



BMJ Open is committed to open peer review. As part of this commitment we make the peer review history of every article we publish publicly available.

When an article is published we post the peer reviewers' comments and the authors' responses online. We also post the versions of the paper that were used during peer review. These are the versions that the peer review comments apply to.

The versions of the paper that follow are the versions that were submitted during the peer review process. They are not the versions of record or the final published versions. They should not be cited or distributed as the published version of this manuscript.

BMJ Open is an open access journal and the full, final, typeset and author-corrected version of record of the manuscript is available on our site with no access controls, subscription charges or pay-per-view fees (<http://bmjopen.bmj.com>).

If you have any questions on BMJ Open's open peer review process please email [info.bmjopen@bmj.com](mailto:info.bmjopen@bmj.com)

# BMJ Open

## How can the uptake of preventive behavior during the COVID-19 outbreak be improved? An online survey of 4827 Chinese residents

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2020-042954
Article Type:	Original research
Date Submitted by the Author:	21-Jul-2020
Complete List of Authors:	Mao, Yimeng; Fudan University, School of Public Health Chen, Hao; Fudan University, School of Public Health Wang, Yi; Fudan University, School of Public Health Chen, Suhong; Fudan University, School of Public Health Gao, Junling; Fudan University, School of Public Health Dai, Junming; Fudan University, School of Public Health Jia, Yingnan; Fudan University, School of Public Health Xiao, Qianyi; Fudan University, School of Public Health Zheng, P; Fudan University, School of Public Health Fu, Hua; Fudan University, School of Public Health
Keywords:	PREVENTIVE MEDICINE, COVID-19, EPIDEMIOLOGY, PUBLIC HEALTH, Public health < INFECTIOUS DISEASES

SCHOLARONE™  
Manuscripts



I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our [licence](#).

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which [Creative Commons](#) licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

# How can the uptake of preventive behavior during the COVID-19 outbreak be improved? An online survey of 4827 Chinese residents

Yimeng Mao<sup>1</sup>, Hao Chen<sup>1</sup>, Yi Wang<sup>1</sup>, Suhong Chen<sup>1</sup>, Junling Gao<sup>1</sup>, Junming Dai<sup>1</sup>, yingnan Jia<sup>1</sup>, Qianyi Xiao<sup>1\*</sup>, Pinpin Zheng<sup>1\*</sup>, Hua Fu<sup>1</sup>,

<sup>1</sup> School of Public Health, Fudan University, Shanghai, China, 200032

\*co-corresponding author

Address correspondence to Qianyi Xiao, PhD, School of Public health, Fudan University, NO.130 Dongan Road, Shanghai 200032, P.R. China. or Pinpin Zheng, PhD, School of Public health, Fudan University, NO.130 Dongan Road, Shanghai 200032, P.R. China.

mail addresses: qianyi0505@163.com or zpinpin@shmu.edu.cn

## Abstract

**Objectives** The aims of this study were to assess the uptake of preventive behavior (UPB) during the coronavirus disease 2019 (COVID-19) outbreak and to investigate the factors influencing the UPB based on the theory of planned behavior.

**Design, setting and participants** A cross-sectional online survey was conducted among Chinese residents aged  $\geq 18$  years and 4827 participants from 31 provinces and autonomous regions were included in the current study. UPB, attitude towards the spread of COVID-19 and preventive behavior (ATT), subjective norms (SN), perceived behavioral control (PBC), demographic characteristics and the information attention and processing mode were measured. Multivariate logistic regressions were used to identify associations between the potential influencing factors and UPB.

**Results** Of the respondents, 52.8% reported high UPB. Multivariate analyses demonstrated that ATT, SN and PBC were significantly correlated with UPB, and PBC was the strongest influencing factor (OR=3.58,  $P < 0.001$ ). Furthermore, systematic information processing mode was positively associated with high UPB compared with heuristic information processing mode (OR=2.08,  $P < 0.001$ ).

**Conclusions** Additionally, married and urban respondents had higher UPB than those who were not married and living in rural areas, respectively. These findings are helpful for developing education and interventions to promote high UPB and enhance public health outcomes during a pandemic.

**Keywords:** COVID-19, uptake of preventive behavior, China, theory of planned behavior

**Strengths and limitations of this study**

- We established a conceptual model based on the theory of planned behavior (TPB) to explore the factors correlated with the uptake of preventive behavior (UPB) during the COVID-19.
- Information attention and systematic information processing mode regarding the pandemic were helpful for promoting high UPB, which may provide references for epidemic control in other countries.
- Online survey was used for rapid assessment, which may have resulted in selection bias.
- The survey was completed in the relatively short-time period so the results may not reflect the long-term practice of preventive measures.
- The measurement accuracy heavily depends on respondents' ability or willingness to recall their behaviors, which may be underreported or overreported.

**1. Introduction:**

The World Health Organization (WHO) declared the coronavirus disease (COVID-19) outbreak a pandemic on March 11, 2020. By June 10, 2020, 7,805,148 confirmed cases of COVID-19 and 431,192 deaths had been reported globally<sup>[1]</sup>. In the absence of a vaccine to prevent COVID-19, the best way to prevent illness is to avoid being exposed to the virus. Early in the outbreak of COVID-19, the Chinese government, the Chinese Center for Disease Control and Prevention (CDC), and local health departments implemented measures to control the transmission of COVID-19, including isolation and quarantine, contact tracing of persons with COVID-19, and community containment.

