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# Different roles of interpersonal trust and institutional trust in COVID-19 pandemic control

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## ARTICLE INFO

## ABSTRACT

The absence of pharmaceutical interventions made it particularly difficult to mitigate the first outbreak of coronavirus disease 2019 (COVID-19). The current study investigated how interpersonal trust and institutional trust influenced the control process. Trusts and COVID-19 data in 44 countries and 50 US states were analyzed; institutional trust was associated with case fatality rate, and interpersonal trust was associated with control speed. Two independent behavioral experiments showed that institutional trust manipulation increased participants' willingness to complete the COVID-19 test and that interpersonal trust manipulation increased conscious compliance with prevention norms and decreased unnecessary outdoor activities. Agent-based modeling further confirmed these behavioral mechanisms for two types of trust in the COVID-19 control process. New interventions are needed to help countries heighten interpersonal and institutional trust as they continue to battle COVID-19 and other collective threats.

## 1. Introduction

It is undeniable that the sudden outbreak of coronavirus disease 2019 (COVID-19) poses a significant threat to global public health. At the beginning of the epidemic, the lack of approved vaccines and other pharmaceutical interventions (Chiu et al., 2020) made it particularly difficult to control the first outbreak COVID-19, and prevention almost completely relied on the public to alter their original living habits, such as maintaining physical distance and testing for the identification of the etiologic agent on a large scale. Unfortunately, in some countries, the poor effect of government intervention and intergroup conflicts have hindered the progress of epidemic prevention.

Trust plays an important role in social construction, operation, and development (Christian and Pierre-Guillaume, 2013). In the context of epidemics, real world uncertainties increase, and people's sense of trust is easily undermined, leading to significant challenges to the public order. According to the rational choice model (Kagan and Scholz, 1984), both institutional and interpersonal trust can encourage individuals to abide by public order.

Institutional trust is defined as the belief or expectation that the government will do the right thing under normative standards (Tyler and Degoey, 1996; Hetherington, 2005; Norris, 2017). People's attitudes toward the restrictions largely depend on the level of trust in the authorities that enact the policies (Salmon et al., 2015). Therefore, institutional trust plays a fundamental role in maintaining social stability. For example, researchers have found that institutional trust was related to lower COVID-19 mortality (Oksanen et al., 2020). In addition, people's trust in the government may interact with their attitudes and behavior toward epidemic prevention policies, and recent research has found that lockdown measures in the Netherlands during the pandemic led to an 18% increase in trust in the government (Oude Groeniger, Noordzij, van der Waal and de Koster, 2021).

The role of institutional trust in infectious disease prevention and control can be explained by the health belief model (Janz and Becker, 1984). This model is a framework to analyze whether individuals will adopt specific health-related behaviors. It consists of five main modules: susceptibility, severity, self-efficacy, action cues, and personal traits. Susceptibility and severity are individuals' perceptions of their health threat, whereas self-efficacy refers to individuals' degree of confidence that they can practice the behavior. Action cues are necessary triggers for individuals' engagement in health-protective behavior (Champion and Skinner, 2008). Clark et al. (2020) found that if individuals trust the

government, the policies that it issues are more likely to become effective action cues for them. Scholars' research on the Ebola epidemic (Blair et al., 2017; Vinck et al., 2019) found that individuals who are not confident in the government's ability to handle the epidemic are unwilling to take preventive measures and behavioral recommendations called for by the government, even if they are aware of the transmission mode and symptoms of the Ebola virus.

Interpersonal trust refers to an individual's positive expectation that others will contribute to overall well-being without causing harm (Simpson, 2007; Dinesen and Bekkers, 2017). Interpersonal trust can influence the behavioral tendencies of individuals. During the Ebola epidemic, the breakdown of interpersonal trust among residents hampered health and epidemic prevention work (Raven et al., 2018). In addition, Diotaiuti et al. (2021) conducted a questionnaire survey on residents in central Italy during the spread of the COVID-19 epidemic and found that interpersonal trust plays a mediating role between risk perception and self-restraint. Thus, it is important to investigate the impact of interpersonal trust during the COVID-19 pandemic.

Situations in which interpersonal trust plays a role often involve interdependence among individuals, which is characterized by individuals recognizing their vulnerability, action risks, and positive expectations of others (Mayer et al., 1995; Rousseau et al., 1998). Interpersonal trust promotes cooperation by reducing individuals' fear of being exploited by others (Yamagishi and Sato, 1986). In other words, individuals are more likely to respect social rules when they think others will respect them (Lahno, 2004; Scholly et al., 2005). Researchers further pointed out that interpersonal trust contributes to building community partnerships to respond to epidemics and increasing the acceptance and effectiveness of future emergency strategies (Nuriddin et al., 2018; Ryan et al., 2019).

However, few researchers have systematically compared the influences of these two types of trust and distinguished their roles in mitigating the development of an epidemic. Although direct answers have been scant, the findings from environmental protection behavior have shown that there is a difference between the mechanisms of interpersonal and institutional trust. Irwin (2019) proposed first- and second-order cooperation to distinguish the different roles and psychological mechanisms of the two kinds of trust in environmental protection behavior. First-order cooperation involves more isolated, independent choices (i.e., individuals have complete freedom) and actions that directly protect the environment, such as volunteers taking part in recycling. Second-order cooperation refers to indirect participation, such as paying taxes to support activities related to environmental protection. It has been shown that interpersonal trust can promote individual cooperation at two levels, whereas institutional trust has no effect on first-order cooperation (Irwin, 2019). Although a series of behaviors may be called for and encouraged by the government, individuals are more likely to behave according to other information they perceive because they realize that the fewer the number of people who contribute to the public good, the higher the cost of each contribution will be (Letki, 2006). Interpersonal trust promotes cooperation by reducing individuals' fear of being exploited by others (Yamagishi and Sato, 1986; Lahno, 2004; Scholly et al., 2005). However, institutional trust promotes cooperation through deterrence and balance, which increases people's confidence in the government to regulate misconduct and impose just punishment (John and Mark, 1998; Uslaner, 2004). Therefore, institutional trust cannot promote first-order cooperation because there is no credible punishment mechanism.

