

Article

An Assessment of Social Distancing Obedience Behavior during the COVID-19 Post-Epidemic Period in China: A Cross-Sectional Survey

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Abstract: Social distancing plays a critical role in reducing the disease diffusion risk during the COVID-19 pandemic and post-pandemic period. In order to explore the social distancing obedience behavior, a comprehensive survey was conducted in this study by collecting data from 1064 Chinese residents in January 2021 by means of a questionnaire. Structural equation modeling (SEM) and hierarchical linear regression (HLR) analyses were employed to investigate the research hypotheses considered, testing the three influencing factors of social distancing obedience behavior: public guidance, risk perception, and regulation punishment. The reliability and validity of the measurements are demonstrated. The outcomes from the conducted analyses show that the public guidance significantly affects risk perception of individuals, while risk perception imposes a positive impact on social distancing obedience behavior. Moreover, risk perception serves a mediating role in the relationship between the public guidance and social distancing obedience behavior. In addition, regulation punishment positively predicts social distancing obedience behavior and could even have a greater effect by enhancing risk perception. Hence, this study suggests that the relevant authorities and agencies implement strong social distancing policies during the COVID-19 post-pandemic period from the perspective of promoting the public guidance, risk perception, and regulation punishment.

Keywords: social distancing obedience behavior; COVID-19 post-pandemic period; pandemic prevention and control; structural equation modeling



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1. Introduction

From the Ebola virus in 1976 to the SARS epidemic in 2002 and to the Middle East Respiratory Syndrome in 2012 and 2018, the impacts of major public health emergencies and other catastrophic events are continuously broadening with an increased severity. The surge of the novel coronavirus disease 2019 (COVID-19) has become a severe public health issue globally. The implementation of public health emergency measures to cope with the negative effects of COVID-19 directly impacts public health and safety. The actions undertaken by the government also play a critical role. The government representatives should have an in-depth knowledge of how the public understands the pandemic and react accordingly. Furthermore, individual cognition should also influence pandemic prevention and social behavior. Through reports and relevant news, scholars implicate that maintaining social distancing is one of the most effective approaches to reducing the COVID-19 infection rate both in the epidemic prevention period and in the post-epidemic era [1,2]. Local governments across the globe have announced social distancing requirements that vary from each other. For instance, the social distancing stipulated in America and Great Britain is at least 2 m (6 feet), 1.5 m for Australia, and 1 m for China and South Africa [3]. Multiple research efforts have explicitly showed that regulating

social distancing of 1–2 m is a sufficient requirement through observation and simulation experiments [4,5]. However, in real-life scenarios (such as transportation hubs, shopping malls, hospitals, and other public facilities), strictly following social distancing can be challenging due to complex individual needs [6].

At present, the studies on social distancing and epidemic prevention and control are mainly carried out from the following three perspectives. First, there exists a group of studies focusing on the influencing factors of social distancing obedience. From the perspective of the government's crisis management ability, the government's "normalized" management of the epidemic can prompt the public to maintain reasonable social distancing [7,8]. From the perspective of public management, the perception and public expectations have become the key factors for a successful participation in public crisis management. As a result, scholars have highlighted the importance of public guidance. Government forces should enhance public awareness of the epidemic trend through news and other means, publicize the role of social distancing in reducing infection, and encourage people to observe social distancing voluntarily [7]. Moreover, these factors also affect the behavioral mechanism of the public's own cognition for social distancing obedience [9,10]. Based on the previously conducted studies, several scholars applied advanced analytical approaches (e.g., a continuous infection model) and concluded that both school management and future urban development need to strengthen the management of social distancing, putting forward suggestions to enhance the governance to achieve the effect of restraining the spread of the pandemic [11,12].

Second, some studies concentrate on social distancing obedience behavior from the perspective of mathematical modeling and simulation. Several research efforts developed mathematical models that could be used to determine the infection rates of the novel coronavirus COVID-19 and assess the severity as well as the large-scale spread potential of the virus based on the results of epidemiological investigation [13–15]. The effectiveness of social isolation and other social distance-keeping measures in response to the COVID-19 outbreak have been evaluated by means of advanced simulation methods [16,17]. According to the simulation results, if over 55% of the population complied with the social distancing rules, the COVID-19 pandemic would disappear [18].

Third, there are several studies assessing the positive impact of social distancing obedience on slowing down the COVID-19 spread. The previous studies have focused on evaluating the impact of social distancing obedience on the COVID-19 transmission [19], believing that social distancing could effectively cut off the transmission route of the virus, thus reducing the basic transmission rate [20]. Through the modeling study of the COVID-19 pandemic transmission cases, it was concluded that different transmission modes of the novel coronavirus and the measures to suppress the transmission of coronavirus [21], such as quarantine, played an important role in inhibiting the transmission of novel coronavirus [22,23]. Therefore, it was proposed that keeping appropriate social distancing could significantly delay or even curb the transmission of the COVID-19 pandemic to a certain extent [24]. To sum up, although the academic community has recognized the importance and necessity of social distancing obedience in the major pandemic situation, the overall law of social distancing and its endogenous effects still need to be further investigated and clarified [25].

In order to effectively address this research gap, we undertook an empirical study on the compliance with social distancing in the context of the normalization of pandemic prevention and control. To explore the impact of public guidance, risk perception, and regulation punishment on social distancing obedience, a comprehensive survey of Chinese residents was conducted. Structural equation modeling was performed by using the collected data. In addition, the mediating and moderating effects were validated among the considered variables. The outcomes of this research could enrich theories and practical guidelines that meet the temporal characteristics and situational requirements for national disease spread prevention and control during the COVID-19 post-pandemic period.

2. Research Hypotheses

2.1. Public Guidance, Risk Perception, and Social Distancing Obedience

While exploring pandemic prevention and control, many scholars have proved the importance of media in providing the latest usable information to enrich the knowledge, awareness, and actions of medical staff and the public [26]. In the era of digital media, the public guidance can advance the impact of social distancing and deepen public recognition. The general risk perception is the worry or anxiety of the public about a particular issue, which shows the process by which the general public has a subjective opinion on a specific risk. In this study, risk perception in the pandemic context is determined as the psychological processes of subjective assessment of the probability of becoming infected with coronavirus, the associated protective measures, and an individual's perceived health risk [27].

Some of the previous studies evaluated the correlation of public guidance with risk perception in risk management [28,29]. Similar studies showed that it is important to identify risk before making a judgment. People must evaluate the risks with reliable institutions, particularly when they lack specific knowledge. The government and its public guidance are key factors that affect how people perceive the risk of a specific danger. The mass media, information communication through the media, and frequent media exposure potentially contribute to a high-level perception risk [30]. Hence, Hypotheses 1 and 2 are proposed in this article.

Hypotheses 1 (H1). *Public guidance encourages social distancing obedience behavior.*

Hypotheses 2 (H2). *Public guidance plays a positive role in risk perception.*

Based on previous research efforts, the risk perception or prevention behavior of the specific infectious disease was found to exert a direct and effective reduction effect on the infection rate [13]. People realize that risk prevention, wearing masks, washing hands, and staying at home have measurable prevention effects for SARS and H1N1 viruses. In consequence, the increase or decrease of infection rate partly depends on risk perception or prevention behavior of individuals. To trigger a response and sense of threat, people are advised to adhere to prevention and control policies and regulations. The mainstream media improves people's self-efficacy in protection, vulnerability to disease, and the severity of pandemic outbreaks through the news [31]. Hence, the frequent users of media are more likely to receive simplified information with higher risk perception. They are also more willing to follow social distancing guidelines. Therefore, Hypotheses 3 and 4 are proposed in this article.

