Collectivism was Associated with Late Vaccination Uptake During COVID Pandemic: Evidence from a National Survey and a Global Analysis

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Classification: SOCIAL SCIENCES—Psychological and Cognitive Sciences

Keywords: collectivism, individualism, vaccination, COVID-19, pandemic control

The first four authors contributed equally and significantly to the studies. We list these four authors alphabetically, in lexicographical order of their last names.

Abstract

Uptake of vaccination was crucial to ending the COVID pandemic by enabling herd immunity. Collectivism is a cultural value that prioritizes collective over personal wellbeing and prescribes cooperation and dependency on group opinions when making personal decisions. Past studies showed that collectivist (vs. individualist) cultures were more successful in enforcing non-pharmaceutical interventions, and hence had lower infection and death rates before vaccines were available. However, collectivists, being more influenced by group opinions in decision-making, might delay vaccination uptake until they are certain that the vaccines are effective and safe for others. We tested our hypotheses in a national survey of Chinese citizens (n = 5,438, Study 1) five months after COVID-19 vaccines were publicly available, and in a study of 183 countries/territories (Study 2). Consistent with past findings, before vaccines were available, more collectivist cultures had fewer COVID-19 infections and deaths per million. However, after vaccines were released in China, Chinese citizens who were more collectivist were less likely to receive early vaccination (Study 1). Furthermore, more collectivist cultures had slower vaccination rates in the first year of vaccination administration (Study 2). These results have important implications for future pandemic control and public health communications.

Introduction

According to the World Health Organization (WHO), nearly 337 million lives were lost in the first two years of the COVID-19 pandemic. When vaccines were unavailable, the transmission of the COVID-19 virus could only be suppressed through adopting effective non-pharmaceutical interventions (NPI; e.g., mask-wearing, social distancing) (1). Research carried out *before vaccines became available* shows that NPI compliance varied across cultures depending on how much a culture valued collectivism, which prioritizes collective over personal wellbeing (2). In collectivist cultures, people are culturally committed to cooperative self-regulation. Therefore, implementing NPIs was more successful in these cultures than in individualist ones (3, 4), and these cultures had lower COVID-19 infection and death rates than individualist ones before vaccines were available (5, 6).

Since vaccines became available to the public on December 8, 2020, mass vaccination was an effective strategy to curb the pandemic and ultimately end it. WHO suggested that the pandemic was controllable through herd immunity when over 70% of the population was vaccinated, and earlier uptake of vaccination by the public would help to meet this target (7). To encourage early vaccination, many countries have publicized the safety and effectiveness of vaccination. Some countries also made vaccine services freely available to their citizens (1).

Although collectivism was a cultural facilitator of NPI adoption, collectivism could be a cultural demotivator of early vaccination uptake because another expression of collectivism is the dependency on group opinions when making personal decisions under uncertainty. To collectivists, NPI adoption is congruent with their cooperative values. Although NPIs required people to forego some personal liberty and caused inconvenience to some individuals, collectivism prescribes cooperative self-regulation to suppress virus

transmission to protect collective wellbeing. Unlike NPIs, which did not increase health risks to NPI adherents, the public was uncertain about the effectiveness and potential side effects of the newly released COVID-19 vaccines. Furthermore, when the COVID-19 vaccines were released to the public, false or misleading information about the vaccines' safety and effectiveness was perpetuated in the physical and digital environments (8). Evidence shows that across cultures, trust in vaccine safety and effectiveness played crucial roles in vaccination uptake (9, 10). Studies also reveal that some people might have delayed vaccination to observe the vaccine's intended and side effects in others (11). This decision-making strategy is known as social proof. If many people waited for others to get vaccinated first, vaccination uptake would slow down. Past studies have shown that, compared to individualists, collectivists who tend to reference the group opinions (vs. self-views) more and rely more on social proof when making decisions under uncertainty (12). Therefore, we hypothesized later vaccination uptake among collectivists (vs. individualists) and collectivist (vs. individualist) cultures.

We tested our hypothesis in two studies: In Study 1, we tested the correlation between citizen collectivism and early vaccination uptake in a national survey of Chinese citizens in May 2021 (five months after the vaccines were publicly available in China). In Study 2, to extend our results beyond China and to track vaccination rates longitudinally, we tracked the vaccination rates of 183 countries/territories in the first year after vaccines were available in these countries/territories and tested the association of their vaccination rates with their levels of collectivism. By illuminating the association of cultural collectivism with people's reactions to vaccination, the results will inform health professions how they could leverage cultural values to prepare for future pandemics.

