Public risk perception and responsive behaviors in the United States, United Kingdom, and Brazil during the COVID-19 Pandemic: a cross-sectional study

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Research Article

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Abstract

Background: Understanding public perception and behaviors toward COVID-19 is valuable for mitigating the severe epidemic. Our study aimed to investigate differences of the public from the US, UK, and Brazil on the aspects of the living environment, behaviors, attitude and risk perception.

Methods: Dataset were taken from the COVID-19 (Coronavirus) Survival Calculator project. 89554 respondents from the US (n=71812), UK (n=10392), and Brazil (n=7350) completed online questionnaire survey from April 28 to July 8. Frequencies and percentages were calculated to describe respondents' responses. Chi-square tests with Holm-Bonferroni correction and binary logistic regression were used to determine the differences in environmental status, behaviors and worried degree of participants among the three countries, and further explore the sociodemographic characteristics related to protective measures.

Results: Brazil participants had the highest risk perception to COVID-19, followed by the US, and the UK was the lowest (39.02 ± 24.57 vs. 32.72 ± 22.38 vs. 29.47 ± 22.39 , $P < 0.001$). More Brazil participants expressed that they were worried about COVID-19. The proportion of respondents from the US and UK who reported they were not worried about COVID-19 was 2.00 times (95%CI: 1.80-2.23) and 3.24 times (95%CI: 2.88-3.65) that of Brazil. A higher percentage of Brazil respondents reported they were in close contact with more than ten people, using public transport and engaging in work. Regarding behaviors, social distancing (ranges:84.9%-86.8%) and washing hands (ranges:84.8%-90.3%) were the most frequently used protective measures, but respondents from the US (69.8%) and UK (15.8%) were relatively reluctant to wear masks. Moreover, it was found that participants from ethnic minorities were more likely to take protective measures. But males, respondents under 20 years, and respondents with poor economic conditions had various degrees of neglect to take steps. Meanwhile, healthcare workers also had a relatively stronger awareness of protection.

Conclusion: There are significant differences in the environment, behaviors, attitude and risk perception of the public from the US, UK and Brazil. The sociodemographic subgroups analysis indicated that it is necessary to enhance protection publicity and support for specific groups. Our findings are conducive to the public health authorities to carry out more targeted publicity work of COVID-19 protection measures.

Background

Coronavirus disease 2019 (COVID-19) was first reported in Wuhan, China, in December 2019 [1]. After that, the virus spread rapidly in the southeast Asia, African, European regions, and the western Pacific. On March 11, 2020, the World Health Organization (WHO) declared COVID-19 a pandemic [2]. Faced with pandemic threats, different countries have varied substantially in their reactions, yet all promulgated lockdown policies. On March 19, 2020, California was the first state to issue a "stay at home" order, followed by similar orders from American states. On 23 March 2020, a national quarantine was imposed on Britain. On 27 March, Brazil announced a temporary ban on foreign air travelers and most state

governors have imposed isolation policies. However, the global epidemic of COVID-19 continues to spread, and the second wave of novel coronavirus infection is becoming more and more intense. As of 6 November 2020, the total number of confirmed cases has exceeded 48 million and the deaths has exceeded 1.23 million. The daily number of new cases in the United States and Brazil remains high and continues to rise. As of 6 November 2020, the number of confirmed cases in the United States has exceeded 21 million, Brazil has exceeded 5.5 million, and the number of confirmed cases in the United Kingdom has also exceeded 1.1 million [3]. In order to prevent and control the second wave of COVID-19 and protect the National Health and Medical System (NHS), the British Prime Minister Boris Johnson announced that a four-week blockade will be implemented in England from November 5.

One key factor for adherence to public health advice is the perception of threats [4]. The speed with which COVID-19 is spreading across the world calls for rapid assessments of the public's perceptions of this infection [5]. Some scholars have conducted related research on this aspect. For example, Taghrir et al. conducted a survey of Iranian medical students on COVID-19 related knowledge, prevention behaviors, and risk perception [6]. Bruine et al. explored the relationship between risk perception and protective health behaviors in the United States at the beginning of the COVID-19 epidemic [7]. Karien et al. conducted a survey on the public perspectives on protective measures during the COVID-19 pandemic in the Netherlands, Germany, and Italy [8]. Pascal et al. used an online survey to determine the American and British public's knowledge and views on COVID-19 [9]. Gordon et al. explored the differences in knowledge and concerns about COVID-19 among the people of Canada, the United Kingdom, and the United States [10]. However, these studies were conducted at the beginning of the COVID-19 pandemic, and their conclusions are not well applicable to the second outbreak of the current epidemic. Additionally, there have been few studies on the relationships between various environmental or behavioral factors and people's perceived risk of contracting COVID-19, especially with regard to the behaviors and attitudes of cohabitants. Moreover, the sample sizes of the existing surveys have been limited, generally hundreds or thousands of samples, which lead to certain limitations with regard to the interpretation of the results. Thus far, there are few large samples of tens of thousands to study the differences in the public's perceptions and behaviors of COVID-19 in different countries.

This study conducted a cross-sectional online survey to understand the current living environment of the people in the United States, the United Kingdom and Brazil, their responsive behaviors, their level of worry about the epidemic, and their risk perception of infection during the COVID-19 pandemic, and explore the impact of various factors such as environment, behaviors and attitude on risk perception. In addition, we also conducted a stratified study of different sociodemographic groups to identify sociodemographic factors associated with different responsive behaviors. We believe that understanding the public's risk perception of COVID-19 and their responsive behaviors is not only valuable for mitigating the current severe epidemic situation in the United States, the United Kingdom and Brazil, but also serves the government and public health organizations' information dissemination and infection control strategy development in the future.

Methods

Participants

The dataset for this cross-sectional study came from the COVID-19 (Coronavirus) Survival Calculator project launched by Nexoid, a software company located in London. Nexoid developed an online questionnaire and translated it from the original English version into multiple languages, including Spanish, Russian, French, and Chinese, aiming to collect information about impact factors associated with COVID-19 from the global public. This dataset is protected under the "Attribution 4.0 International (CC BY 4.0)" license, which is free for personal, educational, research, and commercial use provided the dataset is attributed to "Nexoid" [11]. Nexoid was constantly updating and adjusting the content of the questionnaire, and released the latest version of the questionnaire on April 25, adding surveys on race, income status, health insurance status, healthcare-related occupation, and other information. From then on to July 8, Nexoid collected 109,969 survey data from the US, the UK, and Brazil, and the respondents reviewed the privacy statement and agreed to participate in the survey. After excluding 19,931 respondents who had a blank field for "chance of getting COVID-19" and "race", and 484 respondents whose gender was "other", there were 89,554 respondents with complete data included in the analysis, including 71,812 respondents from the US, 10,392 respondents from the UK, and 7,350 respondents from Brazil. They participated in this cross-sectional study from April 28 to July 8, 2020.