In the early stage of the epidemic, nonpharmaceutical interventions (NIPs) played a key role in containing the epidemic. Thus, it is worth exploring the mechanism of how the two types of trust affect the indicators of pandemic control. Previous studies have indicated that NIPs include case-driven measures (e.g., testing, contact tracing, and isolation), personal preventive measures (e.g., face mask use, hand hygiene), and social distancing measures (e.g., reducing unnecessary outdoor activities) (Chiu et al., 2020). In particular, COVID-19 testing was

organized and monopolized by government agencies in the early days of the outbreak, and patients could be directly admitted to official hospitals after being diagnosed. It was assumed that individuals' COVID-19 testing is closely related to institutional trust. In addition, social distancing measures usually require self-restraint and cannot be fully monitored by authorities. Based on the first- and second-order cooperation model (Irwin, 2019), it was predicted that interpersonal trust rather than institutional trust can influence individuals' willingness or behavior to reduce unnecessary outdoor activities.

The present study aimed to explore the effects and mechanism of interpersonal trust and institutional trust during the control of the first wave of the COVID-19 pandemic. In study 1, we collected COVID-19 data and trust values from 44 countries and 50 US states to preliminarily examine the relationship between trust and pandemic control. Then, trust manipulation experiments were designed to explore whether institutional trust (study 2A) and interpersonal trust (study 2B) influence individuals' different behaviors in the context of infection outbreaks. Furthermore, in study 3, we constructed computational models to connect individuals' prevention behaviors with their trust value, according to the results of two independent behavioral experiments, to simulate the infection control process and to test whether the relationship observed in global and US samples would emerge, thereby robustly explaining the underlying mechanism. Based on a synthesis of relevant theoretical perspectives and empirical research, we developed the following research hypotheses to guide our data analysis and interpretation of the results.

(1) Interpersonal trust predicts a reduction in unnecessary outdoor activities and is associated with epidemic control efficiency.
(2) Institutional trust predicts individuals' willingness to receive the COVID-19 test and is associated with the case fatality rate.

## 2. Methods

### 2.1. Sampling and participants

(1) **Data Sources of global and US samples.** Two types of trust data from 44 countries were obtained from the World Values Survey (WVS) 2012–2018. The interpersonal trust data of 41 states within the US were obtained from the General Social Survey, and institutional trust scores for all 50 states were referenced from a Gallup Poll (Posten and Mussweiler, 2013). Original time series data for confirmed cases and death numbers in each country were taken from publications by the WHO, and information on the 50 states was reported by the data resource center at Johns Hopkins (Supplementary Materials).

(2) **Participants in behavioral experiments. Study 2A**: A total of 169 US participants (85 males, 83 females, 1 gender not disclosed) with a mean age of 38.4 years (SD 10.3) were recruited on the Amazon Mechanical Turk (MTurk) platform. Eighty-five participants were randomly assigned to the high institutional trust group and 84 to the low institutional trust group. The sample size was determined through calculations using G*Power 3.1.1 software (Faul et al., 2007). In the absence of prior data, the G*Power default values were used in the current calculation, and power analysis indicated that a total of 128 participants (64 pre cells) were needed for two independent sample t-tests, effect size d = 0.50, α = 0.05 (two tailed), power = 0.80. **Study 2B**: Another independent sample consisted of 217 participants: 126 US participants (70 males, 53 females, 3 persons of unknown gender) with a mean age of 39.3 years (SD 11.0) (66 participants were assigned to the high interpersonal trust condition, and 60 participants were assigned to the low interpersonal trust condition) and 91 Chinese participants (30 males, 58 females, 3 persons of unknown gender) with a mean age of 23.6 years (SD 5.8) (44 participants were assigned to the high interpersonal trust

condition and 47 to the low interpersonal trust condition). Prior to the data collection, the sample size for the current study was estimated with G*Power software (Faul et al., 2007), and the final sample allowed us to detect a medium effect size of d = 0.53 (alpha = 0.05, power = 0.80)

*2.2. Data collection*

**(1) Manipulation of institutional trust and experimental procedure.** We informed the participants that tokens accumulated in the experiment would transform into true rewards. After providing demographic information and other control variables, the participants were randomly assigned to low or high institutional trust conditions by a computer program. The participants were asked to read a 500-word text (adapted from Wahl et al., 2010) and to imagine living in the "city". In the high institutional trust group, the "city" was politically stable, the government was service-oriented and had a high reputation, and the tax system was open and transparent. In the low group, the "city" government was rife with corruption and had a very poor reputation, and the tax system was unfair. After reading, the participants were required to describe their life in the "city", self-report institutional trust and complete tax games (Wahl et al., 2010) in which they could accumulate tokens. Next, the participants were asked to imagine an infectious disease outbreak in the "city" and self-report behavioral willingness (Supplementary Materials).

**(2) Manipulation of interpersonal trust and experimental procedure.** The instructions and procedures before the trust manipulation were the same as in the previously described experiment.The deception game (Fershtman et al., 2005; Posten and Mussweiler, 2013) was adopted to manipulate interpersonal trust (we called this a "two-player game"). Each round involved two different token allocation programs. The "consultant" preferentially understood two programs and sent a suggestion to the "decision-maker": "Program X (or Y) provides more tokens for the decision-maker". After reading the suggestion and submitting the choice, the decision-makers were informed about Programs X and Y and whether they were deceived. The participants were told that they had been randomly assigned to the role of "decision-maker" and to play 10 rounds with 10 matched MTurk workers. In the high interpersonal trust group, participants were deceived in the fourth and seventh rounds. In the low group, participants were not deceived in the fourth and seventh rounds. Then, they were asked to imagine living in a "community" with the 10 players (only 11 people), describe their interactions, and self-report interpersonal trust toward the 10 players. Next, the participants were asked to imagine an infectious disease outbreak in which their "community" was at risk of infection and someone in the "community" called on everyone to comply with prevention norms, specifically, reducing unnecessary outdoor activities. The participants then completed the relevant measurements (Supplementary Materials).