Results

We conducted regression analyses on the national survey data from China (Study 1) to assess the association of participants' level of collectivism with their reports of vaccination intention, vaccination uptake, and trust in the COVID-19 vaccines. As predicted, participants' level of collectivism was negatively associated with vaccination rate (B = -0.10, 95% CI [-0.16, -0.05], p = 0.0005), vaccination intention (B = -0.27, 95% CI [-0.30, -0.25], p < 0.0001), and trust in the COVID-19 vaccines (B = -0.25, 95% CI [-0.27, -0.23], p < 0.0001; Table 1) after controlling for a host of pertinent variables.

In Study 2, we tested if Study 1 results can be generalized from the individual level to the cultural level by extending our analysis to 183 countries/territories. Past findings showed that before vaccines were available, collectivism was positively related to favorable COVID-19 outcomes (4, 5). Therefore, we first replicated these findings using multilevel modeling of the daily changes in the infection and mortality rates before vaccines were available, with Global Collectivism Index (GCI) as the predictor (12) (see Table S5). In these analyses, the interactions between collectivism and days (number of days between the day when the first COVID-19 case was reported and the day when vaccine became available in the culture) on infection and mortality rates were significant (Table S5; infection: B = -37.11, 95 % CI [-45.13, -29.08], $p < 0.0001$; mortality rate: B = -0.48, 95% CI [-0.63, -0.33], $p < 0.0001$), and these effects remained significant after controlling for relevant covariates (infection: B = -39.55, 95% CI [-49.67, -29.44], $p < 0.0001$; mortality rate: B = -0.50, 95% CI [-0.72, -0.29], $p < 0.0001$). As shown in Figure 1a and 1b, before COVID-19 vaccines became available, more collectivist cultures had a slower increase in infection and mortality rates.

Next, we tested the main hypothesis regarding the negative correlation between collectivism and vaccination rates in the first year of vaccination administration. As shown

in Figure 1c, consistent with our hypothesis, more collectivist cultures had lower average vaccination rate (r = -0.63, 95% CI [-0.71, -0.53], $p < 0.0001$) in the first year.

To provide corroborative evidence for our hypothesis, we tested whether collectivism moderated how fast vaccination rates grew over time in a culture (i.e., the interaction of Collectivism and Days on cumulative vaccination rate). Multilevel modeling of daily changes in the cumulative number of people vaccinated per hundred in each culture was performed with culture-level collectivism and the number of days after vaccines were released (days) as predictors. The predicted Collectivism * Days interaction was significant (Table 3; B = -5.77, 95% CI [-6.84 to -4.69], $p < 0.0001$). This interaction remained significant after controlling for pertinent covariates (B = -5.09, 95% CI [-6.51 to -3.66], $p < 0.0001$). The covariates included severity of pandemic infection (new cases per million) and the stringency of NPI implementation in the country/territory. As shown in Figure 1d, more collectivist cultures had a slower vaccination rate in the first year of vaccination administration after controlling for the infection rate and NPI stringency. The same results were obtained when we replaced the GCI with Hofstede's individualism/collectivism index as the measure of cultural collectivism (all result tables are available in the online supporting information (https://osf.io/yt39c/)).

[Insert Figure 1 here]

Discussion

We replicated the association of collectivism with lower COVID-19 infection rates when vaccines were unavailable (5). This association is consistent with the past finding that people in collectivist cultures are more compliant with NPIs than those from individualist cultures (3, 4). Before vaccines were available, suppression of COVID-19 infection benefited mainly from NPI compliance.

However, when the novel COVID-19 vaccines were released, people were uncertain of their effectiveness and side effects. Past studies revealed that collectivists are more susceptible to group influence and tend to rely on social proof when making decisions under uncertainty (11). Hence, they might delay vaccination to observe the vaccines' intended and side effects in others. As shown in Study 1, compared to their individualist counterparts, the collectivists in China had slower vaccination uptake rates and weaker vaccination intentions. This result was replicated in Study 2 at the culture level. Compared to individualist cultures, collectivist cultures had slower vaccination rates in the first year of vaccine administration, despite these cultures were more successful in suppressing the spread of COVID-19 by implementing NPIs before vaccines were available.