Additionally, measures related to improved personal hygiene were widely publicized in the media as a way to prevent infection. The greatest gains in health come through behavioral change. Several

studies have reported that transmission may occur early in the course of infection<sup>[2]</sup> and that persons who show no signs or symptoms of respiratory infection nevertheless shed SARS-CoV-2<sup>[3-4]</sup>. In addition, the communicable period can be up to three weeks, and communicated patients could develop severe illness<sup>[5]</sup>. Under such circumstances, several institutions, including the WHO, the Chinese CDC and the US CDC, recommend that the general public take preventive actions to prevent the spread of respiratory diseases, such as avoiding travel to high-risk areas and contact with individuals who are symptomatic, washing hands frequently with soap and water, and wearing a mask if coughing or sneezing<sup>[6-8]</sup>. In China, considering that China's population density is much higher than that in most other countries, which increases the likelihood of virus transmission, the Chinese CDC and National Health Commission of the People's Republic of China additionally recommended wearing masks when out in public, decreasing communication and avoiding nonessential excursions<sup>[9]</sup>. All these findings and official recommendations indicate that individual behavior is essential in controlling the pandemic. Hence, it is important to investigate the factors influencing people's uptake of preventive behavior (UPB) to minimize the spread of COVID-19. The theory of planned behavior (TPB), which has been widely applied to explain many types of behaviors<sup>[10-11]</sup>, suggests that one's intention is the most important predictor leading to behavior and is determined by three direct factors: attitude towards the behavior (ATT, a favorable or unfavorable evaluation of the particular behavior), subjective norms (SN, perceived social pressure to perform or not perform the behavior), and perceived behavioral control (PBC, the perception of self-efficacy with respect to the ability to perform the behavior)<sup>[10, 12-13]</sup>. Previous studies based on the TPB have demonstrated that ATT, SN, and PBC have a significant positive influence on self-isolation during a pandemic emergency<sup>[14]</sup>. Furthermore, the TPB model was reported to explain 51.7% ( $p < .001$ ) of the variance in A/H1N1 vaccine intentions<sup>[15]</sup>, and the extended TPB could predict 60% of adults' intention to receive the swine flu vaccine<sup>[16]</sup>. In addition, several other factors may affect the UPB. The information processing mode can interact with social media to influence people's perception formation<sup>[17]</sup> and then affect behavior; sociodemographic characteristics such as gender<sup>[18-20]</sup> and education<sup>[21]</sup> were also reported to affect attitudes and behaviors related to pandemics.

To date, few studies in the health context have investigated the factors influencing UPB during the

COVID-19 outbreak. Considering the global spread of COVID-19, we aim to investigate the factors related to UPB based on the TPB to identify ways to promote the UPB among the public and provide a reference for epidemic control in other countries.

**2. Method**

**2.1 Design and Participants**

This cross-sectional online survey was conducted through the Wenjuanxing platform (<https://www.wjx.cn/app/survey.aspx>) from Jan 31 to Feb 2, 2020. The survey took approximately 10 minutes to complete, and an item with required answer was established to avoid the return of invalid questionnaires. Chinese residents aged  $\geq 18$  years were invited through social media to participate in the survey. In total, 5,851 surveys were returned. After information sorting and cleaning, we removed the participants who returned incomplete questionnaires, who spent fewer than 5 minutes completing the questionnaires, and who failed to select an answer as required. Finally, 4827 participants from 31 provinces and autonomous regions were included in the current study. The survey and consent documents were approved by the Institutional Review Board of Fudan University, School of Public Health (IRB#2020-01-0800).

**2.2 Patient and Public Involvement statement**

Some participants were invited to help design the questionnaires and the survey pilot initially in pilot survey, but they were not involved in the recruitment, conduct, reporting or dissemination plans. The results of the survey have already been disseminated to all participants via website and WeChat, especially behavioral advice for prevention of COVID-19.

**2.3 Conceptual Model and Measurements**

We established a conceptual model to explore the factors correlated with the UPB based on the TPB. The resources and opportunities available to a person, such as the availability of masks, to some extent dictate the likelihood of intended and actual behavior<sup>[22]</sup>. Hence, we added other potential influencing factors as normative variables to the TPB (see Figure 1). We added “attitude towards COVID-19 outbreak” to the ATT section because it could directly influence the attitude towards

preventive behavior<sup>[23-24]</sup>. We divided SN section into two levels of social pressure: concern about COVID-19 among relatives and friends and public preventive action. Three questions related to self-efficacy were used to assess PBC<sup>[25]</sup>.

UPB, ATT, SN, PBC and the information attention and processing mode were measured by questionnaires. The detailed information of survey questions, variable description and processing were shown in Table 1.

## 2.4 Statistical analyses

The chi-square test was applied to determine the prevalence of the UPB by the categorical variables, including demographic characteristics, ATT, SN, PBC, degree of attention to COVID-19 and the information processing mode. Multivariate logistic regression analyses were used to assess the association between the potential influencing factors and the UPB after controlling for related characteristic covariates. Adjusted ORs and their 95% confidence intervals (CIs) were used to quantify the effects. SPSS software version 22.0 (SPSS, Inc., Chicago, Illinois, US) was used to carry out all analyses. All tests were two-sided, and  $P < 0.05$  was considered statistically significant.

## 3. Results

### *Descriptive statistics*

Among the 5,851 questionnaires returned, 4827 (82.5%) were valid, reflecting a response rate of 83.27%. We additionally excluded 294 participants who could not buy masks. Ultimately, 4,533 participants were included in the analysis. Table 2 provides descriptive statistics for the characteristics of the respondents. Overall, the mean age of the respondents was  $32.45 \pm 9.971$  years (range 18-85), and almost half of respondents were between the ages of 21 and 30. Of the participants, 68.1% were women. The majority of the respondents (62.1%) had a bachelor's degree or a college education. More than half of respondents (55.0%) were married. Only 5.3% were medical staff, and 2.7% had a history of travel to Hubei Province (the high risk areas of COVID-19 outbreak). Approximately 82.0% lived in urban areas, and 18.0% reported that someone in their community was suspected or confirmed to have COVID-19.