**(3) Basic settings of agent-based modeling.** The model environment has a capacity of $121 \times 121$ units and generates a total of 3000 software agents, each of which has a size of 0.8 units and is randomly distributed (details in Supplementary Materials). In every simulation, there were initially 10 COVID-19-infected agents, all assumed to be asymptomatic. When there were no infected agents who could infect others, the simulation ended. The simulations were based on the traditional susceptible-exposed-infected-removed (SEIR) model (Murray and Young, 2002; Zhang et al., 2014; Anderson et al., 2020): Agents were classified into susceptible, exposed, infectious, and recovered (Fig. 4a & 4b). Each agent processes different endowments: personal protection ability, individual differences in personal protection measures that influence their risk of infection and recovery; institutional trust and interpersonal trust influence their prevention case traces and voluntary quarantine, respectively. Case trace (CT) depends on the series behavior: voluntary testing or being tracked for close contact. When case traces occurred, 'I' agents were officially registered and became 'Ic's. When

infected agents become symptomatic, the proportion of case traces becomes higher. CT is the only way to seek testing and formal medical care (details in Supplementary Materials), if confirmed and to register infected cases. However, there is a time lag between being tested and receiving accurate testing results, which we assumed to be $N(7, 2^2)$. In this model, case traces relate to individuals' institutional trust.

$$P(CT) = 0.4. \ T_{Institutional}$$

Once the COVID-19 control simulation starts, agents who perform voluntary quarantine (VQ) will not be able to move and have no risk of being infected or infecting others. We assumed that one cycle of voluntary quarantine was $N(14, 2^2)$. The probability of voluntary quarantine relates to individuals' interpersonal trust. If the agent has been tested, then the possibility of VQ during the time lag between being tested and receiving testing results is higher (details in Supplementary Materials):

$$P(VQ) = 0.3. \ T_{Interpersonal}$$

**3. Results**

To facilitate the follow-up analysis, a logistic function model was established to define the indicators of the COVID-19 pandemic. Several COVID-19 indices were classified into two categories: epidemic severity and epidemic control efficiency. Epidemic severity is mainly reflected by the accumulative total number of confirmed cases (TC) and deaths (TD) as of the cutoff date. TD divided by TC was also calculated, representing the case fatality rate (CFR) for each country. CFR refers to the proportion of patients with a given disease who die from the disease and, thus, reflects the seriousness of the condition or the severity of the disease. We calculated the number of confirmed cases and deaths per million population (PMC; PMD) to exclude the confounding factors of population size. Epidemic control efficiency is mainly reflected by the speed of control of the epidemic obtained from the model fitting parameters: overall control speed (OCS) and two-stage duration (first-stage duration (FD), second-stage duration (SD)) from overall fitting and first- and second-stage control speeds (FCS, SCS) from two-stage fitting. Specifically, the FD and the SD were defined through the inflection point of the sigmoid logistic curve. (Supplementary Materials, Table S1 & Table S2).

*3.1. Different roles of trust in the context of COVID-19*

The time series cumulative confirmed case data of 44 countries and 50 states were fitted by the three-parameter logistic model. Correlation and multiple regression analyses were then conducted to explore the relationships between trust and COVID-19 indicators (Supplementary Materials, Table S1 & Table S2).

Interpersonal trust was significantly correlated with epidemic control efficiency indicators, including overall control speed (worldwide: $r(43) = .548$, $p = .0001$; US: $r(41) = .388$, $p = .012$) and second-stage control speed (worldwide: $r(39) = .576$, $p = 1.0 \times 10^{-4}$; US: $r(41) = .563$, $p = .0001$) (Figs. 1 and 2; Supplementary Materials, Table S4).

Institutional trust was significantly correlated with the case fatality rate (CFR; worldwide: $r(43) = -.389$, $p = .009$; US: $r(49) = -.451$, $p = .001$) (Figs. 1 and 2; Supplementary Materials, Table S5), which is an indicator of epidemic severity. Considering that personal health-care access and quality in a country may influence the relationship, to eliminate confusion about medical competence, we ran a partial correlation between institutional trust and CFR controlling for the countries' Healthy Access and Quality Index (Fullman et al., 2017). When the personal income per US state and Gini index were controlled, the negative association remained marginally significant (worldwide: $r(41) = -.270$, $p = .080$; US: $r(46) = -.281$, $p = .053$).

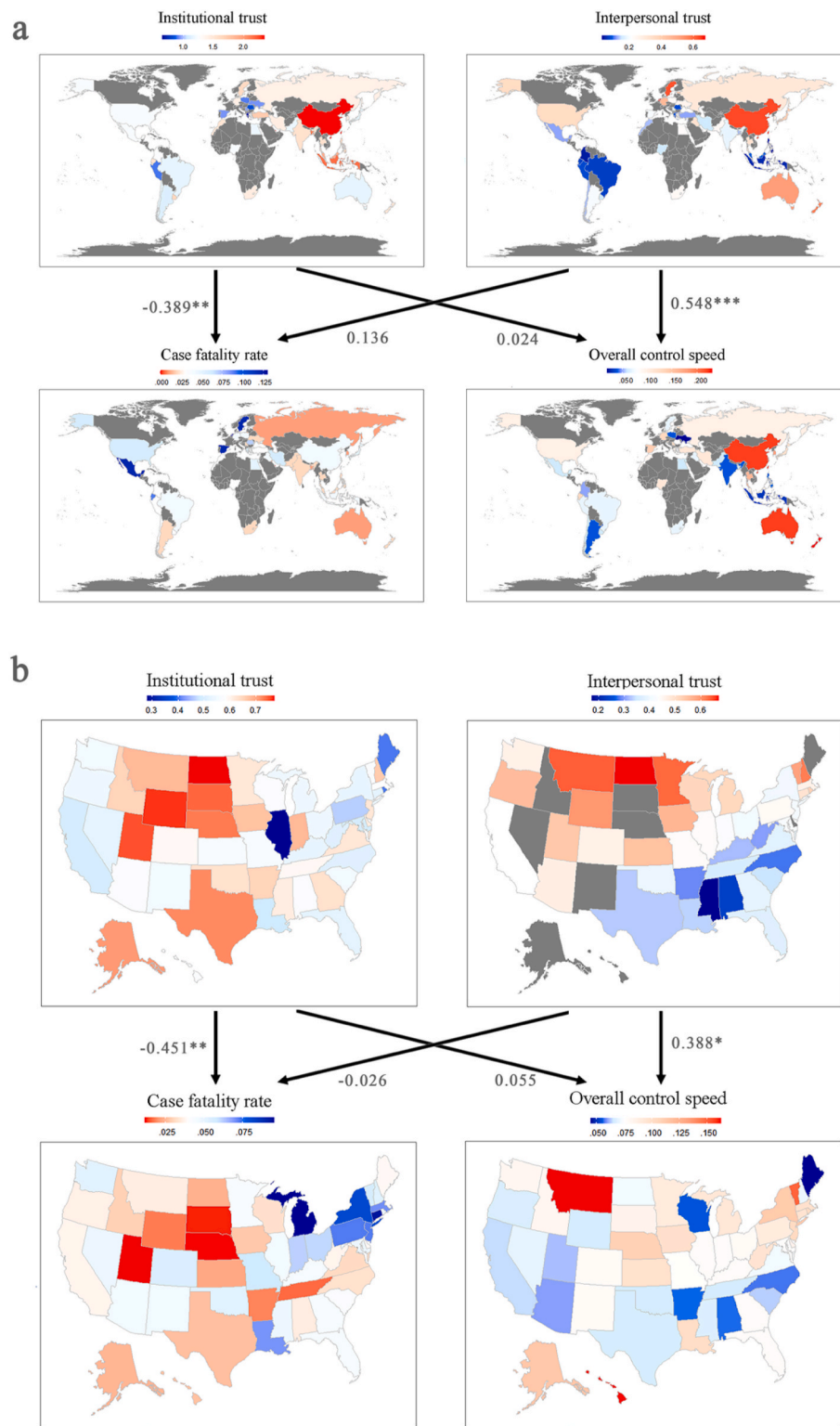We also explored the relationships between trust and epidemic