Hypotheses 3 (H3). *Risk perception imposes a positive impact on social distancing obedience behavior.*

Hypotheses 4 (H4). *Risk perception is a mediator between public guidance and social distancing obedience behavior.*

2.2. Regulation Punishment and Social Distancing Behavior

In undertaking specific solutions, regulation punishment adequately protects a smooth implementation of measures. This prevents threats to public safety in the event that the public turn a blind eye to regulations [32]. A threat to the public safety may trigger much more negative moral emotions. Punishment measures play a key role in pandemic prevention and control. For national groups, the strong negative sentiment for the group disobeying the existing regulations is further emphasized to support the decision by the government to curb the virus spread using a punishment for noncompliance [33]. Following the experience of law enforcement legislation in Britain (such as a mandatory use of seat belts), a rapid change can be felt in areas where people did not accept the imperative stipulations with full preparation [34]. In other countries, without evidence of severe public disorder, the majority would support adopting much more coercive measures. Community participation is also warranted to reduce the risk of negative impacts [35,36].

Therefore, the community should take part in such activities to adopt the essential critical social distancing measures through legislation.

Considering the social distancing effect caused by compulsory measures, a simple theoretical framework demonstrates that people more effectively increase compliance rates with the social distancing requirements in response to information on the virus and fear rather than in response to an order from the government [37]. Furthermore, the early national policies seem to deliver pandemic information, showing that the policy response can also be channeled voluntarily [38]. Hypotheses 5 and 6 are hence suggested as follows.

Hypotheses 5 (H5). *Regulation punishment could supervise and promote social distancing obedience behavior.*

Hypotheses 6 (H6). *Regulation punishment could encourage social distancing obedience behavior by enhancing risk perception.*

The conceptual framework of this study showcasing the considered hypotheses and relationships between these hypotheses is presented in Figure 1.

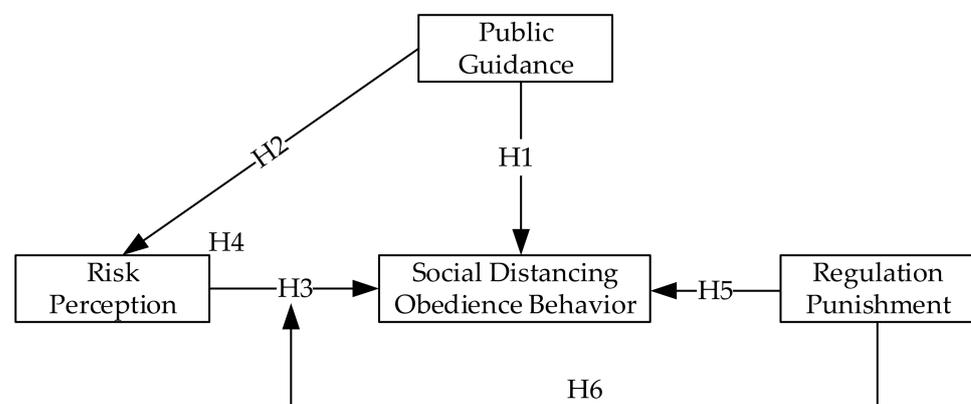


Figure 1. Conceptual model framework.

3. Study Design

3.1. Data Collection

For the survey development, a seven-step scale design proposed by Artino et al. [39] was adopted in this study: (1) literature review; (2) organization of focus groups; (3) literature synthesis and discussion in the focus groups; (4) development of questionnaire items; (5) expert validation; (6) cognitive interviews with respondents to verify that the questions were understood; (7) pilot testing.

A thorough literature review was conducted in December 2020 to identify valid questions for the topic of interest. According to the questions posed by the aforementioned research hypotheses, public guidance, risk perception, social distancing obedience behavior, and regulation punishment were selected as variables. Referring to the maturity scale, we designed a questionnaire with a total of 25 questions in this study [37,40–43].

We received suggestions from the healthcare and academic experts before the investigation and undertook a pre-survey with 100 online users randomly. Following the reliability and validity test of the pre-survey structure, some questions were eliminated and adjusted to generate a formal scale comprising 17 observed variables only. All the answer scales of questions followed the traditional Likert scale. Scores ranged from 1 = “completely disagree” to 5 = “completely agree”. All questions had positive descriptions, such that a higher score denoted a stronger consistency. The specification of the scale and the questions that were adopted in the questionnaire are presented in Table 1.

Table 1. Overview of questionnaire items.

Variable	Code	Survey Instrument Statements
Risk Perception (RP)	RP1	The possibility of having COVID-19 during the pandemic period.
	RP2	The possibility of the people in your area having COVID-19 during the pandemic period.
	RP3	The threat of having COVID-19 to your life and health.
	RP4	The negative impact of having COVID-19 on your life and work (study).
	RP5	The threat of having COVID-19 to the people in your area.
Public Guidance (PG)	PG1	I think the government and media's public guidance has a positive leading role in encouraging people to follow social distancing.
	PG2	I would have much more sense of the crisis after receiving a publication of pandemic prevention and control released by the government and media.
Regulation Punishment (ReP)	ReP1	The government should advocate keeping social distancing frequently in the present social environment.
	ReP2	The government should set compulsory rules to make people socially distance from each other.
	ReP3	I would think more about the social communication issue during the pandemic if the government would set a relevant regulation mechanism to facilitate social distancing.
	ReP4	I would follow social distancing even if the government had no regulations.
Social Distancing Obedience Behavior (SOB)	SOB1	During the pandemic, I have kept at least 1 m away from others outside of the home.
	SOB2	During the pandemic, I would wear a mask in public areas, the workplace, or at school.
	SOB3	I would keep a greater distance from those who do not follow social distancing.
	SOB4	I would take persuasive measures for those who do not follow social distancing.
	SOB5	I am used to avoiding physical contact when greeting strangers.
	SOB6	I would keep certain social distancing in a queuing service even after the pandemic.

During the formal investigation period, we used the online questionnaire as the primary form. It was adopted with the non-probability method of snowball sampling for all citizens in China. To enhance the objectivity of the results, we conducted offline questionnaires simultaneously. Because of the problems of omission, indiscriminate filling and overfilling in the online questionnaire, the online survey samples initially had to be screened. The initial screening criteria included the following: (1) incomplete questions; (2) questions that were filled with obvious regularity, such as a category between 1 and 5; 1, 2, 3, 4, 5; or 5, 4, 3, 2, 1. If the sample after the initial screening had certain credibility, the second round of screening was conducted. At this stage, when there was a sizeable gap between the answers selected for the same or similar items for a given sample, the response was removed from consideration.