Regarding preventive behavior, 75.1% of the respondents reported that they wore masks when going outside, 66.1% washed their hands frequently, 66.0% avoiding talking to or touching others, and 73.0% avoided unnecessary use of public transportation. Overall, 52.8% of participants reported high UPB. As shown in Table 2, the proportion of high UPB among men (51.0%) was lower than that among women (53.6%). The UPB was also influenced by age, with those 31 to 50 years old accounting for the highest proportion of high UPB and those younger than 20 accounting for the lowest proportion of high UPB. Education was also an influencing factor, with the highest proportion of high UPB observed among respondents with a high school education and the lowest proportion among respondents with a master's degree. Respondents from urban areas reported a significantly higher proportion of high UPB than those from rural areas (53.9% vs 47.5%). Respondents who had a history of travel to Hubei Province (53.4%) reported a higher proportion of high UPB than others (45.7%).

*Association of the UPB with influencing factors based on the TPB*

Table 3 shows that ATT, SN and PBC are important factors influencing the UPB ( $P < 0.001$ ). However, regarding ATT, there was no difference in the UPB between respondents with completely positive attitudes or partially positive attitudes ( $P = 0.068$ ). Additionally, attention to COVID-19 and the information processing mode were also significantly associated with UPB. Respondents who paid more attention to COVID-19 or whose tendency was toward systematic information processing were more likely to exhibit high UPB ( $P < 0.001$ ).

As shown in Table 4, multivariate logistic regression analysis was used to test the influencing factors associated with the UPB. For ATT, compared with those with partially positive attitudes, respondents with completely positive attitudes towards preventive behavior (OR=1.41, 95%CI: 1.19-1.66) or towards the risk of COVID-19 (OR=1.70, 95%CI: 1.49-1.94) had increased adjusted odds of high UPB. Regarding SN, greater concern about COVID-19 among relatives and friends (OR=1.43, 95%CI: 1.19-1.72) and a higher proportion of public precaution (Most vs Half and less than half: OR=1.47, 95%CI: 1.11-1.94, All vs Half and less than half: OR=1.66, 95%CI: 1.23-2.24, OR=1.47, 95%CI: 1.11-1.94, respectively) increased the adjusted odds of high UPB. PBC was the strongest influencing factor of UPB. Respondents with high self-efficacy in preventing COVID-19 were 3.59 times more likely to have a high UPB than those with low self-efficacy (OR=3.59, 95%CI: 3.14-4.10).

Furthermore, there are also several other influencing factors of UPB. Respondents who engaged more in systematic information processing (SIP) mode were more likely to have high UPB than those engaged more in Heuristic information processing (HIP) mode and HS-equivalent information processing mode (SIP vs HIP: OR=2.08, 95%CI: 1.61-2.69, HS-equivalent vs HIP: OR=1.78, 95%CI: 1.35-2.34). Increased attention to COVID-19 was significantly associated with increased adjusted odds of high UPB (1-3 h vs <1 h: OR=1.18, 95%CI: 0.99-1.39 and > 3 h vs <1 h: OR=1.40, 95%CI: 1.18-1.66). Additionally, married and urban respondents had higher UPB than those who were not married and living in rural areas (OR=1.25, 95%CI: 1.05-1.48, and OR=1.21, 95%CI: 1.01-1.44, respectively).

We also compared the characteristics of the respondents reporting that they could obtain masks and those reporting that they could not (Table 5). The results indicated that respondents who were male, over 31 years old, not married or from a rural area were more likely to report that masks were not available ( $P < 0.05$ ).

#### 4. Discussion

In the present study, we demonstrate that 52.8% of participants reported high UPB, with full compliance with wearing masks in public, frequent hand washing, avoidance of talking to or touching others and avoidance of unnecessary public transportation use. We also built a conceptual model based on the TPB to investigate the potential factors influencing the UPB during a pandemic. The results show that ATT, SN, and PBC have significant influences on UPB. Information processing mode, attention to the pandemic and several sociodemographic characteristics also influenced high UPB.

The results showed that ATT, SN, and PBC have significant positive influences on the UPB in the context of COVID-19, which was consistent with a previous study that reported the positive influence of ATT, SN, and PBC on self-isolation during the pandemic<sup>[14]</sup>. Of these three considered factors, PBC (self-efficacy with respect to preventing COVID-19) was the strongest predictor. Respondents with high self-efficacy regarding preventing COVID-19 were 3.6 times more likely to have high UPB than those with low self-efficacy. This result supports previous studies indicating that self-efficacy will result in protection motivation leading to changes in attitudes, perceptions, or behaviors<sup>[26]</sup>. For ATT, compared with a partially positive attitude, a completely positive attitude towards preventive behavior

or towards the risk of COVID-19 was significantly associated with high UPB. However, the degree of agreement with the likelihood of self-infection was not associated with high UPB in a multivariable analysis. Consistent with our findings, Kim also reported that the perceived likelihood of getting sick (cognitive element) was not strongly associated with preventive behaviors, whereas perceived concern (emotional element) was significantly associated with precautionary and preparatory behaviors<sup>[27]</sup>. One possible reason is that the population is generally susceptible due to the highly contagious nature of the virus<sup>[28]</sup>; therefore, people's judgments of the severity of the pandemic better reflect their awareness and precautions.