**Fig. 1.** Association between institutional trust/interpersonal trust and case fatality rate/control speed in both global and US samples.

indicators from a representation similarity perspective. The representational similarity pattern in interpersonal trust was similar to that in second-stage control speed (worldwide: $r = .423$, $p = .003$; US: $r = .329$, $p = .0001$) (Supplementary Materials, Fig. S3; Tables S4 & S5), while severity indicators were not significant ($ps > .05$).

### 3.2. Institutional trust and willingness to receive COVID-19 testing

An independent sample *t*-test was conducted for the two institutional trust priming groups in study 2A, and the difference in the willingness to receive COVID-19 testing reached marginal significance ($t(167) = -1.86$, $p = .06$, 95% CI $= [-0.94, 0.03]$, *Cohen's d* $=.29$, Table 1, Fig. 3a), suggesting a trend that institutional trust was associated with individuals' voluntary compliance and willingness to test, but enforced
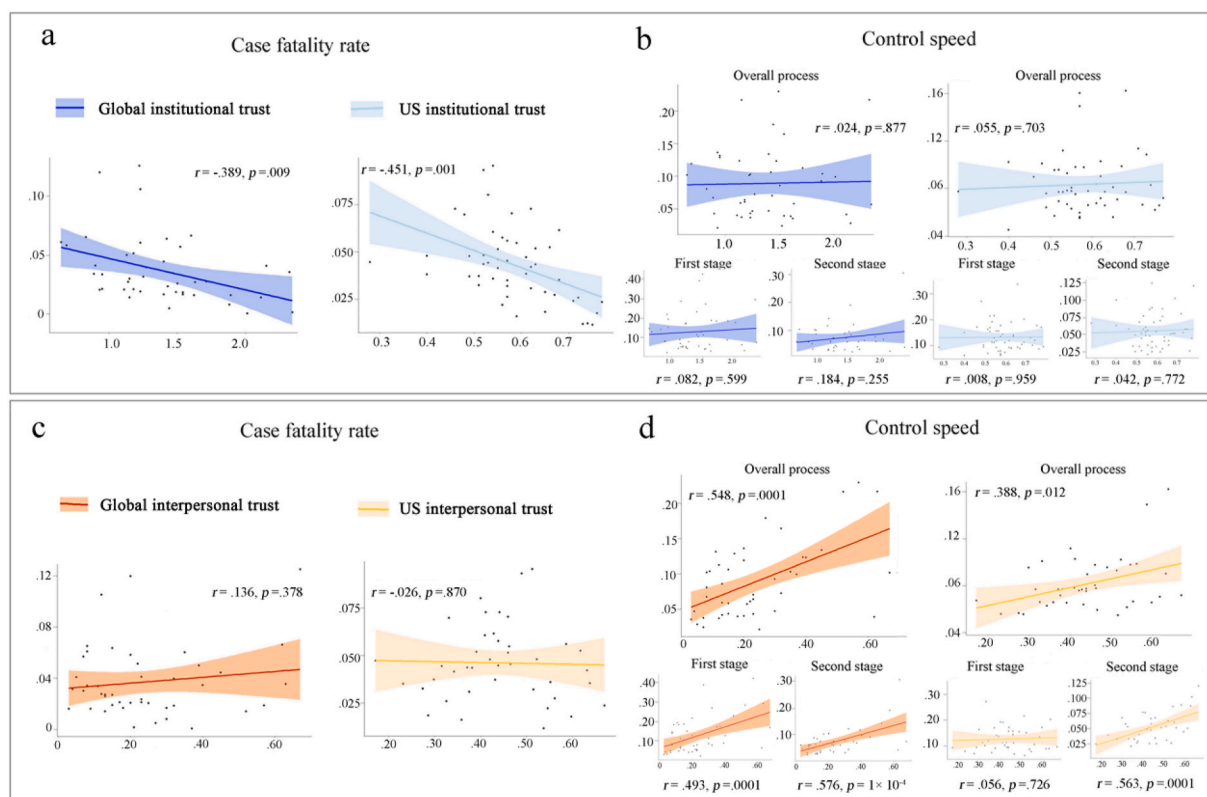
**Fig. 2.** Scatter diagram of trusts and COVID-19 indicator with regression lines and 95% CIs in both global and US samples. **a** Negative association between institutional trust and case fatality rate. **b** Effects of institutional trust on control speed. **c** Effects of interpersonal trust on case fatality rate. **d** Positive association between interpersonal trust and control speed.

**Table 1**
Behavior Difference in the Low and High Institutional Trust Group.

| | $M$ (SD) | | $t$ | $df$ | $p$ | $d$ | $\Delta M$95% CI | |
|---|---|---|---|---|---|---|---|---|
| | Low | High | | | | | | |
| Willingness of COVID-19 test | 5.06 (1.70) | 5.52 (1.49) | −1.86 | 167 | .06 | 0.29 | −0.94 | 0.03 |
| Voluntary compliance | 4.71 (1.79) | 5.68 (1.34) | −3.99 | 167 | .0001 | 0.62 | −1.45 | −0.49 |
| Enforced compliance | 5.80 (1.26) | 5.86 (1.37) | −0.30 | 167 | .76 | 0.05 | −0.46 | 0.34 |

*Note.* Self-reported behavioral willingness was measured in order using a 7-point scale (1 = *not at all*; 4 = *not sure*; 7 = *extremely willing*). Two items were used to measure compliance, adapted from Wahl et al. (2010). Voluntary compliance: "I think of following infection disease control policies as helping the government do worthwhile things". Enforced compliance: "If I were caught violating a country's infectious disease control policies, I would be severely punished". Willingness to undergo COVID-19 testing: "I would volunteer for testing demanded by the government if a member of my family or myself had suspected symptoms".

compliance was not. Furthermore, voluntary compliance was significantly associated with institutional trust ($r(168) = .45, p = 9.3 \times 10^{-10}$) and willingness to receive a COVID-19 test ($r(168) = .48, p = 3.5 \times 10^{-11}$), but enforcement compliance was not (institutional trust: $r(168) = .002, p = .98$; willingness to complete the COVID-19 test: $r(168) = .18, p = .02$). The mediation effect of voluntary compliance was analyzed (sampling number of 5000), and the results showed that the indirect path was significant ($B = .42, \beta = .43, t(167) = 5.63, 95\%$ CI = [0.28, 0.57], $p = 7.5 \times 10^{-8}$), while the direct path was not significant ($B =.006, \beta =.12, t(167) = 1.57, 95\%$ CI = [-0.001, 0.013], $p = .14$). The 95% CIs of the indirect effect was [0.005, 0.015], suggesting that voluntary compliance mediated the association between institutional trust and willingness to receive the COVID-19 test.