We sent questionnaires to about 1200 people, and eventually 1064 valid samples were obtained, with a response rate of 88.67%. The 1064 effective samples, 57.52% females and 42.48% males, showed a balanced generation ratio. The interviewees were from Hebei Province, Hubei Province, Guangdong Province, and 28 other provinces (municipalities directly under the Central Government of China). The age proportion structure of young, middle age, and older adults was fairly balanced. In summary, the participants of the conducted survey represented the current population characteristics of the entire country. Figure 2a–d show a summary of the demographic characteristics, including gender, age, epidemic situation, and province distribution of the respondents who filled in the online survey. Note that the epidemic situation refers to whether there was an epidemic in the participant's community prior to the time of the survey (i.e., before January 2021).

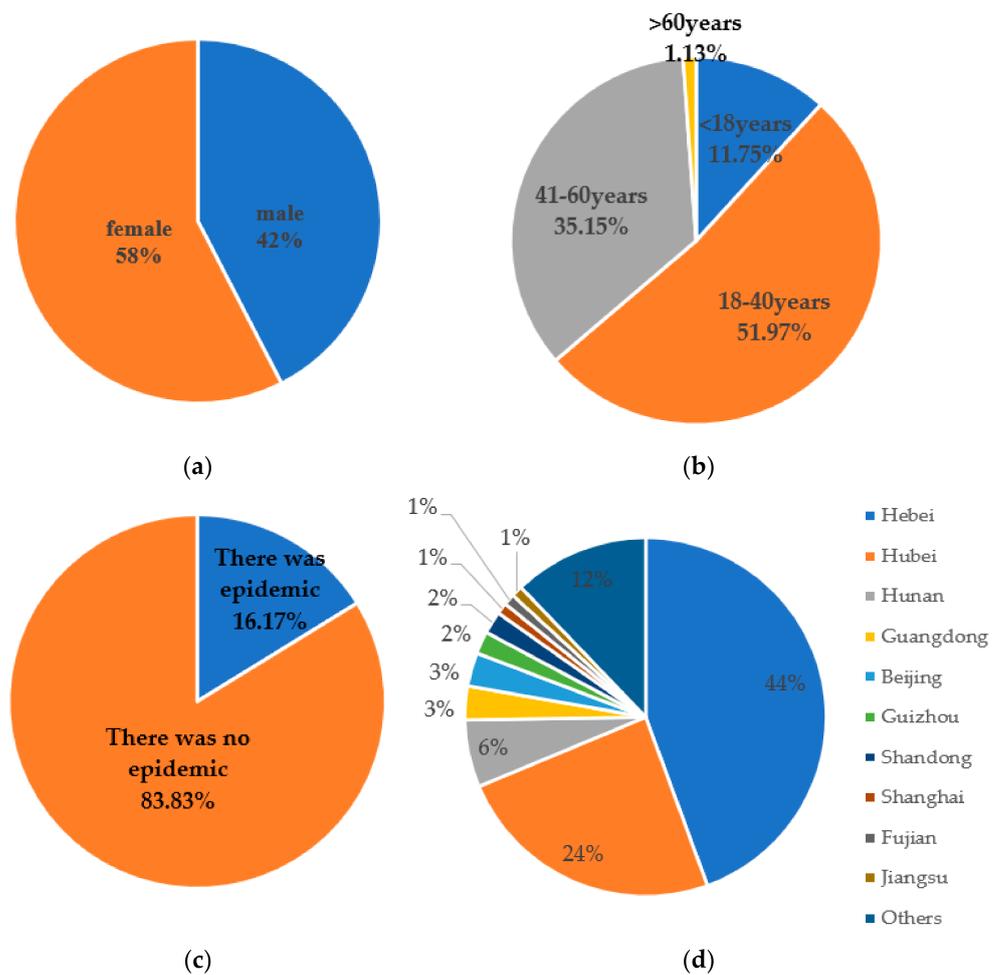


Figure 2. (a) Gender distribution. (b) Age distribution. (c) The epidemic situation in the respondent's community. (d) Province distribution.

Note that the studies relying on self-reported surveys may suffer from a common method bias (i.e., variations in responses result from the survey instrument, not from participant intentions). In this study, the program control method was adopted to reduce the common method bias, namely, the control of the source of the bias. The following strategies were mainly implemented [44]: (1) The prediction and criterion variables were measured from different sources; (2) appropriate separation of predictive variables and response variables in time (measurement spacing), space (different environments), psychology (insertion of stories), and methodology (pen and paper, computer, Internet, interview, scale form); (3) the anonymity of respondents was protected, and the guessing of the purpose of measurement was reduced; (4) the sequential effects of projects were balanced; and (5) the scale items were improved after the pre-survey.

3.2. Analysis Methods

According to the study hypotheses, there was a complicated correlation between variables. We tested the hypotheses with structural equation modeling to explore the impact of independent variables on dependent variables and the mediating effect correlation between the variables. The hypotheses were validated based on the outcomes from the structural equation modeling. Structural equation modeling has been widely applied in recent studies [45]. The developed model is equipped with the capability to consider and handle multiple observed variables and latent variables simultaneously. Before constructing the structural equation model, the reliability and validity of data were tested using

SPSS 22.0. The path analysis, mediating effect test, and moderating effect analysis were performed via structural equation modeling executed using Amos 24.0.

4. Study Results

4.1. Reliability and Validity Tests

The reliability and validity tests for the recovered data were performed using SPSS 22.0. As shown in Table 2, the Cronbach's α coefficient of RP, PG, ReP, and SOB was over 0.7, indicating an acceptable reliability level and high internal consistency [46]. This analysis was followed by the validity test with the confirmatory factors. Notably, the factor load value exceeded 0.5 for all the independent variables considered [47]. The congeneric reliability (CR) and the average variance extracted (AVE) are viewed as representative metrics for evaluation of the construct validity. The CR and AVE values exceeded ~ 0.70 and ~ 0.50 (see Table 2), which can be considered as acceptable [48]. Based on these analyses, the reliability and validity of the data were found to be satisfactory. Therefore, the structural equation modeling (SEM) analysis could be further carried out to draw managerial implications.

Table 2. Results of the reliability and validity analysis.

Variable	Code	Factor				Cronbach's α	CR	AVE
		1	2	4	5			
Risk Perception (RP)	RP1		0.834			0.727	0.8937	0.6284
	RP2		0.820					
	RP3		0.780					
	RP4		0.837					
	RP5		0.682					
Public Guidance (PG)	PG1				0.711	0.794	0.6847	0.5207
	PG2				0.732			
Regulation Punishment (ReP)	ReP1			0.727		0.757	0.7909	0.4872
	ReP2			0.658				
	ReP3			0.639				
	ReP4			0.761				
Social Distancing Obedience Behavior (SOB)	SOB1	0.675				0.833	0.8351	0.4597
	SOB2	0.756						
	SOB3	0.586						
	SOB4	0.633						
	SOB5	0.655						
	SOB6	0.747						

4.2. SEM Analysis

The primary structural equation model was built within the Amos 24.0 environment. Since the initial model fitting effect may not be at the appropriate level, the goodness of the model fitting should be improved. As the reliability and validity tests for the recovered data demonstrated acceptable outcomes, the measurable variable index of latent variables was not modified, and only the covariance correction index was modified. This was why we added e1-e19. Following the principle of releasing one parameter at a time, the hypothesis model was modified one by one, until the optimal model was obtained.