It is worth noting that the information processing mode was a pivotal factor influencing the UPB during the COVID-19 outbreak. Respondents who engaged more in SIP were twice as likely to intend to take a high level of preventive behavior against COVID-19 than those who engaged in HIP. SIP requires greater attention to acquiring information<sup>[29]</sup>, so people engaged more in SIP will have greater risk awareness due to the evaluation of information and then uptake of preventive actions. However, this result should be interpreted in a specific context or situation, such as the COVID-19 pandemic, as people were unfamiliar and uninformed regarding the infectious disease. As Trumbo mentioned, the notion that only rational and systematic judgement can lead to suitable actions, avoidance of inadequate actions or unnecessary overreactions to risk needs to be reexamined<sup>[30]</sup>. Additionally, information processing is an important component of health literacy, which can be understood as the capacity of individuals to obtain, process, and understand basic health information to make decisions to maintain health and improve quality of life<sup>[31]</sup>. Hence, it may be an effective way to improve the health literacy and in turn UPB regarding the pandemic through educate the public to evaluate and analyze information (SIP mode) of pandemic.

The sociodemographic characteristic factors should also be given more attention. Our findings suggested that people living in rural areas have a lower proportion of high UPB than those living in urban areas, which may be due to poorer health literacy related to infectious diseases in rural areas than in urban areas<sup>[32]</sup>. Low literacy relates to less knowledge about health, which leads to decreased adherence to positive health behaviors<sup>[33-34]</sup>. Furthermore, marital status is an important social factor associated with human health and longevity<sup>[35-38]</sup>. The marriage protection effect refers to the fact that

married people have more advantages related to family support, including psychological support and health behavior support. Our results support the protective role of marriage in the UPB during the pandemic. All these findings indicated that people living in rural areas and people who are not married should be given more attention in terms of health education and health promotion, and their social, psychological and physiological characteristics should be taken into account. In addition, the issue of mask availability among those who are male, over 31 years old, not married or from rural areas should be taken into account because in this survey, these people reported that masks were not available.

The results of this study should be considered in the light of the following limitations. First, an online survey was used for rapid assessment, which may have resulted in selection bias. For example, some older people with low education levels or serious chronic diseases may not be included in the survey, and more comprehensive investigations are needed. Second, this study relied on cross-sectional survey data to examine the relationships. Therefore, the results of the analyses should be interpreted with care because causal relationships between variables may exist. Third, the survey was completed in the relatively short-time period so the results may not reflect the long-term practice of preventive measures after the survey. Finally, although self-report measures are very convenient and common in some fields of media research<sup>[39]</sup>, the measurement accuracy heavily depends on respondents' ability or willingness to recall their behaviors, which may be underreported or overreported.

## Conclusion

Despite the cited limitations, our results are helpful for developing education and interventions to support health behaviors and enhance outcomes in the public during a pandemic emergency. The results demonstrate that the TPB is a useful framework for future interventions to improve the UPB. ATT, SN, and PBC have significant positive influences on the UPB during a pandemic, with PBC (self-efficacy) playing the most important role. Furthermore, developing education programs focused on improving awareness of SIP and attention to the pandemic are helpful for promoting high UPB during pandemics. Moreover, we suggest that governments and policy makers give more attention and support to people who live rural areas and who are not married, thereby improving their UPB in the pandemic context.

**Declarations**

**Funding**

This work was supported by the National Natural Science Foundation of China [71573047].

**Conflict of interest**

There are no any conflicts.

**Ethics approval and consent to participate**

The Institutional Review Board of Fudan University, School of Public Health (IRB#2020-01-0800), approved the study protocol.

**Availability of data and materials**

The data that support the findings of this study are available from school of public health, Fudan University but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of school of public health, Fudan University.

**Code availability**

SPSS version 22.0 (SPSS, Chicago, IL, USA);

**Authors' contributions**

Pinpin Zheng, Junling Gao, Junming Dai, Yingnan Jia and Hua Fu designed the study and obtained the data. Junling Gao and Junming Dai organized. Yimeng Mao, Yi Wang, Suhong Chen and Hao Chen performed the survey. Yimeng Mao and Qianyi Xiao undertook the data analysis and interpretation supervised by Pinpin Zheng. Qianyi Xiao and Yimeng Mao wrote the manuscript. Pinpin Zheng reviewed and commented on the manuscript. All authors read the final manuscript and agree with the text.

**Acknowledgements:**

We gratefully thank all participants for their cooperation.

Table 1. Description of the variables

Variable	Indicators	Variable Description	Variable processing	Mean $\pm$ SD	Range
Independent variable	Uptake of preventive behavior (UPB)	(1) Since the outbreak of COVID-19, I have been wearing a mask in public.	1= Strongly disagree; 2= Disagree; 3=Neutral; 4=Agree; 5=Strongly agree; Obtain the degree of agreement. Participants who chose 5 (strongly agree) for all four questions were defined as having high UPB.	4.64 $\pm$ 0.505	1-5
		(2) Since the outbreak of COVID-19, I have washed my hands more frequently and thoroughly with soap and water.			
		(3) Since the outbreak of COVID-19, I have avoided nonessential conversation and personal contact with others.			
		(4) Since the outbreak of COVID-19, I have avoided nonessential excursions and public transportation.			
Attitude towards the behavior (ATT)	Attitude towards preventive behavior	(1) Smoking can prevent COVID-19.	1=correct; 0=incorrect; Obtain a binary categorical classification of attitude: completely positive attitude or partially positive attitude. A completely positive attitude was indicated by correct answers to all 6 items.	5.69 $\pm$ 0.807	0-6
		(2) Food must be cooked before it is eaten.			
		(3) The virus mainly infects the elderly, and young people need not be concerned about it.			
		(4) If you do not eat wild animals or seafood, you will not be infected with COVID-19.			
		(5) You must wash your hands when you come in from outside.			
		(6) It is important to eat a balanced diet and maintain a positive mood to prevent infection.			