Measures

Based on the purpose of this study, we selected questions from the COVID-19 (Coronavirus) Survival Calculator online survey for in-depth analysis. Sociodemographic characteristics included gender, age, race, income status, private health insurance status, underlying medical conditions, and healthcare-related occupation information (Table 1). There were too many answer options for some questions in the original questionnaire, which is not conducive to the analysis of practical problems. Therefore, we regrouped the answer options for some questions. The age of participants was divided into 4 groups: 0–20 years, 20–40 years, 40–60 years, and more than 60 years. The underlying medical conditions were defined as asthma, chronic kidney disease being treated with dialysis, chronic liver disease, compromised immune system, serious heart condition, chronic lung disease, diabetes, HIV positive, and hypertension, and we divided it into 2 groups: have and none.

Furthermore, it also contained four sections: 1) four questions based on the environmental status, including the number of close contacts in the last week, the number of cohabitants, the number of using public transport in the last week and the situation of going to work/school; 2) six responsive behaviors questions to determine that participants take protective measures to reduce infection, including social distancing, washing hands, using alcohol hand sanitizer and wearing masks outside, as well as the situation of social distancing and washing hand in cohabitants; 3) one attitude-based question to assess participants' degree of worry about COVID-19; 4) one question about risk perception to understand the participants' chance of getting COVID-19. A five-point Likert scale was used to measure the implementation level of six responsive behaviors questions and degree of worry about COVID-19, "1–5"

respectively means “Extremely disagree/Never”, “Disagree/Rarely”, “Neutral/Sometimes”, “Agree/Usually” and “Extremely agree/Always”. Ten probability intervals from 0–10% to 90–100% were used to measure the participant’s risk perception, and the median of each probability interval was selected in the dataset as the final result of participants’ risk perception (5%, 15%, 25%,, 95%). See Additional file 1 in the Online Supplementary Document for the complete list of questions.

Table 1
Sociodemographic characteristics of respondents

	United States	United Kingdom	Brazil
	n (%)	n (%)	n (%)
All participants	71812(100%)	10392(100%)	7350(100%)
Gender			
Male	24971(34.8%)	4482(43.1%)	3732(50.8%)
Female	46841(65.2%)	5910(56.9%)	3618(49.2%)
Age			
0 to 20 years	1501(2.1%)	380(3.7%)	319(4.3%)
20 to 40 years	32161(44.8%)	4121(39.7%)	4261(58.0%)
40 to 60 years	27836(38.8%)	4494(43.2%)	2319(31.6%)
More than 60 years	10314(14.4%)	1397(13.4%)	451(6.1%)
Race			
White	62713(87.3%)	9623(92.6%)	4128(56.2%)
Hispanic	3035(4.2%)	32(0.3%)	151(2.1%)
Asian	2037(2.8%)	352(3.4%)	87(1.2%)
Black	1348(1.9%)	73(0.7%)	199(2.7%)
Mixed	1702(2.4%)	222(2.1%)	1138(15.5%)
Other or unknown	977(1.4%)	90(0.9%)	1647(22.4%)
Income status			
High	21846(30.4%)	3510(33.8%)	2262(30.8%)
Medium	37645(52.4%)	5144(49.5%)	3778(51.4%)
Low	9204(12.8%)	1010(9.7%)	806(11.0%)
Social welfare	1211(1.7%)	325(3.1%)	139(1.9%)
Unknown	1906(2.7%)	403(3.9%)	365(5.0%)
Private health insurance			
Have	61537(85.7%)	2804(27.0%)	5277(71.8%)
None	6625(9.2%)	6029(58.0%)	1849(25.2%)
Unknown	3650(5.1%)	1559(15.0%)	224(3.0%)

	United States n (%)	United Kingdom n (%)	Brazil n (%)
Underlying medical conditions			
None	45393(63.2%)	7058(67.9%)	5483(74.6%)
Have	26419(36.8%)	3334(32.1%)	1867(25.4%)
Healthcare worker			
No	66495(92.6%)	9702(93.4%)	6430(87.5%)
Yes	5317(7.4%)	690(6.6%)	920(12.5%)

Statistical analysis

The statistical analysis software used in this study was IBM SPSS Statistics version 23.0. Frequencies and percentages were calculated to describe the sociodemographic characteristics, environmental status, and responsive behaviors of participants toward COVID-19 in the US, the UK, and Brazil. Mean $\pm$ standard deviation (Mean $\pm$ SD) and percentages of each interval were calculated to indicate the worried degree and risk perception of participants. Independent sample t test, one-way analysis of variance (ANOVA), and chi-square test were used to compare categorical variables between different groups, and using Holm Bonferroni correction to account for multiple comparisons. Odds ratios (ORs) and 95% confidence intervals (CIs), which obtained from binary logistic regression, were used to quantify the differences in environmental status and responsive behaviors of participants, and further explore the specific performance of taking protective measures in groups with various sociodemographic characteristics. Multiple linear regression was utilized to explore the correlation between attitude, environmental status, responsive behaviors, and risk perception of participants towards COVID-19. Variance inflation factor was estimated to ensure the absence of multicollinearity. Results were considered statistically significant when $P < 0.05$.

Results

Environmental status

Table 2 shows the environmental status of respondents in the three countries, and the logistic regression results suggest several important differences, as shown in Table 3. It was found that among three countries, participants from Brazil had the highest proportion who had close contacts with more than 10 people in the last week (the US: 18.2% vs. the UK: 11% vs. Brazil: 28.4%), which was 1.79 times (95%CI: 1.69–1.88) and 3.22 times (95%CI: 2.97–3.49) that of the US and the UK. Most respondents living in these three countries reported that fewer than 5 people lived in their houses/apartments (ranges: 95%-96.6%), but the US respondents have a higher proportion of living together for more than 5 people.

