-19-0625. Accessed on 29 Nov 2020.

5 According to the Our World in Data website (https://ourworldindata.org/), the goal is to make knowledge regarding big problems accessible and understandable. The COVID-19 data can be downloaded from https://github.com/owid/covid-19-data/tree/master/public/data, Accessed on 18 Oct 2020.

6 The Hofstede national culture website can be accessed at https://geerthofstede.com/research-and-vsm/dimension-data-matrix/. Accessed on 18 Oct 2020.

7 Our data start from 22 January 2020 because the World Health Organization (WHO) held an emergency committee meeting on this date to assess whether the outbreak of novel coronavirus 2019 in China, Korea, Japan, Thailand and Singapore should be considered a Public Health Emergency of International Concern (PHEIC). The meeting prompted countries across the world to pay attention to COVID-19. Before 22 January 2020, COVID-19 had not received substantial attention and no COVID-19 case data had been collected and reported to the public. We end our data on 31 December 2020 as the vaccine as this is when vaccines became widely available in many countries. Our study thus does not consider the effect of widespread vaccination on the spread of COVID-19.

8 15 countries experienced SARS outbreaks: China, Australia, Brazil, Colombia, India, Indonesia, Italy, Malaysia, Ireland, South Korea, South Africa, Spain, Thailand, the UK and the USA.

9 These countries include China, France, Italy, Spain and the UK, among others. Some studies (Brodeur et al., 2021; Layard et al., 2020) report that government interventions such as lockdowns may severely affect peoples' mental health.

10 Harrington and Gelfand (2014) report a correlation of 0.37 between the collectivism measures and tightness scores.

11 Note that the results reported in this section are subject to interpretation. It has been reported that COVID-19 deaths are primarily related to pre-existing medical conditions. Our regression analysis does not include this important variable due to data limitations.

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Author contributions

ML: Methodology, formal analysis, writing—original draft; writing—review and editing; BL: conceptualization, methodology, formal analysis; JZ contribution: software, writing, review and editing, and supervision; HW contribution: resources, writing, review and editing, and supervision.

Competing interests

The authors declare no competing interests.

Ethical approval

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