	Attitude towards COVID-19	How great do you perceive the overall risk of the COVID-19 pandemic to be?	1=No risk at all; 2=Low risk; 3= General risk; 4=Relatively high risk; 5=Very high risk;	Obtain the degree of risk perception of COVID-19: Completely positive attitude = Very high; Partially positive attitude = Relatively high/General/Low/None	4.51±0.647	1-5
		How great do you perceive the risk of infection?		Obtain the degree of perceived personal infection risk: High = Very high/Relatively high; Moderate = General; Low = Low/None	3.00±1.268	1-5
Subjective norms (SN)	Subjective norms	Concern about COVID-19 among relatives and friends.	1=Not worried at all; 2=Not too worried; 3=General; 4=Fairly worried; 5=Very worried;	Obtain the degree of concern about COVID-19: High = Very worried/Fairly worried; Low = General/Not too worried/Not worried at all	4.25±0.781	1-5
		The proportion of others wearing masks in public places.	1=No one; 2=Less than half; 3=Half; 4=Most; 5=All;	Obtain the proportion: Half and less than half = Half/Less than half/No one; Most; All; and Unknown.	4.20±0.643	1-5
Perceived behavioral control (PBC)	Self-efficacy regarding COVID-19 prevention	(1) I can avoid COVID-19 infection.	1=Strongly disagree; 2=Disagree; 3= Neutral; 4=Agree; 5= Strongly agree;	The median of respondents' averaged index (median = 4.0) was used for binary categorical classification (high/low level).	4.15±0.705	1-5
		(2) I know how to avoid COVID-19.				
		(3) I can recover from an infection even if I am infected by COVID-19.				
Information attention and processing mode	Heuristic-systematic processing (HSM)	Heuristic information processing ( HIP )	1=Strongly disagree; 2=Disagree; 3= Neutral; 4=Agree; 5= Strongly agree;	By comparing the means of the two corresponding items, information processing was classified as HIP ( HIP score > SIP score), HS-equivalent (HIP score = SIP score), or SIP (SIP	3.61±0.734	1-6
		(1) I am able to make decisions about COVID-19 based on my existing knowledge without seeking additional information.				

	(2) I can make a fully informed decision about COVID-19 based on my previous experience.	score > HIP score).	
	Systematic information processing ( SIP )		
	(1) When I encounter information about COVID-19, I make an effort to carefully analyze it.		
	(2) When I encounter information about COVID-19, I am likely to stop and think about it.		
Degree of attention to COVID-19	In the past month, how much time did you spend focused on COVID-19 information every day?	1=None; 2= Less than an hour; 3= 1–3 hour; 4= None/Less than an hour, 1–3 hours; 5=More than 5 hours/more than 5 hours;	Obtain the degree of attention: <1 hour = 1; 1–3 hours = 2; 3–5 hours = 3; >3 hours = 3–5 hours/more than 5 hours = 4–5 3.34±1.038 1-5

Table 2. Participants’ characteristics and uptake of preventive behavior (UPB)

	Total N(%)	Low UPB N(%)	High UPB N(%)	$\chi^2$	<i>p</i>
<b>Gender</b>				2.752	0.097
Male	1444(31.9)	708(49.0)	736(51.0)		
Female	3089(68.1)	1433(46.4)	1656(53.6)		
<b>Age(years)</b>				30.255	<0.001
<20	234(5.2)	140(59.8)	94(40.2)		
21-30	2145(47.3)	1058(49.3)	1087(50.7)		
31-40	1236(27.3)	538(43.5)	698(56.5)		
41-50	705(15.6)	304(43.1)	401(56.9)		
>51	213(4.7)	101(47.4)	112(52.6)		
<b>Education</b>				31.925	<0.001
Middle school	240(5.3)	113(47.1)	127(52.9)		
High School	742(16.4)	301(40.6)	441(59.4)		
College	2817(62.1)	1322(46.9)	1495(53.1)		
Master’s degree	734(16.2)	405(55.2)	329(44.8)		
<b>Marital status</b>				55.88	<0.001
Married	2492(55.0)	1052(42.2)	1440(57.8)		
Not married	2041(45.0)	1089(53.4)	952(46.6)		
<b>Occupation</b>				0.014	0.906
Health care worker	239(5.3)	112(46.9)	127(53.1)		
Other	4294(94.7)	2029(47.3)	2265(52.7)		
<b>Province</b>				0.982	0.322
Hubei	124(2.7)	64(51.6)	60(48.4)		
Other	4409(97.3)	2077(47.1)	2332(52.9)		
<b>Area</b>				10.87	0.001
Urban	3719(82.0)	1714(46.1)	2005(53.9)		
Rural	814(18.0)	427(52.5)	387(47.5)		
<b>Community COVID-19 epidemic</b>				4.844	0.184
No COVID-19 cases	3488(76.9)	1626(46.6)	1862(53.4)		
Under medical observation	376(8.3)	191(50.8)	185(49.2)		
Suspected case	242(5.3)	126(52.1)	116(57.9)		
Confirmed case	427(9.4)	198(46.4)	229(53.6)		
<b>Travel to Hubei</b>				7.861	0.005
No	4176(92.1)	1947(46.6)	2229(53.4)		
Yes	357(7.9)	194(54.3)	163(45.7)		

Table 3. Factors influencing the uptake of preventive behavior (UPB)