Our results illustrate the significance of cultural influence on vaccination. Past findings have focused on collectivism's associations with higher NPI compliance, lower COVID-19 infection and mortality rates before vaccines were released to the public (7). When vaccines were available, however, collectivism was accompanied by slower uptake of vaccination. By revealing the association between collectivism and the decision to receive vaccination early, our results further illuminate the role of cultural values on people's responses to different pandemic control strategies, depending on how collectivists resolve uncertainty when they make risky choices.

Vaccination confers personal and collective benefits. When sufficient people get vaccinated, the entire society will benefit from herd immunity. To prepare for future pandemics, public health communications could emphasize the collective benefits of vaccination in collectivist cultures.

Method and Materials

In Study 1, we surveyed 5,438 residents from 29 provinces of China between May 8 and May 17, 2021. The participants reported their intention to be vaccinated, how many doses of the COVID-19 vaccines they had gotten by the survey date (vaccination uptake), their trust in the COVID-19 vaccines, their levels of collectivism (13), and other pertinent demographic information.

In Study 2, we collected data from 183 countries/territories. For every country/territory, we obtained daily data from Our World in Data (14) on infection and mortality rates up to the day before vaccines were released, and the cumulative number of people vaccinated per hundred for 365 days starting from the day COVID-19 vaccines were released in these cultures. We used GCI (12) to measure the level of collectivism in a country/territory in 2022 and included pertinent covariates, such as trust in science, in the multilevel analysis.

For more details, see the online supporting information (online supplementary document and https://osf.io/yt39c/)

Data sharing

Data and codes are available in https://osf.io/yt39c/.

Acknowledgement

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors. We are thankful to Dr. Jie Yuan, Miss Hongze Yu, and Miss Chunlan Xu for their assistance with data collection and pilot analysis.

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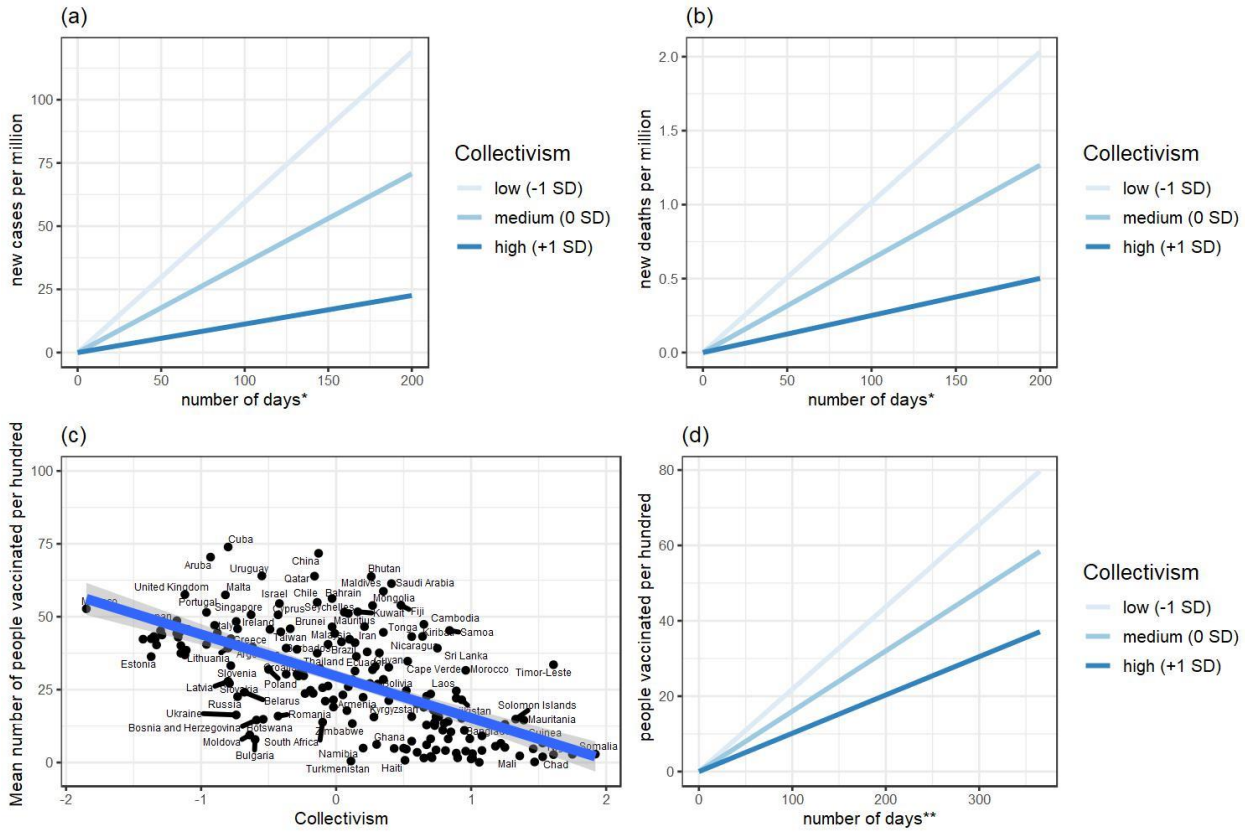