### 3.3. Interpersonal trust and reduction in unnecessary outdoor activities

Independent-sample t-tests were conducted for groups with different interpersonal trust levels in study 2B. The results showed that self-reported interpersonal trust was significantly higher in the high group

(US: $t(124) = 5.43, p = 2.8 \times 10^{-7}$, Cohen's $d = .98$; China: $t(89) = 10.57, p = 2.0 \times 10^{-17}$, Cohen's $d = 2.24$).

The results of reducing unnecessary outdoor activities revealed a significant difference between the high and low interpersonal trust groups in the sample from China ($t(89) = -2.24, p = .03, 95\%$ CI = [−1.21, 0.07], Cohen's $d = .48$) but not in the sample from the US ($t(124) = -1.17, p = .24, 95\%$ CI = [-0.79, 0.20], Cohen's $d = .21$, Table 2). Susceptibility perception showed a significant difference between the groups in the US sample ($t(124) = 2.71, p = .008, 95\%$ CI = [0.21, 1.34], Cohen's $d = .49$) but not in the Chinese sample ($t(89) = .18, p = .86, 95\%$ CI = [−0.66, 0.79], Cohen's $d = .038$), suggesting that American participants in the higher interpersonal trust group were less aware of the negative impact of others' noncompliance. We regressed reducing unnecessary outdoor activities on the factor of the interpersonal trust group while controlling the score of perceived susceptibility. The predictive effect reached a margin of significance in the US (US: $B = .486, \beta = .1720, t(124) = 1.943, p = .005, 95\%$ CI = [-0.009, 0.981]; China: $B = .648, \beta = .234, t(89) = 2.288, p = .025, 95\%$ CI = [0.085, 1.211]) (Fig. 3b), indicating that high interpersonal trust positively
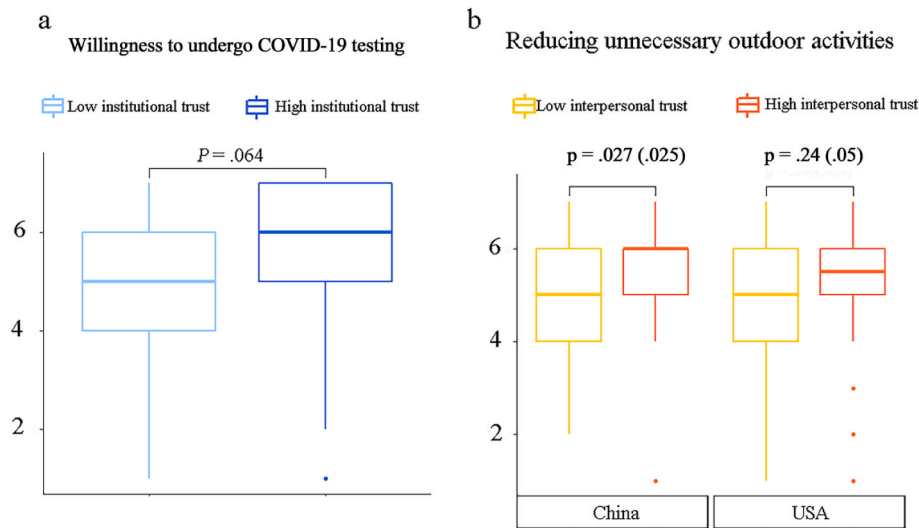
**Fig. 3.** Results of behavioral experiments. **a** Score of willingness to undergo a COVID-19 test in two groups (centerline, median; box limits, upper and lower quartiles; whiskers, 1.5 × interquartile range; points, outliers). **b** Score of reducing unnecessary outdoor activities in the Chinese and US samples. The two p-values represent the p-value for the independent test of two interpersonal trust groups and (p-value) of the multiple regression with the score controlled for perceived susceptibility.

predicted the tendency to reduce unnecessary outdoor activities in the two countries.

### 3.4. Differential mechanism of two different trusts on COVID-19 pandemic control

According to the relationship examined in the behavioral experiment setting, we constructed computational models to connect individuals' prevention behaviors with their trust value to simulate the infection control process, and we manipulated the mean value of interpersonal trust and institutional trust (Low: μ = .35; High: μ = .45) at group level and simulated the COVID-19 controlling process 200 times in each 2 (interpersonal trust: Low, high) × 2(institutional trust: Low, high) condition in study 3.

The results were consistent with the association observed in worldwide sample and in the US sample in study 1. The control speed differed between the two interpersonal trust conditions in both the low institutional trust condition ($M = .087, SD = .016$ vs. $M = .097, SD = .019$; $M_{diff} = .011$, $M_{diff}$95% CI = [0.007, 0.14]) and the high institutional trust condition ($M = .091, SD = .023$ vs. $M = .101, SD = .018$; $M_{diff} = .010$, $M_{diff}$95% CI = [0.006, 0.010]). while the control speed did not differ between the two institutional trust conditions (Fig. 4c & Table 3). The CFR in the low institutional trust condition was higher than that in the high institutional trust condition in both the low interpersonal trust condition (CFR_rep: $M = .023, SD =.011$ vs. $M = .013, SD = .011$; $M_{diff} = .01$, $M_{diff}$95% CI = [0.007, 0.013]) and the high interpersonal trust condition (CFR_rep: $M = .022, SD = .011$ vs. $M = .015, SD =.012$; $M_{diff} = .007$, $M_{diff}$95% CI = [0.004, 0.010]). However, manipulation of interpersonal trust did not influence CFR (Fig. 4c & Table 3). These results confirmed the different behavioral mechanisms of interpersonal trust and institutional trust in COVID-19 pandemic control. At the group level, higher interpersonal trust promoted epidemic control efficiency, and higher institutional trust decreased the case fatality rate.