We conducted an evaluation test for the hypothesis models with the maximum likelihood estimate (MLE). The fitting degree between each hypothesis model and evaluation indexes such as χ^2/df , goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), root-mean-square residual (RMR), root-mean-square error of approximation (RMSEA), comparative fit index (CFI), non-standardized fit index (NFI), Tucker–Lewis index (TLI), parsimony adjusted measures index (PNFI), and parsimony goodness-of-fit index (PGFI) were selected. The results from the conducted analysis are summarized in Table 3. It

can be observed that the fitting values of all the considered indexes met the standard requirements (shown in the second column of Table 3). Such results demonstrate a high degree of accuracy for the developed SEM model. A detailed structure of the developed SEM is illustrated in Figure 3. Note that Figure 3 explores potential correlations among all the exogenous variables according to the Amos model. On the other hand, Figure 1 shows just the correlations between certain variables based on the hypotheses considered.

Table 3. Goodness-of-fit indexes summary of the SEM.

Index	Fitting Standard	Fitting Value
χ^2/df	≤ 3.00	3.259
GFI	≥ 0.80	0.963
AGFI	≥ 0.80	0.947
RMR	≤ 0.05 (Good)	0.050
RMSEA	≤ 0.1 (Reasonable)	0.046
CFI	≥ 0.90	0.955
NFI	≥ 0.90	0.937
TLI	≥ 0.90	0.942
PNFI	≥ 0.50	0.724
PGFI	≥ 0.50	0.661

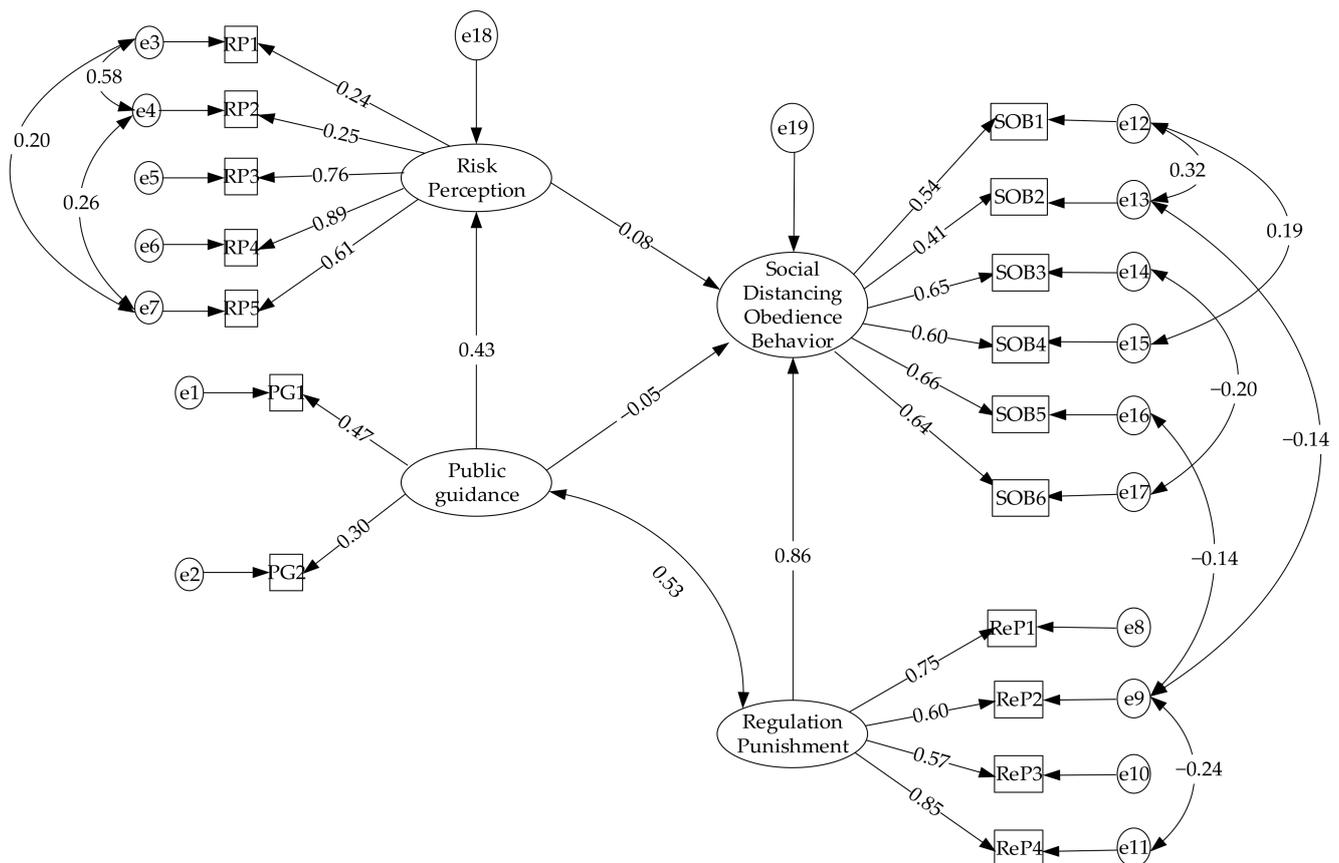


Figure 3. SEM model.

4.3. Empirical Results

4.3.1. Path Analysis

As a part of this study, Hypotheses 1, 2, 3, and 5 were examined via the path analysis. Based on the results from the path analysis (Table 4), there is a substantial positive correlation between PG and RP as well as between RP and SOB and ReP and SOB. The p -value between PG and SOB was 0.481 (>0.05), without showing any significant correlation. Thus, hypothesis 1 is not supported, while Hypotheses 2, 3, and 5 are supported.

Table 4. Results of the SEM path analysis.

Path	Non-Standardized Path Coefficient	Standardized Path Coefficient	S.E.	C.R.	p
PG→RP	0.376	0.434	0.086	4.358	0.000 ***
PG→SOB	−0.091	−0.050	0.130	−0.705	0.481
RP→SOB	0.169	0.080	0.083	2.036	0.042 *
ReP→SOB	0.855	0.858	0.065	13.115	0.000 ***

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Furthermore, throughout the analysis, it was found that PG in the path test imposes a negative impact on SOB, which is potentially attributed to the distrust of the public to the media propaganda. However, new technologies and media are yet to be tested in such a large-scale pandemic. Media can provide excessive public guidance via various channels that might further trigger negative emotions from the public and cause distrust [49]. Nevertheless, the public guidance positively affects risk perception of individuals, as they become more aware of the pandemic status and consequences. This finding confirmed hypothesis 2.

Hypotheses 3 and 5 were supported by the finding that RP and ReP both promote SOB. How people perceive the risk of the pandemic is a crucial premise for them to take self-protection measures. Individuals that are aware of the severity of the pandemic and the risk to their health remain alert and adopt social distancing among other protection measures. Meanwhile, particular social distancing regulations and punishment for noncompliance with these regulations in public sites were found as compulsory solutions that would effectively improve social distancing obedience behavior.