		Total N(%)	Low level UPB N(%)	High level UPB N(%)	$\chi^2$	<i>p</i>
ATT	<b>Attitude towards preventive behavior</b>				3.33	0.068
	Completely positive	3659(80.7)	1704(46.6)	1955(53.4)		
	Partially positive	874(19.3)	437(50.0)	437(50.0)		
	<b>Risk perception of COVID-19</b>				129.588	<0.001
	High	2586(57.0)	1032(39.9)	1554(60.1)		
	Low	1947(43.0)	1109(57.0)	838(43.0)		
	<b>Perceived personal risk of self-infection</b>				16.995	<0.001
	High	1562(34.5)	712(45.6)	850(54.4)		
	Moderate	1227(27.1)	641(52.2)	586(47.8)		
	Low	1744(38.5)	788(45.2)	956(54.8)		
SN	<b>Concern among relatives and friends</b>				29.264	<0.001
	High	3900(86.0)	1779(45.6)	2121(54.4)		
	Low	633(14.0)	362(57.2)	271(42.8)		
	<b>Other people wearing masks in public places</b>				60.101	<0.001
	Half or less	278(6.1)	174(62.6)	104(37.4)		
	Most	2784(61.4)	1367(49.1)	1417(50.9)		
	All	1266(27.9)	501(39.6)	765(60.4)		
	Unknown	205(4.5)	99(48.3)	106(51.7)		
PBC	<b>Self-efficacy</b>				443.284	<0.001
	Low	2394(52.8)	1484(62.0)	910(38.0)		
	High	2139(47.2)	657(30.7)	1482(69.3)		
Information attention and processing mode	<b>Attention on COVID-19</b>				32.712	<0.001
	<1 hour	1009(22.3)	531(52.6)	478(47.4)		
	1-3hour	1764(38.9)	868(49.2)	896(50.8)		
	>3hour	1760(38.8)	742(42.2)	1018(57.8)		
	<b>Information-processing</b>				16.472	<0.001
	HIP	316(7.0)	182(57.6)	134(42.4)		
	HS-equivalent	1057(23.3)	472(44.7)	585(55.3)		
	SIP	3160(69.7)	1487(47.1)	1673(52.9)		

Table 4. Logistic regression of the uptake of preventive behavior (UPB)

	Variables	B	S.E.	Wald	p	OR	95% CI	
							lower	upper
Demographic characteristics	<b>Age(years)</b>							
	<20			4.917	0.296	1.000		
	21-30	0.279	0.152	3.343	0.067	1.321	0.980	1.781
	31-40	0.159	0.173	0.842	0.359	1.172	0.835	1.646
	41-50	0.251	0.184	1.852	0.174	1.285	0.896	1.844
	>51	0.180	0.222	0.660	0.416	1.197	0.775	1.849
	<b>Education</b>							
	Middle school			6.195	0.103	1.000		
	High School	0.134	0.163	0.673	0.412	1.143	0.830	1.575
	College	0.022	0.153	0.020	0.886	1.022	0.757	1.381
	Master's degree	-0.159	0.171	0.859	0.354	0.853	0.610	1.193
	<b>Area</b>							
	Rural					1.000		
	Urban	0.188	0.090	4.403	0.036	1.207	1.012	1.439
	<b>Marital status</b>							
	Not married					1.000		
	Married	0.219	0.088	6.131	0.013	1.245	1.047	1.480
ATT	<b>Travel to Hubei</b>							
	No					1.000		
	Yes	0.231	0.120	3.684	0.055	1.260	0.995	1.596
	<b>Risk perception of COVID-19</b>							
	Low					1.000		
	High	0.529	0.067	62.378	<0.001	1.698	1.489	1.937
	<b>Perceived personal risk of infection</b>							
	Low			0.034	0.983	1.000		
	Moderate	-0.008	0.079	0.010	0.921	0.992	0.849	1.159
	High	0.008	0.082	0.009	0.924	1.008	0.858	1.184
SN	<b>Attitude towards preventive behavior</b>							
	Completely positive attitude					1.000		
	Partially positive attitude	0.340	0.085	16.142	<0.001	1.405	1.190	1.658
	<b>Concern among relatives and friends</b>							
	Low					1.000		
	High	0.356	0.095	14.047	<0.001	1.427	1.185	1.719
	<b>Other people wearing masks in public places</b>							
	Half and less than half			11.717	0.008			
	Most	0.385	0.142	7.400	0.007	1.470	1.114	1.941
	All	0.508	0.152	11.170	0.001	1.661	1.234	2.237
PBC	Unknown	0.486	0.203	5.735	0.017	1.625	1.092	2.419
	<b>Self-efficacy</b>							
	Low					1.000		
Information attention and processing mode	High	1.278	0.068	354.789	<0.001	3.588	3.142	4.098
	<b>Information processing</b>							
	HIP			31.931	<0.001	1.000		
	HS-equivalent	0.575	0.141	16.770	<0.001	1.778	1.350	2.342
	SIP	0.733	0.131	31.118	<0.001	2.082	1.609	2.694

Attention to COVID-19							
<1 hour			15.753	<0.001	1.000		
1-3 hours	0.162	0.086	3.564	0.059	1.175	0.994	1.390
>3 hours	0.335	0.086	15.188	<0.001	1.398	1.181	1.655

Table 5. Characteristics of respondents reporting the availability or unavailability of masks