### 4. Discussion

Through three studies combining correlation analyses, behavioral experiments and agent-based modeling, we clarified how institutional trust and interpersonal trust may play different roles in mitigating the first COVID-19 outbreak and relevant behavioral and psychological mechanisms (Fig. 5).

This phenomenon was observed in both global and US samples.

Institutional trust was connected with a lower CFR, which was associated with alleviating the worst scenario produced by the epidemic. The association between institutional trust and acceptance of scientific and medical measures was initially supported by previous studies on Ebola virus prevention (Blair et al., 2017; Vinck et al., 2019). Behavioral experiments further distinguished the specific behavioral mechanism, namely, acceptance of etiologic agent testing. This preventive measure has been shown to be effective in reducing the number of secondary infections (Chiu et al., 2020). In combination with the health belief model (Janz and Becker, 1984), laboratory testing for the identification of the etiologic agent is a "state monopoly", indicating that individuals comply with policies to guide their behaviors only if they trust the government. At the beginning of the outbreak of COVID-19, information was varied and unclear. It is difficult to rely on rational decision-making in most circumstances, and individuals' institutional trust influences their judgment of whether an institutional decision is correct (Lind and Tyler, 1988; Tyler and Degoey, 1996). Furthermore, the mechanism by which individuals' voluntary testing can reduce the CFR is as follows: voluntary testing can reduce the number of secondary infections and provide more treatment time for infected persons. In contrast, if most individuals are being tested or sent to the hospital because of advanced disease, 1) confirmed cases may have missed the gold treatment period, 2) more secondary infections may lead to an increased risk of medical resource shortages, and 3) most people are critically ill when they are sent to the hospital, resulting in medical resource shortages. These adverse factors lead to an increased probability of individual death and a higher case fatality rate at the population level.

Data analysis results also showed how interpersonal trust might influence the development of the first COVID-19 outbreak in 44 countries worldwide and 50 states in the US. Interpersonal trust is related to a higher control speed of the epidemic and an earlier end to the spread of the virus. The representation similarity perspective supports the different potential correlation mechanisms of trust. We observed representation pattern similarity only between interpersonal trust and control speed. The influence of interpersonal trust on the speed of epidemic prevention and control is mainly suggested in the second stage. The explanation may be that the spread of the virus in the first stage is mainly limited to natural factors such as population density, human mobility and climate and is not associated with high or low interpersonal trust. There are already large infection numbers (approximately 1/2 of the maximum number of infected people) in the second stage (Campbell and Madden, 1990), and the epidemic has been controlled
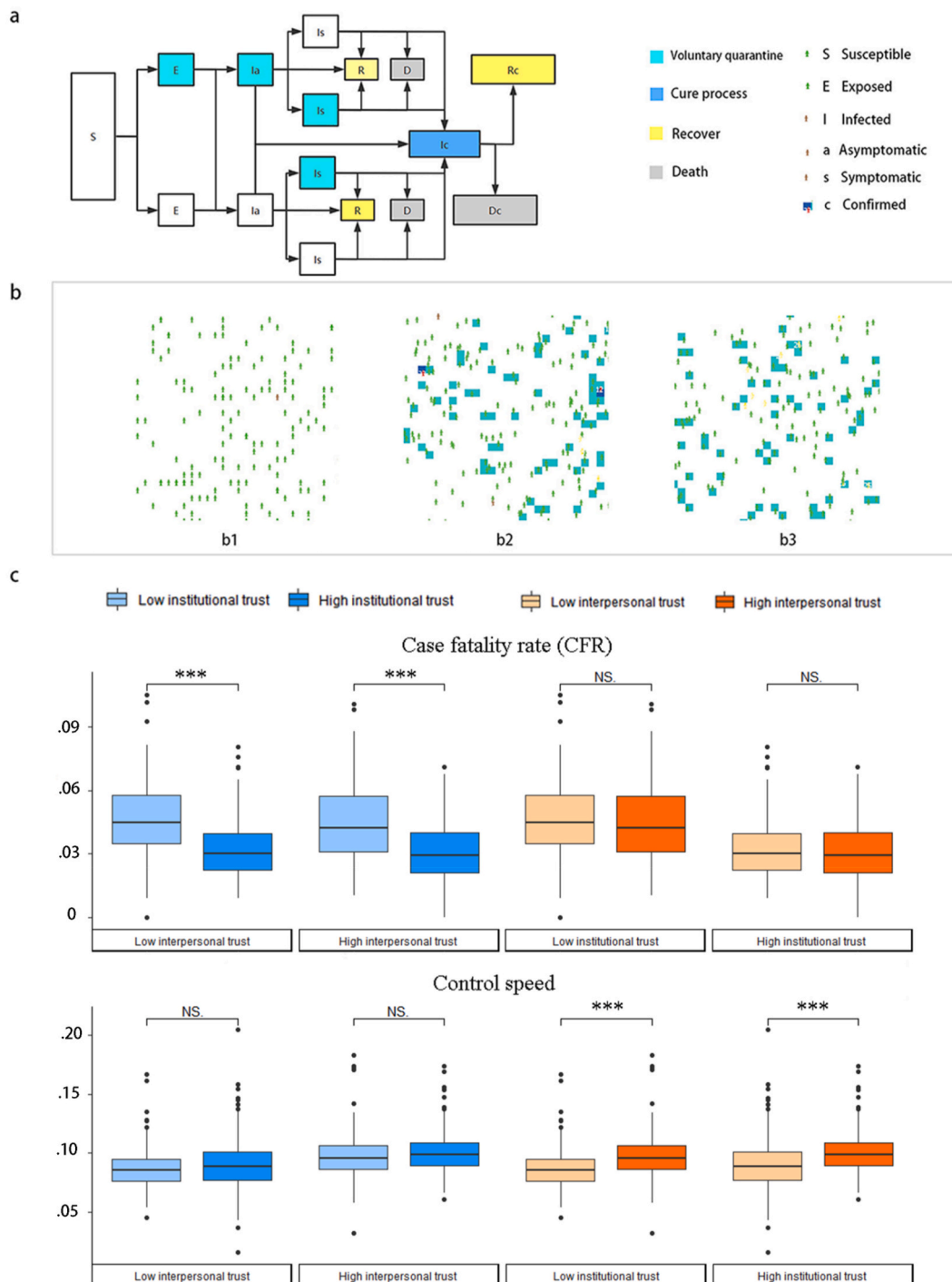
**Fig. 4.** Simulation model and result. **a** Adjusted SEIR model in study 3. **b** COVID-19 controlling simulation process: begin (b1), controlling (b2) and controlled (b3). **c** Effects of institutional trust and interpersonal trust on case fatality rate and control speed (centerline, median; box limits, upper and lower quartiles; whiskers, 1.5 × interquartile range; points, outliers.

conspicuously; therefore, individuals' susceptibility and perception of the severity of COVID-19 decrease, and even epidemic mitigation staff reduce their work standards. This phase is associated with complex economic activities and an increase in population mobility (Chiu et al., 2020). More epidemic prevention efforts are needed to prevent virus rebound. Therefore, individuals who consciously abide by epidemic prevention norms can not only compensate for existing lax control but also respond flexibly and efficiently to the risk of infection in the absence of official control.