4.3.2. Mediating Effect Assessment

Hypothesis 4 was analyzed by means of bootstrapping, which is viewed as a common approach for evaluation of mediating hypotheses [50]. The mediating effect of RP between PG and SOB was tested by repeated sampling across 5000 sub-samples. The concept model for the RP mediating effect assessment is presented in Figure 4. The results from the conducted analysis show that there were no zero values among 95% confidence intervals (see Table 5), which supports hypothesis 4. Therefore, RP can be considered as a mediator between PG and SOB. However, such a mediating effect can be viewed as partial only. In particular, RP can enhance the effects of PG on SOB. However, PG alone cannot encourage SOB, which resulted in rejection of hypothesis 1 (see Section 4.3.1 of the manuscript).

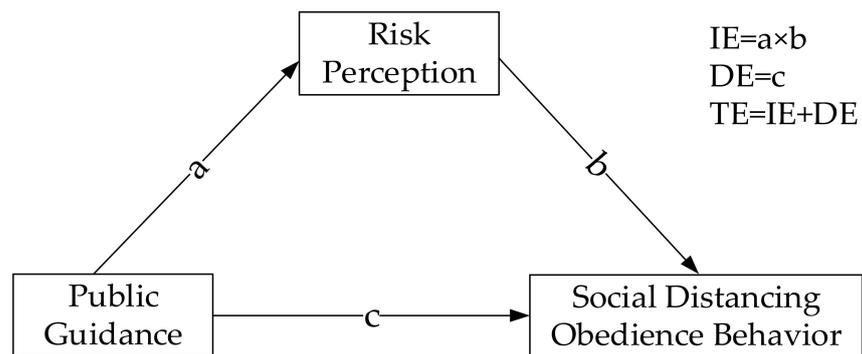


Figure 4. Mediating effect model.

Table 5. Mediating effect test (bootstrapping 5000 times).

Path	Effect	Effect Value	S.E.	Bootstrapping 95%			Effect Proportion
				Lower Bound	Upper Bound	p	
Public guidance–Risk Perception–Obedience Behavior	Total Effect (TE)	0.527	0.166	0.274	0.943	0.000 ***	-
	Indirect Effect (IE)	0.101	0.049	0.035	0.247	0.001	19.17
	Direct Effect (DE)	0.426	0.156	0.202	0.848	0.001	80.83

Note: *** $p < 0.001$.

4.3.3. Moderating Effect Assessment

Multicollinearity refers to the high correlation between explanatory variables in the linear regression model, which makes the model estimation distorted or difficult to conduct accurately. In this study, SPSS 22.0 was used to conduct the multicollinearity analysis with a stepwise regression method. It is generally believed that if tolerance < 0.2 or variance inflation factor (VIF) > 5 , the problem of multicollinearity among independent variables should be considered [51]. As shown in Table 6, the tolerance and VIF values of independent variables indicate that there is no collinearity among the independent variables.

Table 6. Interactive effect path analysis.

Path	Non-Standardized Path Coefficient	Standardized Path Coefficient	S.E.	C.R.	p	Collinearity Statistics	
						Tolerance	VIF
RP→SOB	0.091	0.125	0.023	3.958	0.000 ***	0.976	1.025
ReP→SOB	0.743	0.861	0.042	17.853	0.000 ***	0.976	1.025
RP × ReP→SOB	−0.256	−0.108	0.103	−2.5	0.012 *	1.000	1.000

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

The latent variable interaction model was adopted in this study to assess the moderating effect of ReP. The latent variable interaction model is a widely used method for assessing the latent variable interaction effects in psychology, behavior, management, economics, and other fields. With the imitation of the continuous explicit variable interaction model [52], the following structural equation with latent variables ζ_1 and ζ_2 was adopted in this study [53]:

$$\eta = \gamma_1\zeta_1 + \gamma_2\zeta_2 + \gamma_3\zeta_1\zeta_2 + \zeta \tag{1}$$

For the same index of the two latent variables, the observed variables of RP5 were canceled to generate a load calculation by the confirmative factor analysis in Amos 24.0. According to the standard load, the observed variables matched according to the principle of “big for big and small for small”, forming interactive items. The developed latent variable interaction model is shown in Figure 5. The path of interactive items was found to

be significant as a result of the conducted analysis (see Table 6). Thus, the ReP moderating effect was significant. In addition, we conducted a simple slope analysis for a more direct presentation of the moderating effect (see Table 7). The effect of the high score was 0.017 (−0.063 ~ 0.085, $p = 0.676$), whereas that of the low score was 0.233 (0.089 ~ 0.424, $p = 0.001$). A breakdown of the ReP moderating effect is outlined in Figure 6, where it can be observed that regulation punishment encourages social distancing obedience behavior of the public even further by enhancing their risk perception. Hence, the social distancing obedience behavior can be effectively achieved by introducing the punishment measures for noncompliance and enhancing the public risk perception regarding the COVID-19 epidemic. Therefore, hypothesis 6 is supported.

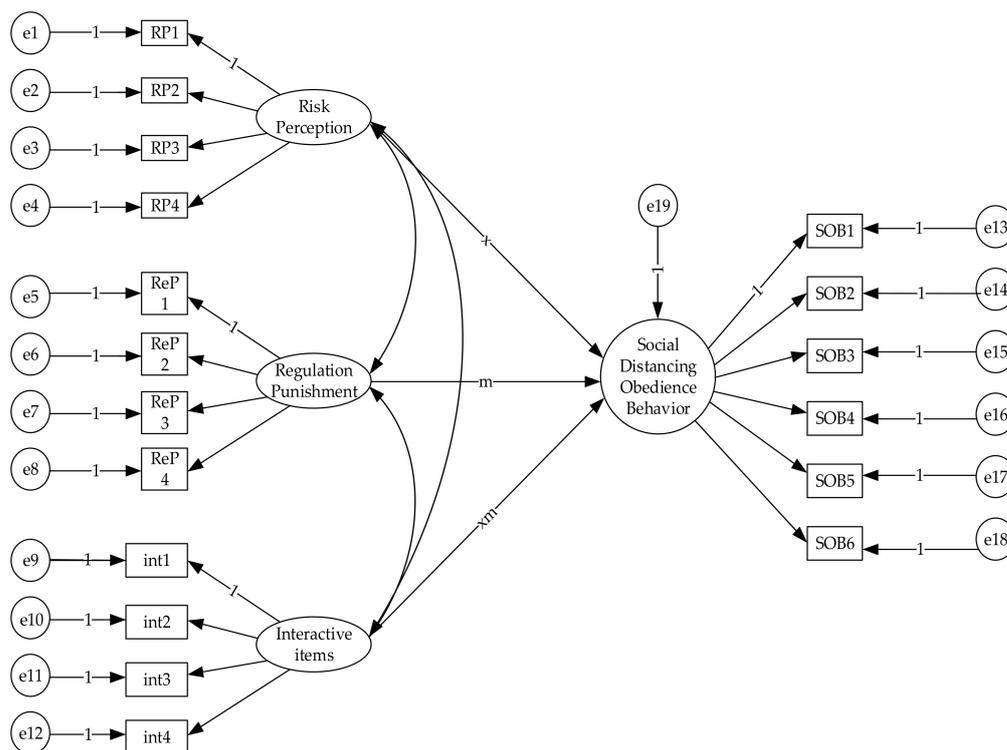


Figure 5. Interactive effect model.

Table 7. Simple slope analysis.