	Total (n= 4649)	Masks are available (n=4533)	Masks are not available (n=294)	$\chi^2$	<i>p</i>
<b>Gender</b>				7.292	0.007
Male	1560(31.9)	1444(92.6)	116(7.4)		
Female	3089(68.1)	3089(94.6)	178(5.4)		
<b>Age(years)</b>				19.154	0.001
<20	256(5.3)	234(91.4)	22(8.6)		
21-30	2312(47.9)	2145(92.8)	167(7.2)		
31-40	1288(26.7)	1236(96.0)	52(4.0)		
41-50	749(15.5)	705(94.1)	44(5.9)		
>51	222(4.6)	213(95.9)	9(4.1)		
<b>Education</b>				1.832	0.608
Middle school	257(5.3)	240(93.4)	17(6.6)		
High School	782(16.2)	742(94.9)	40(5.1)		
College	3002(62.2)	2817(93.8)	185(6.2)		
Master's degree	786(16.3)	734(93.4)	52(6.6)		
<b>Marital status</b>				27.955	<0.001
Married	2607(54.0)	2492(95.5)	115(4.4)		
Not married	2220(46.0)	2041(91.9)	179(8.1)		
<b>Occupation</b>				0.794	0.373
Health care worker	251(5.2)	239(95.2)	12(4.8)		
Other	4576(94.5)	4294(93.8)	282(6.2)		
<b>Province</b>				0.508	0.476
Hubei	130(2.7)	124(95.4)	6(4.6)		
Other	4697(97.3)	4409(93.9)	288(6.1)		
<b>Area</b>				33.838	<0.001
Urban	3920(81.25)	3719(94.9)	201(5.1)		
Rural	907(18.8)	814(89.7)	93(10.3)		
<b>Community COVID-19 epidemic</b>				1.822	0.610
No COVID-19 cases	3707(76.80)	3488(94.1)	219(5.9)		
Under medical observation	404(8.37)	376(93.1)	28(6.9)		
Suspected case	262(5.43)	242(92.4)	20(7.6)		
Confirmed case	454(9.41)	427(94.1)	27(5.9)		

References:

1. WHO. Coronavirus(COVID-19) Situation Report. 2020 2020 2020/4/10]https://who.sprinklr.com/

2. Rothe C, Schunk M, Sothmann P, Bretzel G, Froeschl G, Wallrauch C, Zimmer T, Thiel V, Janke C, Guggemos W. Transmission of 2019-nCoV infection from an asymptomatic contact in Germany. NEW ENGL J MED 2020.

3. Hoehl S, Berger A, Kortenbusch M, Cinatl J, Bojkova D, Rabenau H, Behrens P, Böddinghaus B, Götsch U, Naujoks F. Evidence of SARS-CoV-2 infection in returning travelers from Wuhan, China. NEW ENGL J MED 2020.

4. Zou L, Ruan F, Huang M, Liang L, Huang H, Hong Z, Yu J, Kang M, Song Y, Xia J. SARS-CoV-2 viral load in upper respiratory specimens of infected patients. NEW ENGL J MED 2020.

5. Hu Z, Song C, Xu C, Jin G, Chen Y, Xu X, Ma H, Chen W, Lin Y, Zheng Y. Clinical characteristics of 24 asymptomatic infections with COVID-19 screened among close contacts in Nanjing, China. Science China Life Sciences 2020: 1-6.

6. Chinses Centers Disease Control and prevention, Prevention of coronavirus: an authoritative tip from China CDC. ] http://www.chinacdc.cn/jkzt/crb/zl/szkb\_11803/jszl\_2275/202001/t20200125\_211423.html

7. Centers for Disease Control and Prevention (2020) 2019 Novel Coronavirus. ]https://www.cdc.gov/coronavirus/2019-ncov/about/transmission.html.

8. WHO. Novel Coronavirus (2019-nCoV) advice for the public. 2020 ]https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public

9. China NHCO. Health education manual for novel coronavirus infection pneumonia. ]http://www.gov.cn/fuwu/2020-02/10/content\_5476794.html10. Ajzen I. The theory of planned behavior. ORGAN BEHAV HUM DEC 1991, 50(2): 179-211.

11. Armitage CJ, Conner M. Efficacy of the Theory of Planned Behaviour: a meta-analytic review. Br J Soc Psychol 2001, 40(Pt 4): 471-499.

12. Connor M SP. Theory of Planned Behaviour and Health Behaviour. In: Connor M NPB (ed). In Predicting Health Behaviour, 2 edition ed. Oxford University Press, 2005, pp 170-222.

13. Bandura A. Self-efficacy : Toward a Unifying Theory of Behavioral Change. PSYCHOL REV 1977, 84(2): 191-215.

14. Zhang X, Wang F, Zhu C, Wang Z. Willingness to Self-Isolate When Facing a Pandemic Risk: Model, Empirical Test, and Policy Recommendations. Int J Environ Res Public Health 2019, 17(1).

15. Agarwal V. A/H1N1 vaccine intentions in college students: An application of the theory of planned behavior. J AM COLL HEALTH 2014, 62(6): 416-424.

16. Myers LB, Goodwin R. Determinants of adults' intention to vaccinate against pandemic swine flu. BMC PUBLIC HEALTH 2011, 11(1): 15.

17. Lee E, Oh SY. Seek and you shall find? How need for orientation moderates knowledge gain from Twitter use. J COMMUN 2013, 63(4): 745-765.