Moreover, a nonhomogeneous effect of individualism in

interpersonal trust and virus spreading control were suggested from high-dimensional representational space (Kriegeskorte et al., 2008). In the experimental setting, we consistently observed that participants in the higher interpersonal trust group had more positive expectations that others would obey prevention norms and were more likely to reduce unnecessary outdoor activities. In addition, the cultural context moderated the relationship: the US participants, but not the Chinese participants, with high interpersonal trust also had a lower infection susceptibility, which is associated with a lower willingness to reduce unnecessary outdoor activities. Accordingly, the influence of

**Table 2**

*Behavior Difference in the Low and High Interpersonal Trust Group.*

|  | M (SD) | | t | df | p | d | ΔM95% CI | |
|---|---|---|---|---|---|---|---|---|
|  | Low | High | | | | | | |
| **China** | | | | | | | | |
| Reduce unnecessary outdoor activities | 5.04 (1.55) | 5.68 (1.14) | −2.24 | 89 | .03 | 0.48 | −1.21 | −0.07 |
| Self-norm compliance | 6.49 (.91) | 6.20 (1.50) | 1.10 | 89 | .27 | 0.23 | −0.23 | 0.80 |
| Trust others' compliance | 4.85 (1.61) | 5.73 (1.26) | −2.87 | 89 | .01 | 0.61 | −1.48 | −0.27 |
| Interest calculative | 5.72 (1.51) | 5.95 (1.46) | −0.74 | 89 | .46 | 0.16 | −0.85 | 0.39 |
| Perceived susceptibility | 5.36 (1.66) | 5.30 (1.81) | 0.18 | 89 | .86 | 0.04 | −0.66 | 0.79 |
| **US** | | | | | | | | |
| Reduce unnecessary outdoor activities | 4.92 (1.44) | 5.21 (1.39) | −1.17 | 124 | .24 | 0.21 | −0.79 | 0.20 |
| Self-norm compliance | 5.08 (1.54) | 5.11 (1.50) | −0.08 | 124 | .93 | 0.01 | −0.56 | 0.51 |
| Trust others' compliance | 4.52 (1.73) | 5.03 (1.40) | −1.84 | 124 | .07 | 0.33 | −1.07 | 0.04 |
| Interest calculative | 5.17 (1.54) | 5.26 (1.46) | −0.34 | 124 | .73 | 0.06 | −0.62 | 0.44 |
| Perceived susceptibility | 5.37 (1.54) | 4.59 (1.66) | 2.71 | 124 | .01 | 0.49 | 0.21 | 1.34 |

*Note.* The variables were measured in order using 1 original item on a 7-point scale (1 = *not at all*; 4 = *not sure*; 7 = *extremely willing*). Self-norm compliance: "I will strictly abide by the disease control policy of the community despite some inconvenience. It is beneficial for everyone". Trust others' compliance: "I believe that the other 10 players will abide by the disease control policy of the community because they can realize that abiding by the policy is beneficial to everyone even though it requires them to give up some of their own interests". Interest calculative: "If the other 10 players abide by the disease control policy, I will also abide by it as much as possible. Otherwise, my personal efforts and sacrifices will be wasted". Perceived susceptibility: "Although I would abide by the disease control policy, I am worried that the other 10 players will not abide by the policy". Reduce unnecessary outdoor activities: "I will reduce unnecessary outdoor activities. Moreover, I think others in the community will do the same".

**Table 3**

*Simulation results in agent-based modeling.*

|  | Interpersonal trust | | | | | | | |
|---|---|---|---|---|---|---|---|---|
|  | Low | | | | High | | | |
|  | M | SD | 95% CI | | M | SD | 95% CI | |
| **Low institutional trust** | | | | | | | | |
| Confirmed | 889.525 | 350.149 | 840.997 | 938.053 | 818.16 | 340.416 | 770.981 | 865.339 |
| Death_rep | 24.025 | 15.788 | 21.837 | 26.213 | 21.22 | 15.103 | 19.127 | 23.313 |
| Infected | 1285.11 | 623.517 | 1198.695 | 1371.525 | 1181.64 | 626.073 | 1094.871 | 1268.409 |
| Death_act | 69.445 | 54.507 | 61.891 | 76.999 | 63.42 | 54.682 | 55.841 | 70.999 |
| CFR_rep | .023 | .011 | .022 | .025 | .022 | .011 | .020 | .023 |
| CFR_act | .046 | .018 | .044 | .049 | .045 | .018 | .042 | .047 |
| Control speed | .087 | .016 | .084 | .089 | .097 | .019 | .095 | .100 |
| **High institutional trust** | | | | | | | | |
| Confirmed | 511.255 | 359.632 | 461.413 | 561.097 | 532.25 | 345.118 | 484.419 | 580.081 |
| Death_rep | 10.385 | 13.868 | 8.463 | 12.307 | 11.595 | 13.926 | 9.665 | 13.525 |
| Infected | 642.5 | 499.112 | 573.327 | 711.673 | 658.515 | 474.876 | 592.701 | 724.329 |
| Death_act | 26.145 | 32.254 | 21.675 | 30.615 | 26.085 | 29.441 | 22.005 | 30.165 |
| CFR_rep | .013 | .011 | .012 | .015 | .015 | .012 | .013 | .017 |
| CFR_act | .032 | .014 | .030 | .034 | .031 | .014 | .029 | .033 |
| Control speed | .091 | .023 | .087 | .094 | .101 | .018 | .098 | .103 |

*Note.* "_rep" indicates results captured from confirmed cases that received the test and curing, in other words reported cases. "_act" indicates results captured from actual infected cases that include confirmed cases and nontest cases.

individualistic culture is suggested. On the one hand, when the effectiveness of epidemic mitigation largely depends on the restriction and regulation of individuals' personal habits, people in areas with a highly individualistic culture are less likely to be influenced by social norms and thus are more likely to disobey when epidemic prevention behavior conflicts with free will. In these regions, individuals who violate norms are seen as adhering to the cultural ideal of individualism for autonomy, which may enhance their status in society (Kinias et al., 2014) and is less likely to cause moral outrage from others (Stamkou et al., 2019). On the other hand, in regions where individualistic culture prevails, individuals are less aware of the connection between themselves and the collective, which is associated with a lower perceived risk of infectious diseases (Germani et al., 2020). Accordingly, we observed that American participants but not Chinese participants in the high interpersonal trust group were less aware of the infection risk caused by others, and the positive effect of interpersonal trust on reducing unnecessary outdoor activities was affected by the decline in the perception of infection risk. This may explain why interpersonal trust was associated with more deaths during the initial phase of the COVID-19 outbreak in Italy (Elgar et al., 2020).