Parameter	Estimate	Lower	Upper	<i>p</i>
high	−0.118	−0.552	0.049	0.224
mean	0.091	0.044	0.154	0.001
low	0.3	0.066	0.784	0.006
std_high	0.017	−0.063	0.085	0.676
std_mean	0.125	0.06	0.205	0.001
std_low	0.233	0.089	0.424	0.001

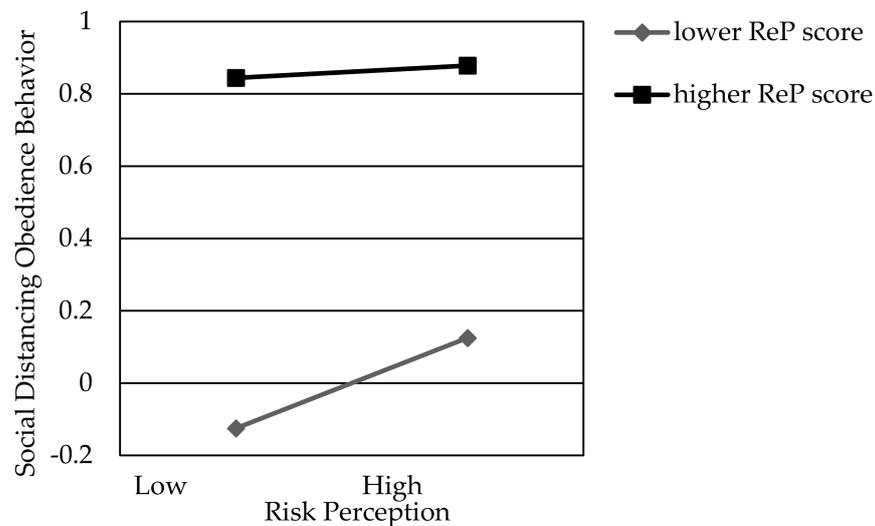


Figure 6. Breakdown of the ReP moderating effect.

5. Recommendations

Through the empirical analysis, this study demonstrated that public guidance, risk perception, and regulation punishment are the influencing factors for social distancing obedience behavior. The public guidance on social distancing by the media and government can enhance risk perception of the public. In consequence, risk perception has a mediating effect, which further enhances social distancing obedience behavior of the public. Furthermore, there is a dual effect of regulation punishment on social distancing obedience behavior. It can directly push social distancing obedience behavior of the public through compulsory measures. Regulation punishment can also encourage social distancing obedience behavior of the public even further by enhancing their risk perception. Hence, this study proposes the following recommendations to facilitate social distancing during the COVID-19 post-epidemic period in China.

5.1. Effective Public Guidance

The government and media should have an effective public guidance. This will help the public to have more faith in the government and media compared to other communication methods. Therefore, the government and media should develop innovative strategies for promoting social distancing behavior among individuals. This objective can be achieved by using alternative media methods (such as WeChat, Weibo and TikTok) to promote social distancing obedience behavior [54]. This would improve the public understanding of the importance of social distancing for prevention of the COVID-19 spread during the epidemic period and post-epidemic era.

5.2. Enhance Risk Perception

Employers should facilitate social distancing obedience at work sites through particular measures (e.g., signs enforcing social distancing and wearing masks at all times if there are positive cases of COVID-19 in the surrounding area) to shape a specific atmosphere and enhance risk perception among workers. These should be integrated with physical and non-physical measures along with the deployment of the appropriate technology [55]. For instance, physical space separation in the office and canteens is a widely adopted approach. More focus should be geared towards the application of non-physical measures, such as flexible working mechanisms and the addition of telecommuting. Without such measures, some manufacturing enterprises would face new challenges to resume and maintain operation during the pandemic period. These requirements will prompt the development of correspondent systems and allow production environments and workflows to meet the requirements of physical distance [56].

5.3. Punishment Measures If Necessary

Setting a social distancing rule in public sites and punishment for those who do not follow the regulations would be an effective alternative. Although China has no compulsory measures regarding social distancing, such policies have been implemented in foreign countries, such as France and Switzerland [57]. As in other countries, the public could take photographs and report through the appropriate channel anybody who does not follow the social distancing requirements. A fine could be then imposed for the individuals who do not comply with the established social distancing requirements.

6. Conclusions

The aim of this study was to comprehensively assess the potential effects of public guidance, risk perception, and regulation punishment on social distancing obedience behavior. A detailed survey was conducted in this study by collecting data from 1064 Chinese residents in January 2021 by means of a questionnaire. Structural equation modeling and hierarchical linear regression analyses were employed to investigate the research hypotheses considered. The outcomes from the conducted analyses showed that the public guidance significantly affected risk perception of individuals, while risk perception had a positive impact on social distancing obedience behavior. Moreover, risk perception was found to play a mediating role in the relationship between the public guidance and social distancing obedience behavior. In addition, the regulation punishment with positively predicted social distancing obedience behavior can have an even greater effect by enhancing risk perception. In terms of comparison between other population subgroups and the general Chinese population, a study in India found a significant correlation between risk perception and knowledge among dental students [58]. This study verifies the promoting effect of public guidance on the risk perception of Chinese people, which is similar to the study in India. In terms of comparison of social distancing with other behaviors, a study in the US showed that participatory dialogue, behavioral confidence, and changes in the physical environment are key influencing factors of hand-washing behavior among college students [59].

This study can provide a theoretical basis and a decision-making reference for policy formulation, social constraints, media publicity, and public opinion guidance during the COVID-19 post-epidemic period. In addition, the results from this study are not limited to just social distancing for COVID-19 prevention and control only but could also provide a useful resource for the prevention mechanisms of other major public health emergencies around the world.

However, there are still several limitations to this study. First, the samples from Hebei and Hubei provinces were fairly large, while participants from some autonomous regions and special administrative regions were not included. Secondly, the missing data and abnormal data were simply discarded without further analysis. More comprehensive approaches for dealing with missing and abnormal data can be considered as a part of future research. Furthermore, social distancing in this study is defined as a spatial physical distance, which does not extend to social culture and ethics.

In future research, the concept of social distancing can be further explored, and interdisciplinary research can be carried out. Social distancing is strongly correlated with the psychological state of individuals and has been applied in the fields of virus infection, biology, management, and others in the epidemic period to carry out cross-disciplinary research. The involvement of psychology experts would enable better understanding of potential human factors that might influence social distancing obedience behavior. A wide range of sociodemographic characteristics of individuals (e.g., age, gender, education, income, marital status) can also be explored to better understand their effects on social distancing obedience behavior. In addition, with the development of deep learning and computer vision technology, it would be possible to carry out real-time monitoring of people's social distancing obedience behavior with the help of target recognition algorithms, such as FASTER region-based convolutional neural networks (R-CNNs), single shot detec-

tion (SSD), spatial pyramid pooling (SPP-net) and You Only Look Once (YOLO). Last but not least, a comprehensive multi-agent simulation model could be developed to accurately emulate real-life scenarios and social distancing obedience behavior of individuals residing in a particular area.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data available in a publicly accessible repository that does not issue DOIs. Publicly available datasets were analyzed in this study. This data can be found here: [Questionnaire data.sav]