Meanwhile, most respondents living in these three countries also did not use public transport in the last week (ranges: 94.4%-97.9%), but the use of public transport for the US respondents and the UK respondents respectively decreased by 64% (OR = 0.36, 95%CI: 0.32–0.40) and 18% (OR = 0.82, 95%CI: 0.72–0.94), compared with Brazil. In the US, the UK, and Brazil, 73.8%, 79.9%, and 70.7% of respondents indicated that they have stopped working or going to school, however, Brazil had the highest percentage of people who were still at school or engaged in work, which was 1.17 times (95%CI: 1.11–1.23) and 1.55 times (95%CI: 1.45–1.67) that of the US and the UK.

Table 2
Environmental status of respondents

	United States n (%)	United Kingdom n (%)	Brazil n (%)	χ^2	P value ^a
Number of close contacts				878.70	P < 0.001
≤ 10	58765(81.8)	9253(89.0)	5264(71.6)		
>10	13047(18.2)	1139(11.0)	2086(28.4)		
Number of cohabitants				49.15	P < 0.001
≤ 5	68240(95.0)	10034(96.6)	7027(95.6)		
>5	3572(5.0)	358(3.4)	323(4.4)		
Using public transport				499.36	P < 0.001
None	70315(97.9)	9907(95.3)	6937(94.4)		
Have	1497(2.1)	485(4.7)	413(5.6)		
Traveling to work/school				662.75	P < 0.001
Never	18782(26.2)	2899(27.9)	2600(35.4)		
Home	6768(9.4)	1011(9.7)	371(5.0)		
Recently stopped	27454(38.2)	4296(41.3)	2227(30.3)		
Travel non critical	6447(9.0)	635(6.1)	795(10.8)		
Travel critical	12361(17.2)	1551(14.9)	1357(18.5)		
Note: ^a Use chi-square tests with Holm Bonferroni correction to account for multiple comparisons. The results were considered statistically significant if corrected P < 0.05.					

Table 3

The binary logistic regression results of environmental status of participants from the US, the UK, and Brazil (pairwise comparison between the three countries)

	Close contacts > 10	Cohabitants > 5	Using public transport	Traveling to work/school
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
US vs. UK	1.80***(1.69, 1.92)	1.47*** (1.31,1.64)	0.44***(0.39,0.48)	1.33***(1.27,1.40)
US vs. Brazil	0.56*** (0.53,0.59)	1.14* (1.01,1.28)	0.36*** (0.32,0.40)	0.86*** (0.81,0.90)
UK vs. US	0.55*** (0.52,0.59)	0.68*** (0.61,0.76)	2.30*** (2.07,2.55)	0.75*** (0.71,0.79)
UK vs. Brazil	0.31*** (0.29,0.34)	0.78** (0.67,0.91)	0.82** (0.72,0.94)	0.64*** (0.60,0.69)
Brazil vs. US	1.79*** (1.69,1.88)	0.88* (0.78,0.99)	2.80*** (2.50,3.13)	1.17*** (1.11,1.23)
Brazil vs. UK	3.22*** (2.97,3.49)	1.29** (1.11,1.50)	1.22** (1.06,1.39)	1.55***(1.45,1.67)
Note: *P < 0.05, **P < 0.01, ***P < 0.001				

Responsive behaviors

The responsive behaviors of participants from the US, the UK, and Brazil are shown in Table 4, and there are some differences among the three countries, as shown in Table 5. The most commonly used protective measures to reduce infection risk included social distancing (ranges: 84.9%-86.8%) and washing hands (ranges: 84.8%-90.3%). In addition, a majority of participants reported their cohabitants were likewise taking protective measures by social distancing (ranges: 63.7%-76.1%) and washing hands (ranges: 71.8%-78.2%). However, Brazil respondents and their cohabitants had a higher proportion of disagreeing with social distancing than respondents from the other two countries. The odds of disagreeing with social distancing decreased by 36% (OR = 0.64, 95%CI: 0.55–0.75) and 25% (OR = 0.75, 95%CI: 0.62–0.91) for participants in the US and UK, and the odds of disagreeing with social distancing decreased by 43% (OR = 0.57, 95%CI: 0.52–0.64) and 38% (OR = 0.52, 95%CI: 0.45–0.60) for participants' cohabitants, respectively. Compared with social distancing and hand-washing, the proportion of respondents who used alcohol hand sanitizer was relatively low in the three countries, with only 54%, 42.9%, and 69.6% of respondents indicated that they often used alcohol hand sanitizer to reduce infection risk. Among them, the odds of rarely using alcohol hand sanitizer in the US and UK were 3.62 times (95%CI: 3.25–4.04) and 5.92 times (95%CI: 5.27–6.66) for respondents in Brazil, respectively. 87.3% of Brazil respondents reported they often wear masks, but respondents in the US and the UK were relatively reluctant to wear masks, only 69.8% of US respondents and 15.8% of UK respondents expressed

an agreement in wearing masks outside. Besides, 59.4% of UK respondents indicated that they rarely wore masks. The odds of rarely wearing masks of UK respondents increased by 12.75 times (95%CI: 12.18–13.35) and 31.86 times (95%CI: 28.31–35.85) for respondents in the US and Brazil, respectively.

Table 4
Responsive behaviors of participants

	United States n (%)	United Kingdom n (%)	Brazil n (%)	χ^2	P value ^a
Participants taking steps to reduce risk by social distancing				49.93	P < 0.001
Disagree	1240(1.7%)	209(2.0%)	196(2.7%)		
Neutral0	8231(11.5%)	1293(12.4%)	915(12.4%)		
Agree	62341(86.8)	8890(85.5%)	6239(84.9%)		
Participants taking steps to reduce risk by washing hands				253.43	P < 0.001
Disagree	762(1.1%)	186(1.8%)	99(1.3%)		
Neutral0	6583(9.2%)	1394(13.4%)	613(8.3%)		
Agree	64467(89.8)	8812(84.8%)	6638(90.3%)		
Participants' taking steps to reduce risk by using alcohol hand sanitizer				1586.26	P < 0.001
Rarely	10898(15.2)	2352(22.6%)	346(4.7%)		
Sometimes	22144(30.8)	3584(34.5%)	1891(25.7%)		
Often	38770(54.0)	4456(42.9%)	5113(69.6%)		
Wear the mask when outside				20081.8	P < 0.001
Rarely	7397(10.3%)	6175(59.4%)	323(4.4%)		
Sometimes	14322(19.9)	2580(24.8%)	609(8.3%)		
Often	50093(69.8)	1637(15.8%)	6418(87.3%)		
Participants' cohabitants taking steps to reduce risk by social distancing				562.13	P < 0.001
Disagree	2540(3.5%)	335(3.2%)	441(6.0%)		
Neutral0	14634(20.4)	2240(21.6%)	2228(30.3%)		
Agree	54638(76.1)	7817(75.2%)	4681(63.7%)		
Participants' cohabitants taking steps to reduce risk by washing hands				214.59	P < 0.001
Disagree	1321(1.8%)	219(2.1%)	150(2.0%)		
Neutral0	14339(20.0)	2443(23.5%)	1925(26.2%)		
Agree	56152(78.2)	7730(74.4%)	5275(71.8%)		
Note: ^a Use chi-square tests with Holm Bonferroni correction to account for multiple comparisons. The results were considered statistically significant if corrected P < 0.05.					