Several applicable border of these findings should be noted. First, the institutional and interpersonal trust data measured before the COVID-19 pandemic were used as a baseline to predict the development of the pandemic's first wave. Recent studies have shown mixed results about whether levels of trust have changed during the COVID-19 pandemic. Some research has found that trust held stable during the pandemic. For example, Graffigna et al. (2021) conducted questionnaire measurements between March 10 and May 4, 2020, in Italy, and their results showed that people's trust toward authorities remained substantially unchanged. In contrast, there is also evidence showing that trust has consistently changed (Algan et al., 2021; Esaiasson et al., 2021; Li et al., 2021). In future research, new methods and technologies (such as big data and text analyses) may be used to track longitudinal trust data. Second, different countries have introduced various epidemic prevention and control policies over time; the development trend of the pandemic has also varied. It can be speculated that the levels of trust and pandemic development might be related through a dynamic co-evaluation process, and the roles of interpersonal trust and institutional trust in COVID-19 pandemic control might change over time. At present, although some studies have explored the impact of trust in the
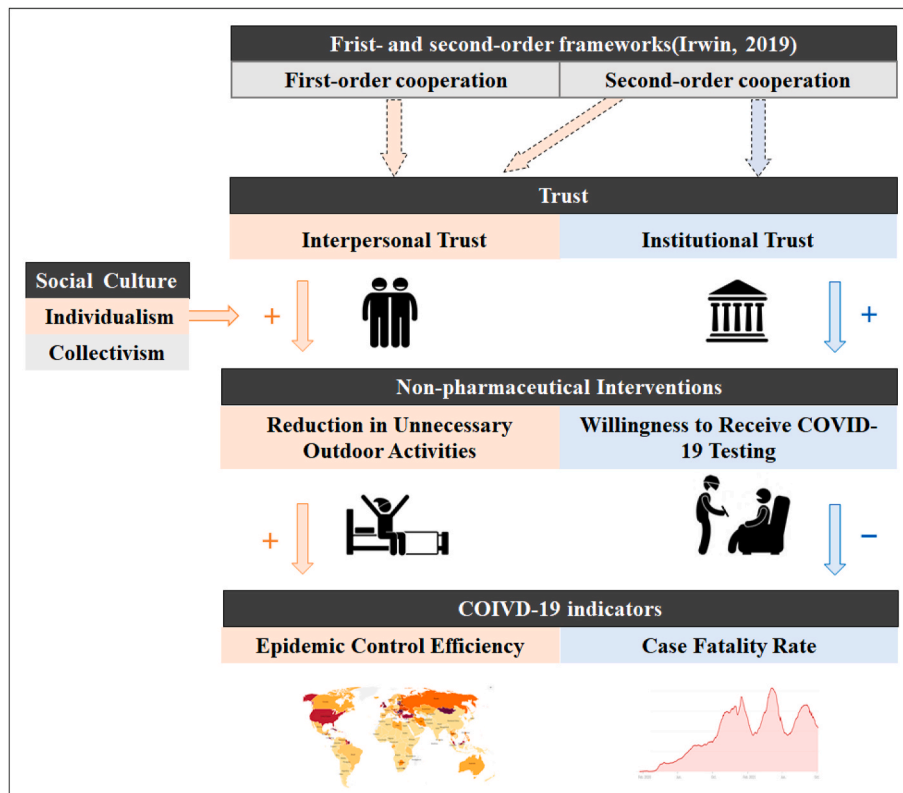
**Fig. 5.** Conceptual framework of trust and COVID-19 pandemic control.

context of the pandemic, it is difficult to reach a general conclusion due to differences in measurement items, periods, and subjects. Future research should carry out worldwide studies to explore the co-evaluation mechanism between trust and a pandemic at different stages. Third, we discussed the effect of trust on the COVID-19 pandemic by using individual and interpersonal trust. However, trust can be classified into several types. Recent studies have suggested that trust in nongovernmental health experts could increase participants' acceptance of protective measures (Ahluwalia et al., 2021). Future studies should investigate the effects of other trust dimensions. Finally, researchers have indicated that emotions could mediate the relationship between institutional trust and prevention behaviors (Min et al., 2020). Amid the COVID-19 pandemic, both paranoia and conspiracy beliefs have changed over time (Suthaharan et al., 2021). Given the potential influences of emotion, cognition, and personality on the association between trust and preventive practices during the pandemic, future studies can further explore this issue by measuring the related indicators during the pandemic.

## 5. Conclusion

The current research explored the role of the two kinds of trust in curbing the first wave of the COVID-19 epidemic and the corresponding behavioral and psychological mechanisms. Collectively, interpersonal trust is related to the faster completion of virus transmission, and higher institutional trust is related to lower case fatality of COVID-19, and the positive effects of the two trusts are independent of each other. Moreover, institutional trust affects the possibility of individuals voluntarily complying with the COVID-19 test, whereas interpersonal trust affects the possibility of individuals consciously observing epidemic prevention norms, and these effects were further confirmed through the evolutionary model. Furthermore, the association between interpersonal trust and COVID-19 control efficiency was modulated by an individualistic culture. These findings provide references for formulating and

implementing a COVID-19 epidemic prevention policy.

### Data availability

Data used for analysis and modeling are available from the corresponding author on request.

### Code availability

All code used for analysis and modeling are available from the corresponding author on request.

### Author contributions

LQY, HGL, HLQ, and LSY designed the research; YH, LQY, HGL, HLQ, and LSY conducted the experiment; YH, LQY, HGL, HLQ, and LSY analyzed the data; YH, LQY and LSY wrote the manuscript. All the authors commented on the manuscript.

### Acknowledgments and Funding Sources

### Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi. org/10.1016/j.socscimed.2021.114677.

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