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References

- Lewnard, J.A.; Lo, N.C. Scientific and ethical basis for social-distancing interventions against COVID-19. *Lancet Infect. Dis* **2020**, *20*, 631–633. [CrossRef]
- Fong, M.; Gao, H.; Wong, J.; Xiao, J.; Shiu, E.; Ryu, S.; Cowling, B. Nonpharmaceutical Measures for Pandemic Influenza in Nonhealthcare Settings—Social Distancing Measures. *Emerg. Infect. Dis.* **2020**, *26*, 976–984. [CrossRef]
- Malay, D.S.; MSCE; FACFAS. COVID-19, Pandemic, and Social Distancing. *J. Foot Ankle Surg.* **2020**, *59*, 447–448. [CrossRef]
- Arumuru, V.; Pasa, J.; Samantaray, S.S.; Varma, V.S. Breathing, virus transmission, and social distancing—An experimental visualization study. *AIP Adv.* **2021**, *11*, 045205. [CrossRef]
- Bhanot, S.; Hopkins, D.J. Partisan Polarization and Resistance to Elite Messages: Results from a Survey Experiment on Social Distancing. Available online: <https://ssrn.com/abstract=3593450> (accessed on 5 May 2020). [CrossRef]
- Xie, K.; Liang, B.; Song, Y.; Dong, X. Analysis of walking-edge effect in train station evacuation scenarios: A sustainable transportation perspective. *Sustainability* **2019**, *11*, 7188. [CrossRef]
- Khan, A.G.; Rahman, M.N.; Kamruzzaman, M.; Mahmood, M.; Uddin, M.A. Quality of life in the COVID-19 outbreak: Influence of psychological distress, government strategies, social distancing, and emotional recovery. *Heliyon* **2021**, *7*, 1–8. [CrossRef] [PubMed]
- Teslya, A.; Pham, T.M.; Godijk, N.G.; Kretzschmar, M.E.; Rozhnova, G. Impact of self-imposed prevention measures and short-term government-imposed social distancing on mitigating and delaying a COVID-19 epidemic: A modelling study. *PLoS Med.* **2020**, *17*, e1003166. [CrossRef]
- Gouin, J.P.; Macneil, S.; Switzer, A.; Carrese-Chacra, E.; Durif, F.; Knuper, B. Socio-demographic, social, cognitive, and emotional correlates of adherence to physical distancing during the COVID-19 pandemic: A cross-sectional study. *J. Public Health* **2021**, *112*, 17–28.
- Zhang, Y.; Zhou, R. Promoting social distancing and preventing panic buying during the epidemic of COVID-19: The contributions of people's psychological and behavioural factors. *J. Public Health* **2021**, *349*, 1–15.
- Herman, K.; Drozda, L. Green infrastructure in the time of social distancing: Urban policy and the tactical pandemic urbanism. *Sustainability* **2021**, *13*, 1632. [CrossRef]
- Henry, B.F. Social distancing and incarceration: Policy and management strategies to reduce COVID-19 transmission and promote health equity through decarceration. *Health Educ. Behav.* **2020**, *47*, 536–539. [CrossRef] [PubMed]
- Dale, W.; Katharina, H.; Richard, A. Infection prevention behavior and infectious disease modelling: A review of the literature and recommendations for the future. *BMC Public Health* **2018**, *18*, 336–352.
- Lim, C.Y.; Bohn, M.K.; Lippi, G.; Ferrari, M.; Loh, T.P.; Yuen, K.-Y.; Adeli, K.; Horvath, A.R. Staff rostering, split team arrangement, social distancing (physical distancing) and use of personal protective equipment to minimize risk of workplace transmission during the COVID-19 pandemic: A simulation study. *Clin. Biochem.* **2020**, *86*, 15–22. [CrossRef] [PubMed]
- Vokó, Z.; Pitter, J.G. The effect of social distance measures on COVID-19 epidemics in Europe: An interrupted time series analysis. *GeroScience* **2020**, *42*, 1075–1082. [CrossRef]