Table 5

The binary logistic regression results of responsive behaviors towards COVID-19 of participants from the US, the UK, and Brazil (pairwise comparison between the three countries)

	Disagree with social distancing	Disagree with washing hands	Rarely using alcohol hand sanitizer	Rarely wearing mask when outside	Cohabitants disagree with social distancing	Cohabitants disagree with washing hands
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
US vs. UK	0.86* (0.74,0.99)	0.59*** (0.50,0.69)	0.61*** (0.58,0.64)	0.08*** (0.075,0.082)	1.10 (0.98,1.24)	0.82 (0.75,1.01)
US vs. Brazil	0.64*** (0.55,0.75)	0.79* (0.64,0.97)	3.62*** (3.25,4.04)	2.50*** (2.23,2.80)	0.57*** (0.52,0.64)	0.90 (0.76,1.07)
UK vs. US	1.17* (1.01,1.35)	1.70*** (1.45,2.0)	1.64*** (1.56,1.72)	12.75*** (12.18,13.35)	0.91 (0.81,1.02)	1.15 (0.99,1.33)
UK vs. Brazil	0.75** (0.62,0.91)	1.34* (1.04,1.71)	5.92*** (5.27,6.66)	31.86*** (28.31,35.85)	0.52*** (0.45,0.60)	1.03 (0.84,1.28)
Brazil vs. US	1.56*** (1.34,1.82)	1.27* (1.03,1.57)	0.28*** (0.25,0.31)	0.40*** (0.36,0.45)	1.74*** (1.57,1.93)	1.11 (0.94,1.32)
Brazil vs. UK	1.34** (1.10,1.63)	0.75* (0.59,0.96)	0.17*** (0.15,0.19)	0.03*** (0.028,0.035)	1.92*** (1.66,2.22)	0.97 (0.79,1.19)
Note: Boldface indicates statistical significance (*P < 0.05, **P < 0.01, ***P < 0.001)						

Attitudes

The average response degree among participants in three countries on the view that they were worried about COVID-19 is shown in Fig. 1. UK respondents had the lowest degree of worry about COVID-19 (3.30 ± 0.82), Brazil was the highest (3.86 ± 0.85), followed by the United States (3.49 ± 0.79), and there were significant differences among the three countries ($P < 0.001$). 44.4% of UK respondents were neutral and 14.6% of respondents disagreed, which was the highest proportion among the three countries. However, more Brazil participants expressed that they were worried about COVID-19, and only 5% of Brazil participants expressed a disagreement about it. The proportion of respondents living in the US and UK who reported not worried about COVID-19 was 2.00 times (95%CI: 1.80–2.23) and 3.24 times (95%CI: 2.88–3.65) that of Brazil, respectively. At the same time, the odds of disagreeing with worry about COVID-19 also increased by 62% (OR = 1.62, 95%CI: 1.53–1.72) for participants in the UK, compared with respondents from the US.

Risk perception

Respondents in these three countries had significant differences in risk perception about COVID-19 ($P < 0.001$), with Brazilian respondents having the highest average self-assessed risk of COVID-19 infection (39.02 ± 24.57), followed by the United States (32.72 ± 22.38), and the United Kingdom was the lowest (29.47 ± 22.39), as shown in Fig. 2. 58.9% of UK participants and 52.8% of US participants thought their chances of getting COVID-19 was less than 30%, which was more than half of the participants in their country, but only 41.5% of Brazil participants expressed their infection risk was less than 30%. Meanwhile, there were 19.7% of respondents from Brazil believed their infection risk would exceed 60%, compared with 10.5% of respondents from the UK and 12.6% of respondents from the US.

The influence of attitude, environmental status, and responsive behaviors on risk perception

The relationship between the degree of worry about COVID-19, environmental status, responsive behaviors, and risk perception is shown in Table 6. Gender, age, race, private health insurance status, income status, underlying medical conditions, and healthcare-related occupation information were used as the control variables. The overall performance of the three countries was that more close contacts, cohabitations, use of public transports, and the situation of going to school/work outside are positively correlated with risk perception. There was a positive correlation between participants' attitude and risk perception. Participants from the US and Brazil expressed that their cohabitants' emphasis on protective measures was negatively correlated with risk perception. In addition, the impact of personal protective measures on risk perception of UK participants was not significant, while the importance of washing hand and wearing masks of US participants was positively correlated with risk perception, the importance of social distancing was negatively correlated with risk perception, and the importance of using alcohol hand sanitizer was positively correlated with perceived risk.

Table 6

The Multiple Linear Regression results between the attitude, environmental status, responsive behaviors and risk perception of participants toward COVID-19 with sociodemographic controls.

	United States		United Kingdom		Brazil	
Categories	B	S.E.	B	S.E.	B	S.E.
R square	0.085***		0.088***		0.124***	
Worry about COVID-19	4.182***	0.116	4.337***	0.282	2.455***	0.363
Number of close contacts (> 10 vs. ≤10)	4.139***	0.245	5.969***	0.798	5.780***	0.708
Number of cohabitants (> 5 vs. ≤5)	1.025**	0.370	2.395*	1.156	-0.802	1.317
Using public transport(have vs. none)	1.172*	0.562	0.344	1.012	3.670**	1.197
Traveling to work/school (non-critical vs. none)	2.284***	0.294	2.546**	0.901	3.150***	0.925
Traveling to work/school (critical vs. none)	4.151***	0.271	4.838***	0.760	9.577***	0.879
Social distancing	0.101	0.186	0.511	0.449	-2.352***	0.482
Washing hands	0.444*	0.193	-0.464	0.472	-0.435	0.552
Using alcohol hand sanitizer	-0.021	0.093	0.128	0.228	0.848**	0.389
Wearing mask when outside	1.071***	0.101	-0.340	0.199	0.532	0.359
Social distancing of cohabitants	-1.070***	0.163	-0.834	0.428	-1.970***	0.402
Washing hands of cohabitants	-1.113***	0.176	0.000	0.453	-2.069***	0.501
Gender	-4.043***	0.175	-3.766***	0.439	-0.928	0.557
Age	-0.160***	0.006	-0.165***	0.015	-0.123***	0.022
Race	-0.406***	0.083	0.422	0.253	-0.423**	0.132
Private health insurance	-0.497**	0.172	0.209	0.347	-0.475	0.553
Income status	0.945***	0.105	0.940***	0.238	-0.560	0.311
Underlying medical conditions	2.101***	0.171	2.379***	0.466	2.118**	0.634
Healthcare worker	5.775***	0.358	5.877***	0.991	8.330***	0.952
Note: Boldface indicates statistical significance (*P < 0.05, **P < 0.01, ***P < 0.001)						