Figure 1: Daily increase in (a) infection rate and (b) mortality rate was slower in more collectivist cultures before COVID-19 vaccines became available. (c) The association between collectivism and the mean number of people vaccinated per hundred in the first year of vaccination administration across 183 countries/territories. (d) Daily increase in vaccination uptake rates was slower in more collectivist cultures. *Number of days between the day when the first COVID-19 case was reported and the day when COVID-19 vaccines became available in the culture. **Number of days after vaccine rollout.

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Supplementary Document

Study 1: Collectivism predicted late vaccination uptake and intention in China

Methods

Given the strict social distancing policies in China at the time the survey was carried out, we administered the survey online via Credamo.com. We obtained informed consent from the participants, who received 6 RMB (about 0.8 USD) as compensation for their participation. The study was approved by the Institutional Review Board at the College of Medicine, Xiamen University (No. XDYX2021009).

Between May 8 and May 17, 2021, we surveyed 5,438 residents (48.8% females; aged from 18 to 76 years old, M = 28.70, SD = 7.81) from 29 provinces of China to test the hypothesized relationship between collectivism and late vaccination uptake. Although China has often been characterized as a collectivist country, recent studies have revealed considerable regional variations within China in the prevalence of collectivist values. (1)

When the study started, there were 9,686 confirmed COVID-19 cases in China. To measure early vaccination uptake, we had the participants report how many doses of the COVID-19 vaccines (0-3) they had gotten by the survey date. Because few respondents had

gotten more than one dose when they completed the survey, we recoded vaccine uptake into 0 (not vaccinated) and 1 (vaccinated).

We also measured respondents' intention to be vaccinated after the survey date, their trust in the COVID-19 vaccines in China, their levels of collectivism, and other pertinent demographic information (e.g., gender, age, education, and income).

Vaccination intention was measured using three items (e.g., "How much do you want to get vaccinated if it is free and your health condition are suitable?"). The participants responded on a 7-point Likert scale (1 = not at all, 7 = very much), and higher scores indicated a stronger intention to get vaccinated (Cronbach $\alpha = 0.83$). (2)

Trust in vaccine was measured using two items (e.g., "How much do you trust the effectiveness of the COVID-19 vaccines in China?"; "How much do you trust the safety of the COVID-19 vaccines in China?"; Cronbach $\alpha = 0.86$). (3)

Individual-level collectivism was measured with ten items (e.g., "I often care about the alignment of my ideas with those of others"; "A person should live independent of others" (reverse coded)). The participants responded on a 7-point Likert scale (1= strongly disagree, 7 = strongly agree), and higher scores indicated a greater level of collectivist values (Cronbach $\alpha = 0.63$). (4)

Participants also reported their gender, age, education, income, and exposure to COVID-19 ("Had you ever been infected with COVID-19?"; "Had your families ever been infected with COVID-19?"; "Had you been quarantined during the COVID-19 pandemic?"; and "Had you been required to be self-isolated during the COVID-19 pandemic?"; Cronbach $\alpha = 0.63$). (5) These measures were included as covariates in our analysis.

Supplementary Analyses & Results

To verify whether the results remain consistent when using the number of doses received instead of a binary vaccinated/not vaccinated measure, we replaced the

dichotomized measure with the number of COVID-19 vaccine doses taken as the dependent variable. As predicted, more collectivist citizens received fewer doses of the COVID-19 vaccine (B = -0.034, 95% CI [-0.06, -0.01], $p < 0.01$).

Because of the small intraclass correlation (ICC=0.006), it was not justified to perform multilevel modeling on the data with citizens nested within Province. Therefore, we reported the results based on the individual-level analyses in the main manuscript. As a robust test, we performed supplementary analysis of data at the provincial level. To elaborate, for every province, we computed the mean scores of all measured variables. Next, we evaluated the association of collectivism at the province level with both vaccination intention and uptake also at the province level. Consistent with our findings at the individual level, we found significant negative associations of collectivism with both vaccination intention and vaccination uptake at the province level. These associations remained significant after controlling for pertinent covariates. See Table S1 and Table S2.