16. Cano, O.B.; Morales, S.C.; Bendtsen, C. COVID-19 modelling: The effects of social distancing. *Interdiscip. Perspect. Infect. Dis.* **2020**, *1*, 1–7. [CrossRef]
17. Lang, B.C.; Cashin, M.; Thorp, K.; Barrick, T.; Leong-Kee, S. Social distancing simulation during the COVID-19 health crisis. *BMJ Simul. Technol. Enhanc. Learn* **2021**, *7*, 171–172. [CrossRef]
18. Okuonghae, D.; Omame, A. Analysis of a mathematical model for COVID-19 population dynamics in Lagos, Nigeria. *Chaos Solitons Fractals* **2020**, *139*, 1–25. [CrossRef]
19. Keskinocak, P.; Oruc, B.E.; Baxter, A.; Asplund, J.; Serban, N. The impact of social distancing on COVID19 spread: State of Georgia case study. *PLoS ONE* **2020**, *15*, e0239798. [CrossRef]
20. Mushayabasa, S.; Ngarakana-Gwasira, E.T.; Mushanyu, J. On the role of governmental action and individual reaction on COVID-19 dynamics in South Africa: A mathematical modelling study. *Inform. Med. Unlocked* **2020**, *20*, 1–8. [CrossRef] [PubMed]
21. Anderson, R.M.; Heesterbeek, H.; Klinkenberg, D.D.; Hollingsworth, T.D. Comment How will country-based mitigation measures influence the course of the COVID-19 epidemic? *Lancet* **2020**, *395*, 931–934. [CrossRef]
22. Huang, N.E.; Qiao, F. A data driven time-dependent transmission rate for tracking an epidemic: A case study of 2019-nCoV. *Sci. Bull.* **2020**, *65*, 425–427. [CrossRef]
23. Castex, G.; Dechter, E.; Lorca, M. COVID-19: The impact of social distancing policies, cross-country analysis. *Econ. Dis. Cli. Cha.* **2020**, *7066*, 1–25.
24. Farboodi, M.; Jarosch, G.; Shimer, R.J.; Internal and External Effects of Social Distancing in a Pandemic (April 2020). NBER Working Paper No. w27059. Available online: <https://ssrn.com/abstract=3586191> (accessed on 1 May 2021).
25. Jason, R.; Gunawan, A. Forecasting Social Distancing impact on COVID-19 in Jakarta using SIRD Model. *Procedia Comput. Sci.* **2021**, *179*, 662–669. [CrossRef] [PubMed]
26. Gralinski, L.E.; Menachery, V.D. Return of the coronavirus: 2019-nCoV. *Viruses* **2020**, *12*, 135. [CrossRef]
27. Xie, K.; Liang, B.; Dulebenets, M.A.; Mei, Y. The impact of risk perception on social distancing during the COVID-19 pandemic in China. *Int. J. Environ. Res. Public Health* **2020**, *17*, 6256. [CrossRef] [PubMed]
28. Nerlich, B.; Jaspal, R. Social representations of ‘social distancing’ in response to COVID-19 in the UK media. *Curr. Sociol.* **2021**, *69*, 566–583. [CrossRef]
29. Huynh, T.L. The COVID-19 risk perception: A survey on socioeconomics and media attention. *Econ. Bull.* **2020**, *40*, 758–764.
30. Eden, A.L.; Johnson, B.K.; Reinecke, L.; Grady, S.M. Media for coping during COVID-19 social distancing: Stress, anxiety and psychological well-being. *Front. Psychol.* **2020**, *11*, 1–38. [CrossRef] [PubMed]
31. Olagoke, A.A.; Olagoke, O.O.; Hughes, A.M. Exposure to coronavirus news on mainstream media: The role of risk perceptions and depression. *Brit. J. Health Psych.* **2020**, *25*, e12427–e12437. [CrossRef] [PubMed]
32. Brambilla, M.; Leach, C.W. On the importance of being moral: The distinctive role of morality in social judgment. *Soc. Cogn.* **2014**, *32*, 397–408. [CrossRef]
33. Assche, J.V.; Politi, E.; Dessel, P.V.; Phalet, K. To punish or to assist? Divergent reactions to ingroup and outgroup members disobeying social distancing. *Brit. J. Health Psych.* **2020**, *59*, 1–13.
34. Michie, S.; West, R.; Rogers, M.B.; Bonell, C.; Amlôt, R. Reducing SARS-CoV-2 transmission in the UK: A behavioural science approach to identifying options for increasing adherence to social distancing and shielding vulnerable people. *Brit. J. Health Psych.* **2020**, *25*, 12428–12440. [CrossRef]
35. Wilder-Smith, A.; Freedman, D.O. Isolation, quarantine, social distancing and community containment: Pivotal role for old-style public health measures in the novel coronavirus (2019-nCoV) outbreak. *J. Travel Med.* **2020**, *27*, 1–4. [CrossRef] [PubMed]
36. Lamming, D.W.; Carter, C.S. Maintaining a scientific community while social distancing. *Transl. Med. Aging* **2020**, *4*, 55–59. [CrossRef] [PubMed]
37. Lcer, S.; Yilmaz-Aslan, Y.; Brzoska, P. Lay perspectives on social distancing and other official recommendations and regulations in the time of COVID-19: A qualitative study of social media posts. *BMC Public Health* **2020**, *20*, 963–972.
38. Ainslie, K.; Walters, C.E.; Han, F.; Bhatia, S.; Riley, S. Evidence of initial success for China exiting COVID-19 social distancing policy after achieving containment. *Wellcome Open Res.* **2020**, *5*, 81–88. [CrossRef] [PubMed]
39. Artino, A.R.; La Rochelle, J.S.; Dezee, K.J.; Gehlbach, H. Developing questionnaires for educational research: AMEE Guide. No. 87. *Med. Teach.* **2014**, *36*, 463–474. [CrossRef]
40. Dionne, G.; Desjardins, D.; Lebeau, M.; Messier, S.; Dascal, A. ‘Health care workers’ risk perceptions and willingness to report for work during an influenza pandemic. *Risks* **2018**, *6*, 8. [CrossRef]
41. Kim, B.; Yoon, E.J.; Kim, S.; Dong, K.L. The effects of risk perceptions related to particulate matter on outdoor activity satisfaction in South Korea. *Int. J. Environ. Res. Public Health* **2020**, *17*, 1613. [CrossRef]
42. Ye, M.; Lyu, Z. Trust, risk perception, and COVID-19 infections: Evidence from multilevel analyses of combined original dataset in China—ScienceDirect. *Soc. Sci. Med.* **2020**, *265*, 1–10. [CrossRef]
43. Prachthauser, M.; Cassisi, J.E.; Le, T.A. The social distancing scale (v1): A screening instrument to assess patient adherence to prevention strategies during pandemics. *Int. J. Environ. Res. Public Health* **2020**, *17*, 8158. [CrossRef]
44. Kock, F.; Berbekova, A.; Assaf, A.G. Understanding and managing the threat of common method bias: Detection, prevention and control. *Tour. Manag.* **2021**, *86*, 104330. [CrossRef]
45. Tarka, P. An overview of structural equation modeling: Its beginnings, historical development, usefulness and controversies in the social sciences. *Qual. Quant.* **2018**, *52*, 313–354. [CrossRef] [PubMed]

46. Mohajan, H.K. Two Criteria for Good Measurements in Research: Validity and Reliability. *Econ. Ser.* **2017**, *17*, 59–82. [[CrossRef](#)]
47. Nunnally, J.; Bernstein, I. *Psychometric Theory*, 3rd ed.; McGraw-Hill: New York, NY, USA, 1994; pp. 536–574.
48. Jacobucci, R.; Grimm, K.J.; Mcardle, J.J. Regularized Structural Equation Modeling. *Struct. Equ. Modeling* **2016**, *23*, 555. [[CrossRef](#)] [[PubMed](#)]
49. Wiederhold, B.K. Social media use during social distancing. *Cyberpsych. Beh. Soc. N* **2020**, *23*, 275–276. [[CrossRef](#)]
50. Coutts, J.J.; Hayes, A.F.; Jiang, T. Easy Statistical Mediation Analysis with Distinguishable Dyadic Data. *J. Commun.* **2019**, *69*, 612–649. [[CrossRef](#)]
51. Tara, K. Reply: 3M—Multicollinearity, mediators, and moderators. *J. Thorac. Cardio. Sur.* **2021**, *162*, 1–27.
52. Toothaker, L.E. Multiple regression: Testing and interpreting interactions. *J. Oper. Res. Soc.* **1994**, *45*, 119–120.
53. Algina, J.; Moulder, B.C. A note on estimating the Joreskog-Yang Model for latent variable interaction using LISREL 8.3. *Struct. Equ. Modeling* **2001**, *8*, 40–52. [[CrossRef](#)]
54. Shen, L.; Yao, R.; Zhang, W.; Evans, R.; Cao, G. Emotional attitudes of Chinese citizens on social distancing during the COVID-19 outbreak: Analysis of social media data. *JMIR Med. Inf.* **2021**, *9*, e27079. [[CrossRef](#)] [[PubMed](#)]
55. Kim, E.A. Social distancing and public health guidelines at workplaces in Korea: Responses to COVID-19. *SH W* **2020**, *11*, 275–283.
56. Ji, Y.N.; Seong, H.; Jin, G.Y.; Song, J.Y.; Kim, W.J. Social distancing against COVID-19: Implication for the control of influenza. *J. Korean Med. Sci.* **2020**, *35*, e182.
57. Vo, H.L.; Hao, N.; Nguyen, K.N.; Nguyen, H.L.T.; Le, H.T. Adherence to Social Distancing Measures for Controlling COVID-19 Pandemic: Successful Lesson From Vietnam. *Front. Public Health* **2020**, *8*, 589900. [[CrossRef](#)] [[PubMed](#)]
58. Batra, K.; Urankar, Y.; Batra, R.; Aaron, F.G.; Meru, S.; Kaurani, P. Knowledge, Protective Behaviors and Risk Perception of COVID-19 among Dental Students in India: A Cross-Sectional Analysis. *Healthcare* **2021**, *9*, 574. [[CrossRef](#)]
59. Sharma, M.; Batra, K.; Davis, R.E.; Wilkerson, A.H. Explaining Handwashing Behavior in a Sample of College Students during COVID-19 Pandemic Using the Multi-Theory Model (MTM) of Health Behavior Change: A Single Institutional Cross-Sectional Survey. *Healthcare* **2021**, *9*, 55. [[CrossRef](#)] [[PubMed](#)]