Responsive behaviors analyses under different sociodemographic factors

The binary logistic regression analysis results revealed the responsive behaviors towards COVID-19 under different sociodemographic factors (Table 7), and some differences of protective behaviors were also observed among subgroups in the three countries. Males were more likely to report disagreement with taking measures (social distancing, washing hands, using alcohol hand sanitizer, or wearing masks outside) to reduce their personal risk than females in all three countries. In the US, compared with respondents aged 20 to 40, the odds of reporting disagreement with taking measures of social distancing, washing hands, using alcohol hand sanitizer, and wearing masks outside increased by 4.03 times (95%CI: 3.28–4.95), 3.15 times (95%CI: 2.36–4.21), 1.32 times (95%CI: 1.15–1.5), and 1.32 times (95%CI: 1.14–1.53) for respondents under 20 years; elderly participants over 60 years expressed more attention to social distancing and wearing masks, but they indicated not using alcohol hand sanitizer relatively more often. In the UK, the odds of reporting disagreement with taking measures of using alcohol hand sanitizer and wearing masks was 3.2 times (95%CI: 2.02–5.07) and 3.64 times (95%CI: 2.23–5.94) higher for participants under 20 years, and participants over 60 years also paid more attention to wearing masks. Young participants under 20 years from Brazil were more likely to disagree with using alcohol hand sanitizer and wearing masks. In contrast to the US and the UK, the proportion of Brazil participants over 60 years who reported not using masks increased by 67% (OR = 1.67, 95%CI: 1.09–2.58), compared with participants aged 20 to 40. There were significant differences in the situation of taking protective measures among different socioeconomic groups. Respondents from US with a middle, low income and those who need to receive social welfare or government support more frequently reported disagreeing with taking protective measures (social distancing, washing hands, using alcohol hand sanitizer or wearing mask outside). The odds of disagreeing with using alcohol hand sanitizer and wearing mask in Brazil respondents who need to receive social welfare increased by 2.7 times (95%CI: 1.42–5.13) and 2.3 times (95%CI: 1.14–4.65), compared with high-income respondents. No obvious differences between subgroups of different economic conditions in the UK was observed. Additionally, respondents without private health insurance from the US and the UK also indicated various degrees of neglect to take protective measures, including social distancing, washing hands, using alcohol hand sanitizer and wearing masks outside, with no differences in Brazil respondents.

Some differences have been observed in the research of race subgroups. Asian participants living in the US were more likely to take measures by social distancing and wearing masks compared to white participants. The proportion of disagreeing with wearing masks outside for Hispanic, black, and mixed-race participants was also lower than white participants. The odds of not wearing masks in Asian, black, and mixed-race participants from UK decreased by 58% (OR = 0.42, 95%CI: 0.34–0.52), 65% (OR = 0.35, 95%CI: 0.21–0.57) and 34% (OR = 0.66, 95%CI: 0.50–0.86), respectively. But the odds of disagreeing with social distancing for Hispanic participants from the UK increased by 5.19 times (95%CI: 1.55–17.4) compared to white participants. And Hispanic participants living in Brazil had less disagreement with using masks, which decreased by 24% (OR = 0.24, 95%CI: 0.06–0.97) of the white participants.

Due to the particularity of their jobs, healthcare workers from the US and the UK reported a significant reduction of disagreeing with using alcohol hand sanitizer and masks. However, the odds of healthcare

workers in the US and Brazil who reported not adopting social distancing increased 1.42 times (95%CI: 1.16–1.73) and 2.32 times (95%CI: 1.64–3.29), respectively.

Table 7

The binary logistic regression results of responsive behaviors towards COVID-19 under different sociodemographic factors in the US, the UK, and Brazil

	Disagree with social distancing	Disagree with washing hands	Rarely using alcohol hand sanitizer	Rarely wearing mask when outside
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
United States				
Gender (Male vs. Female)	1.86 (1.66,2.09) ***	1.97 (1.70,2.28) ***	1.64 (1.58,1.72) ***	1.97 (1.88,2.08) ***
Age (reference: 20 to 40)				
0 to 20 years	4.03 (3.28,4.95) ***	3.15 (2.36,4.21) ***	1.32 (1.15,1.50) ***	1.32 (1.14,1.53) ***
40 to 60 years	0.67 (0.58,0.77) ***	0.76 (0.64,0.91) **	1.05 (1.00,1.10)	0.91 (0.86,0.96) ***
More than 60 years	0.61 (0.50,0.74) ***	0.81 (0.64,1.02)	1.16 (1.09,1.23) ***	0.77 (0.71,0.84) ***
Race (reference: White)				
Hispanic	0.93 (0.72,1.21)	0.83 (0.58,1.18)	0.73 (0.65,0.81) ***	0.58 (0.51,0.67) ***
Asian	0.57 (0.38,0.84) **	0.73 (0.45,1.17)	1.07 (0.95,1.21)	0.62 (0.53,0.74) ***
Black	0.64 (0.39,1.03)	0.84 (0.49,1.43)	0.70 (0.59,0.84) ***	0.62 (0.50,0.76) ***
Mixed	0.78 (0.53,1.14)	0.96 (0.62,1.50)	0.86 (0.74,0.99) *	0.67 (0.56,0.81) ***
Other or unknown	1.50 (1.03,2.18) *	1.17 (0.68,2.01)	1.06 (0.90,1.27)	1.00 (0.83,1.21)
Private health insurance (reference: Have)				
None	1.49 (1.24,1.79) ***	1.60 (1.29,1.98) ***	1.23 (1.14,1.32) ***	1.59 (1.46,1.72) ***
Unknown	1.79 (1.44,2.21) ***	1.25 (0.92,1.69)	1.08 (0.98,1.20)	1.89 (1.71,2.09) ***
Income status (reference: High)				