Study 2: Collectivism was associated with late vaccination uptake across 183 countries/territories

Methods

In the second study, the analysis was extended to 183 countries/territories, covering 99.9% of the world population. Countries/territories with higher levels of collectivism were expected to have slower vaccination uptake.

We used the Global Collectivism Index (GCI) to measure the levels of collectivism in a country/territory in 2022. The GCI was constructed based on the prevalence of collectivist practices and institutions in a country/territory, as reported in representative national statistics

such as fertility rates, collective living arrangements, marriage-to-divorce ratio, religiosity, motor vehicles per capita, and ingroup favoritism.(6)

Daily information on the cumulative number of people vaccinated (at least one dose) per hundred was retrieved from Our World in Data (see: https://ourworldindata.org/covid-cases) (7). For every country/territory, we obtained the cumulative daily uptake rate for 365 days starting from the day when vaccines were released in the country/territory.

Because trust in science strongly influences vaccination decisions,(8) we included trust in science as a covariate in our analysis. Country-level data on trust in science were available from the 2020 Wellcome Global Monitor Study (Gallup, 2020),(9) in which trust in science was measured by five items (e.g., "In general, would you say that you trust science a lot, some, not much, or not at all?"; "In general, how much do you trust scientists to find out accurate information about the world?"; Cronbach's alpha = 0.74). A 4-point scale (4 = a lot, 1 = not at all) was used for each item.

Other covariates included in our analysis were log-transformed gross domestic product per capita (retrieved from the World Bank, 2019 (10)), income inequality (the most recent Gini coefficients retrieved from the World Bank, 2019 (11)), population density (log-transformed people per km^2, latest available data retrieved from the World Bank (12)), percentage of migrants in the country/territory (United Nations, 2019 (13)), religiosity (World Religion Project, 2010 (14)), pandemic severity (measured by the daily increase in the confirmed cases per million, Our World in Data (7)), and Government stringency in enforcing NPIs (Oxford COVID-19 Government Response Tracker (15)). All covariates were standardized before analysis.

To replicate the past finding that collectivism was associated with more favorable COVID-19 outcomes before vaccines were available, we also obtained data from Our World

in Data on infection and morbidity rates of these countries/territories up to the day before COVID-19 vaccines were released in these countries.

Supplementary Analyses & Results

We also tested the main hypothesis regarding the negative correlation between collectivism and vaccination rates in the first year of vaccination administration, using Hofstede's individualism-collectivism index. Hofstede' individualism-collectivism index was obtained from geerthofstede.com. Four items (e.g., it is important to "have sufficient time for your personal and home life" and "do work that is interesting", not important to "have a job respected by your family and friends" and "have security of employment") were used to assess the extent to which a society is individualist (16). Higher scores on this index indicate stronger individualism in the country/territory. Consistent with our hypotheses and the results using the GCI as the measure of cultural collectivism, results of this supplementary analysis show that more collectivist cultures had lower average vaccination rate (B = -7.81, 95% CI [-10.42, -5.20], $p < 0.0001$) in the first year.

To provide corroborative evidence for our hypothesis, we also tested whether Hofstede's individualism-collectivism index moderated how fast vaccination rates grew over time in a country/territory (i.e., the interaction of the Hofstede individualism-collectivism index and days on cumulative vaccination rate). Multilevel modeling of daily changes in the cumulative number of people vaccinated per hundred in each culture was performed with Hofstede's individualism-collectivism index and the number of days after vaccines were released (days) as predictors. The predicted interaction of Hofstede's individualism-collectivism index and days was significant (B = -3.41, 95% CI [-4.81 to -1.94], $p < 0.0001$). This interaction remained significant after controlling for pertinent covariates (B = -3.77, 95% CI [-5.41 to -2.14], $p < 0.0001$). The covariates included severity of pandemic infection (new cases per

million) and the stringency of NPI implementation in the culture. As expected, countries/territories higher on the Hofstede individualism-collectivism index had a slower vaccination rate in the first year of vaccination administration after controlling for the infection rate and NPI stringency.

For the tables and the additional graphs of the results, see the online supporting information (https://osf.io/yt39c/)

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