Note: Boldface indicates statistical significance (*P < 0.05, **P < 0.01, ***P < 0.001)

	Disagree with social distancing	Disagree with washing hands	Rarely using alcohol hand sanitizer	Rarely wearing mask when outside
Medium	1.1 (0.96,1.27)	1.24 (1.03,1.50) *	1.01 (0.96,1.06)	1.26 (1.18,1.33) ***
Low	1.24 (1.02,1.52) *	1.84 (1.44,2.35) ***	1.19 (1.11,1.29) ***	1.10 (1.01,1.21) *
Social welfare	1.14 (0.73,1.76)	4.17 (2.91,5.98) ***	1.74 (1.51,2.01) ***	1.37 (1.14,1.64) **
Other	1.41 (1.04,1.93) *	1.47 (0.94,2.29)	1.18 (1.03,1.36) *	1.70 (1.47,1.96) ***
Underlying medical conditions (Have vs. None)	0.85 (0.75,0.96) *	1 (0.86,1.16)	0.95 (0.91,1.00) *	0.79 (0.75,0.83) ***
Healthcare worker (Yes vs. No)	1.42 (1.16,1.73) **	0.77 (0.55,1.07)	0.41 (0.37,0.46) ***	0.77 (0.69,0.86) ***
United Kingdom				
Gender (Male vs. Female)	1.14 (0.86,1.52)	1.70 (1.26,2.3) **	1.33 (1.2,1.46) ***	1.23 (1.13,1.33) ***
Age (reference:20 to 40)				
0 to 20 years	3.20 (2.02,5.07) ***	3.64 (2.23,5.94) ***	1.18 (0.92,1.51)	1.15 (0.92,1.44)
40 to 60 years	0.71 (0.51,0.97) *	0.86 (0.61,1.20)	1.07 (0.96,1.18)	0.93 (0.85,1.02)
More than 60 years	0.80 (0.50,1.28)	0.63 (0.37,1.08)	1.23 (1.07,1.42) **	0.66 (0.58,0.75) ***
Race (reference: White)				
Hispanic	5.19 (1.55,17.4) **	3.59 (0.84,15.29)	1.34 (0.61,2.91)	0.55 (0.27,1.12)
Asian	1.14 (0.57,2.27)	0.91 (0.42,1.98)	0.97 (0.75,1.27)	0.42 (0.34,0.52) ***
Black	2.51 (0.90,7.04)	2.59 (0.92,7.28)	1.31 (0.78,2.21)	0.35 (0.21,0.57) ***
Mixed	1.00 (0.40,2.47)	0.42 (0.10,1.71)	0.79 (0.56,1.12)	0.66 (0.50,0.86) **
Other or unknown	0.57 (0.08,4.15)	0.65 (0.09,4.75)	0.95 (0.57,1.59)	0.31 (0.20,0.48) ***
Note: Boldface indicates statistical significance (*P < 0.05, **P < 0.01, ***P < 0.001)				

	Disagree with social distancing	Disagree with washing hands	Rarely using alcohol hand sanitizer	Rarely wearing mask when outside
Private health insurance (reference: Have)				
None	0.98 (0.69,1.38)	1.54 (1.05,2.27) *	1.24 (1.10,1.39) ***	1.28 (1.16,1.41) ***
Unknown	0.97 (0.61,1.55)	1.40 (0.83,2.35)	0.98 (0.83,1.15)	1.12 (0.98,1.28)
Income status (reference: High)				
Medium	0.92 (0.66,1.29)	0.74 (0.52,1.05)	0.84 (0.75,0.94) **	1.10 (1.00,1.21) *
Low	1.18 (0.72,1.94)	1.22 (0.75,1.99)	1.19 (1.00,1.40)	1.07 (0.92,1.25)
Government assistance	1.56 (0.77,3.16)	1.77 (0.91,3.45)	1.26 (0.97,1.64)	1.03 (0.81,1.31)
Other	1.15 (0.58,2.28)	0.39 (0.14,1.11)	0.99 (0.77,1.28)	1.19 (0.95,1.48)
Underlying medical conditions (Have vs. None)	1.01 (0.75,1.37)	1.28 (0.94,1.74)	1 (0.90,1.10)	0.75 (0.69,0.82) ***
Healthcare worker (Yes vs. No)	1.09 (0.62,1.90)	0.97 (0.52,1.82)	0.48 (0.38,0.61) ***	0.59 (0.50,0.69) ***
Brazil				
Gender (Male vs. Female)	1.81 (1.33,2.45) ***	1.86 (1.21,2.86) **	1.97 (1.56,2.49) ***	2.37 (1.85,3.04) ***
Age (reference: 20 to 40)				
0 to 20 years	0.92 (0.44,1.92)	1.31 (0.59,2.91)	2.57 (1.76,3.76) ***	1.80 (1.12,2.87) *
40 to 60 years	0.76 (0.54,1.06)	0.38 (0.22,0.66) **	0.66 (0.50,0.87) **	1.29 (1.00,1.67) *
More than 60 years	0.94 (0.51,1.74)	0.41 (0.15,1.16)	0.75 (0.45,1.24)	1.67 (1.09,2.58) *
Race (reference: White)				

Note: Boldface indicates statistical significance (*P < 0.05, **P < 0.01, ***P < 0.001)

	Disagree with social distancing	Disagree with washing hands	Rarely using alcohol hand sanitizer	Rarely wearing mask when outside
Hispanic	0.97 (0.35,2.69)	2.21 (0.78,6.28)	0.45 (0.16,1.24)	0.24 (0.06,0.97) *
Asian	0.81 (0.20,3.37)	3.43 (1.03,11.44) **	0.89 (0.32,2.49)	0.22 (0.03,1.57)
Black	0.74 (0.27,2.06)	0.95 (0.29,3.14)	1.18 (0.67,2.06)	1.02 (0.53,1.98)
Mixed	1.21 (0.82,1.78)	1.34 (0.77,2.31)	0.79 (0.57,1.08)	0.75 (0.54,1.06)
Other or unknown	1.03 (0.71,1.51)	1.14 (0.68,1.93)	0.53 (0.39,0.74) ***	0.77 (0.57,1.04)
Private health insurance (reference: Have)				
None	1.07 (0.75,1.52)	1.56 (0.98,2.47)	1.18 (0.90,1.55)	1.12 (0.84,1.48)
Unknown	0.80 (0.34,1.88)	1.06 (0.31,3.56)	1.92 (1.12,3.30) *	1.00 (0.52,1.92)
Income status (reference: High)				
Medium	0.94 (0.66,1.33)	1.13 (0.68,1.88)	0.95 (0.73,1.24)	1.07 (0.81,1.40)
Low	1.28 (0.76,2.16)	1.36 (0.67,2.77)	1.39 (0.94,2.06)	1.18 (0.76,1.83)
Government assistance	0.88 (0.26,2.99)	0.43 (0.06,3.35)	2.70 (1.42,5.13) **	2.30 (1.14,4.65) *
Other	2.11 (1.15,3.88) *	1.57 (0.62,3.97)	0.99 (0.55,1.79)	1.88 (1.12,3.15) *
Underlying medical conditions (Have vs. None)	1.05 (0.75,1.46)	2.08 (1.37,3.17) **	1.09 (0.84,1.40)	0.86 (0.66,1.12)
Healthcare worker (Yes vs. No)	2.32 (1.64,3.29) ***	0.97 (0.51,1.84)	0.72 (0.49,1.07)	0.85 (0.58,1.25)
Note: Boldface indicates statistical significance (*P < 0.05, **P < 0.01, ***P < 0.001)				

Discussion

Main Findings

To summarize, this study comprehensively analyzed the differences in environmental status, responsive behaviors, degree of worry about COVID-19, and risk perception of the public from the US, the UK, and Brazil during the COVID-19 pandemic. Compared to the US and UK, more Brazil respondents reported that they were in close contact with more than ten people, still using public transport, and engaging in work. Social distancing and washing hand were the most frequently used protective measures in the three countries, but respondents from the US and UK were relatively reluctant to using masks to reduce risk. Brazil participants had the highest average worried degree and self-assessed infection risk of COVID-19, followed by the US, and the UK was the lowest. Meanwhile, it was found that people with a higher degree of worry about COVID-19, more close contacts and cohabitants, using public transport, and going out to work in daily life tend to show a higher risk perception. And the active use of protective measures by cohabitants would reduce the participants' risk perception. On this basis, we further analyzed the specific performance of participants with different sociodemographic characteristics in taking protective measures, and it was found that there were significant differences among participants of different gender, age, race, health insurance status, income status, and occupations. We believe that these insights are conducive to provide reference information for public health work during the COVID-19 epidemic and for the future.

Possible Explanations

Participants' self-assessed infection risk can comprehensively reflect participants' perceptions and attitudes towards the COVID-19 epidemic. Among the three countries, participants from the UK and the US generally represented a more optimistic anti-epidemic performance, but Brazil participants' performance was relatively nervous. Our findings also indicate that participants' risk perception in the three countries is affected by living environment, responsive behaviors and worried degree towards COVID-19 to a certain extent. The worried degree and risk perception of participants from Brazil were much higher than those from the US and the UK, which might be closely related to Brazil's long-standing lack and uneven distribution of medical resources, the rising number of confirmed cases and deaths, and the inactive national prevention and control policies [12, 13]. At the same time, due to relatively complicated political, economic, and geographic factors, Brazil's quarantine measures have not been implemented thoroughly. Only 40% of Brazils are in formal employment, and there were a large number of informal workers who were still working outside during the COVID-19 epidemic [14]. The survey results indicated that a higher proportion of respondents from Brazil was in close contact with too many people, still using public transport and engaging in work. The excessive number of close contacts and the crowded living environment will increase the chances to be exposed to the SARS-Cov-2 virus, and also limit the quarantine options of family members [15, 16], and a higher use proportion of public transport can also easily lead to COVID-19 infection [17], thus causing greater worried and panic among the public. The Brazil Government needs to take more economic interventions to ensure that people comply with quarantine measures, while also pay attention to reducing the infection risk during public transport.

The less situation of working outside and lower risk perception of UK participants might be related to the national lockdown measures promulgated by the British government [18, 19]. The time nodes of this survey (from April 28 to July 8) were within the period of the nationwide lockdown in the UK. These measures have reduced the spread of the SARS-Cov-2 virus in the community to a certain extent. On June 19, the British government announced that the threat level of the COVID-19 epidemic was lowered from level 4 to level 3 [20], indicating that the COVID-19 in the UK was in a state of widespread transmission, but the transmission rate is no longer high or rising. The average risk perception of US participants was slightly lower than that of Brazil, but the development of the COVID-19 epidemic in the US was also severe. Although the United States Federal Government has also announced social distancing recommendations, the actual and specific decisions related to restricted behaviors were left to the state governments. Researches have shown that due to various economic and political factors, there was much difference in the time interval between governors' response to quarantine, which would cause delays in epidemic prevention and control [21]. It was not until April 7, 2020, that 42 states in the United States and Washington, DC issued "Home Orders" one after another. But by mid-May, although the incidence of COVID-19 in many states continued to increase, most states had begun to relax lockdown measures to support economic recovery [22], which might result in 18.2% of participants from the US still reporting a close contact with more than 10 people in the last week and 26.2% of participants still going to work or school.

Respondents from the US and UK were even less optimistic about the use of masks. Many studies have confirmed that wearing masks is important for mitigating pandemics caused by viruses, including SARS, H1N1, and SARS-CoV-2 [23, 24], but the mask usage rate in the US and the UK has been low, and the UK was even worse. The "International COVID-19 tracker" jointly launched by Imperial College and YouGov [25] also showed that as of early June, only about 66% of Americans and 21% of British expressed they would wear masks in public places. In Italy, where the epidemic was equally severe, reached 82% in early April. The low usage rate of masks is related to the government's failure to implement the mandatory mask policy. With the COVID-19 epidemic becoming ever more severe, the attitudes of the US and UK governments towards masks use have gradually changed. As of August 1, 2020, 33 states in the US and Washington, DC have announced statewide mask orders [26]; The British government first forced people to wear masks on public transportation on June 15 and issued a "National Mandatory Mask Order" on July 22. These policies may help the subsequent increase in the use of masks.

Our research also found that gender, age, race, income status, health insurance status, and occupation were all related to the enforcement degree of preventive behaviors. Men, participants under 20 years, participants without private health insurance, and participants in a poor income showed varying degrees of inattention to take protective measures in these three countries, with the performance of US participants was more obvious. These findings are consistent with other research on COVID-19 between March and April this year. Males compared with females [27, 28], young people compared with elderly people [16, 18, 19], and low-income groups compared with high-income groups [29, 30] are less likely to adopt preventive behaviors. Some studies considered that COVID-19 has a certain gender orientation, and males are more susceptible than females [31]. Our finding results also support to a certain extent that

males may increase the infection risk due to insufficient protective measures. While participants without private health insurance and with relatively poor income conditions would be unable to take effective protective measures due to the living environment and economic conditions. The incidence of COVID-19 is inversely proportional to the economic situation. Therefore, governments should also strengthen the publicity of protective measures and equipment for indigent areas and people.

In terms of race subgroups, participants with non-white backgrounds were more likely to report taking behaviors to reduce infection risk, such as the Hispanic, Asian, black, and mixed-race participants from the US, the Asian, black, and mixed-race participants from the UK, and Brazil Hispanic participants were more willing to use masks outside than white participants. Ethnic minorities in the US, UK, and Brazil are generally more susceptible to more serious impacts and are accompanied by a higher risk of death [32–35], compared with white people. These situations may affect minority groups to take protective measures relatively actively to a certain extent. Rubin et al. conducted a survey of the swine flu outbreak in the UK showing that people with non-white backgrounds are more likely to take protective measures to reduce infection than white [36]. This finding was also consistent with the recent research on COVID-19 [28–30]. In addition, participants in healthcare work were also less likely to disagree with using alcohol hand sanitizer and masks. A survey of non-pharmaceutical interventions against the American public indicated that ordinary people not sure about the effectiveness of masks use in slowing down the disease spread, which is related to the spread of publicity and the level of information transmission by public health authorities [37]. Due to the particularity of their work, healthcare workers are bound to understand the protective effects of alcohol and masks more precisely than non-healthcare staff, and have a stronger awareness of using alcohol hand sanitizer and masks. Our findings are conducive to the public health authorities to carry out more targeted publicity work of COVID-19 protection measures and improve the deficiencies.

Limitation

This research has several limitations. First, the COVID-19 (Coronavirus) Survival Calculator project is an online survey for the global public, not specific to certain countries and regions, which results in different sample sizes in each country. Then, the survey recruited participants based on the willingness of individual users to visit the website, which may bias the results toward those who can use the internet. Secondly, the study population cannot be representative of the individual countries, especially there are relatively small sample sizes for some race subgroups in the study. Limited by the setting of the questionnaire, the included race types contain white, Hispanic, Asian, black, mixed-race, and other race. Participants living in the US and the UK are mostly white (87.3% vs. 92.6%), while in Brazil, except for 56.2% of white participants, 15.5% of mixed-race and 22.4% of other race are involved. Moreover, the Hispanic and black participants from the UK are relatively few, accounting for only 0.3% and 0.7% of the total. Finally, information related to COVID-19 is constantly evolving. There is a certain lag in the results of our study, and the online investigation is likewise ongoing, which is worthy of follow-up research.

Conclusions

This study was the first attempt to use large-scale data to compare and analyze the performance and differences of ordinary people in the US, UK, and Brazil in terms of environmental status, responsive behaviors, attitudes, and risk perception towards COVID-19. We focused on the US, the UK, and Brazil, which were representative countries in the development of the COVID-19 epidemic in North America, Europe, and Latin America. The online survey began in the 7th week after the World Health Organization announced that the COVID-19 epidemic constituted a pandemic. Countries around the world have issued various policies and measures to respond to the epidemic, and the development trend of the COVID-19 epidemic has also been constantly changing. Respondents from the UK and the US were generally more optimistic, believing that their chance of contracting COVID-19 was relatively low, but Brazil respondents expressed more tension about the COVID-19 epidemic. Our finding observed that respondents living in the US and the UK did not pay much attention to masks use. Among sociodemographic subgroups analysis in the US, UK, and Brazil, it is also found that males, participants under 20 years, participants without private health insurance, and participants in a poor income are relatively less concerned about taking protective measures. At present, the global epidemic prevention and control has developed into a normalized and persistent battle. Governments and people of all countries should continue to strictly implement epidemic prevention and control measures. We believe that all countries should strengthen targeted publicity and assistance of public health intervention measures for different groups, and take effective steps to increase the protection awareness of ordinary people, thereby slowing down the process of the pandemic to a certain extent.

Abbreviations

US: United States; UK: United Kingdom; COVID-19: Coronavirus Disease 2019; SARS-CoV-2: Severe Acute Respiratory Syndrome Coronavirus-2; WHO: World Health Organization; CDC: Centers for Disease Control and Prevention; SD: standard deviation; OR: odds ratio; CI: confidence interval

Declarations

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Availability of data and materials

This study used the third party material. The data that support the findings of this study are available from the COVID-19 (Coronavirus) Survival Calculator project launched by Nexoid United Kingdom. This dataset is protected under the "Attribution 4.0 International (CC BY 4.0)" license (<https://www.covid19survivalcalculator.com/en/download>), which is free for personal, educational, research, and commercial use provided the dataset is attributed to "Nexoid".

Ethics approval and consent to participate

As the study was an observational study using open datasets from the Nexoid United Kingdom, the Institutional Ethics Committee of Institute of Medical Information, Chinese Academy of Medical Sciences confirmed that ethics approval was not required for this study. Proper permission was taken from the Nexoid United Kingdom for our conducting study, and it conformed to the ethics guidelines of the Declaration of Helsinki. Informed consent was obtained from all participants. They all reviewed the privacy statement and agreed to participate before the start of the survey.

Competing interests

The authors declare that they have no competing interests.

Consent for publication

Not applicable.

Authors' contributions

Sizhu Wu generated the project idea and provided scientific and technical comments to strategic options discussed in this manuscript. All authors contributed to the study design. Anran Wang carried out all analyses. Anran Wang and Xiaolei Xiu drafted the manuscript. All authors contributed to further drafts and approved the final manuscript.

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Figures

Figure 1

(a) The average degree of worry about COVID-19 for participants from the US, the UK, and Brazil (Holm Bonferroni correction to account for multiple comparisons; *: $P < 0.001$); (b) The percentage of participants at different degree of worry about COVID-19 in three countries

Figure 2

(a) The average risk perception of COVID-19 for participants from the US, the UK, and Brazil (Holm Bonferroni correction to account for multiple comparisons; *: $P < 0.001$); (b) The percentage of participants at different risk perception in three countries

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