18. DeLay P. Gender and Monitoring the Response to HIV/AIDS Pandemic. EMERG INFECT DIS 2004, 10(11): 1979-1983.

19. Park JH, Cheong H, Son D, Kim S, Ha C. Perceptions and behaviors related to hand hygiene for the prevention of H1N1 influenza transmission among Korean university students during the peak

- pandemic period. BMC INFECT DIS 2010, **10**(1): 222.
20. Ek S. Gender differences in health information behaviour: a Finnish population-based survey. HEALTH PROMOT INT 2015, **30**(3): 736-745.
  21. Wong LP, Sam I. Public Sources of Information and Information Needs for Pandemic Influenza A(H1N1). J COMMUN HEALTH 2010, **35**(6): 676-682.
  22. Terry DJ, O'Leary JE. The theory of planned behaviour: The effects of perceived behavioural control and self - efficacy. BRIT J SOC PSYCHOL 1995, **34**(2): 199-220.
  23. Fazio RH, Zanna MP. Direct Experience And Attitude-Behavior Consistency. ADV EXP SOC PSYCHOL 1981, **14**: 161-202.
  24. Torre GL, Semyonov L, Mannocci A, Boccia A. Knowledge, attitude, and behaviour of public health doctors towards pandemic influenza compared to the general population in Italy. SCAND J PUBLIC HEALT 2012, **40**(1): 69-75.
  25. Choi D, Yoo W, Noh G, Park K. The impact of social media on risk perceptions during the MERS outbreak in South Korea. COMPUT HUM BEHAV 2017, **72**: 422-431.
  26. Dorsey AM, Miller KI, Scherer CW. Communication, risk behavior, and perceptions of threat and efficacy: A test of a reciprocal model. 1999.
  27. Kim Y, Zhong W, Jehn M, Walsh L. Public risk perceptions and preventive behaviors during the 2009 H1N1 influenza pandemic. DISASTER MED PUBLIC 2015, **9**(2): 145-154.
  28. Zhao S, Lin Q, Ran J, Musa SS, Yang G, Wang W, Lou Y, Gao D, Yang L, He D. Preliminary estimation of the basic reproduction number of novel coronavirus (2019-nCoV) in China, from 2019 to 2020: A data-driven analysis in the early phase of the outbreak. INT J INFECT DIS 2020, **92**: 214-217.
  29. Eagly A, Chaiken S. The psychology of attitudes. Fort Worth, TX: HBJ.: Inc; 1993.
  30. Trumbo CW. Heuristic - systematic information processing and risk judgment. RISK ANAL 1999, **19**(3): 391-400.
  31. Parker RM, Ratzan SC, Lurie N. Health literacy: a policy challenge for advancing high-quality health care. HEALTH AFFAIR 2003, **22**(4): 147-153.
  32. WU Shuang-sheng YPLH. Analysis of status and influence factors of health literacy related to infections diseases in residents of Beijing. Beijing Daxue Xuebao Yi Xue Ban 2012, **44**(04): 607-611.
  33. Guo Y, Logan HL, Dodd VJ, Muller KE, Marks JG, Riley III JL. Health literacy: a pathway to better oral health. AM J PUBLIC HEALTH 2014, **104**(7): e85-e91.
  34. Fleary SA, Joseph P, Pappagianopoulos JE. Adolescent health literacy and health behaviors: a systematic review. J ADOLESCENCE 2018, **62**: 116-127.
  35. Goldman N, Hu Y. Excess mortality among the unmarried: a case study of Japan. SOC SCI MED 1993, **36**(4): 533-546.
  36. Shor E, Roelfs DJ, Bugyi P, Schwartz JE. Meta-analysis of marital dissolution and mortality: Reevaluating the intersection of gender and age. SOC SCI MED 2012, **75**(1): 46-59.
  37. Sorlie PD, Backlund E, Keller JB. US mortality by economic, demographic, and social characteristics: the National Longitudinal Mortality Study. AM J PUBLIC HEALTH 1995, **85**(7): 949-956.
  38. Davis MA, Murphy SP, Neuhaus JM, Gee L, Quiroga SS. Living arrangements affect dietary quality for US adults aged 50 years and older: NHANES III 1988 - 1994. The Journal of nutrition 2000, **130**(9): 2256-2264.
  39. De Vreese CH, Neijens P. Measuring media exposure in a changing communications environment.: Taylor & Francis; 2016.

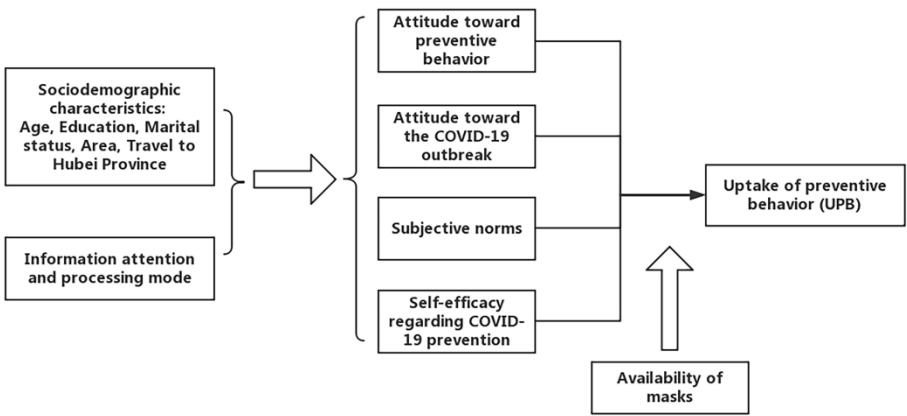


Figure 1. The Theory of Planned Behavior

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page No
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	1-2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2-3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4-5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	9
Study size	10	Explain how the study size was arrived at	4-5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5, 13-15
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	5
		(b) Describe any methods used to examine subgroups and interactions	5
		(c) Explain how missing data were addressed	Didn’t have missing data
		(d) If applicable, describe analytical methods taking account of sampling strategy	Not applicable
		(e) Describe any sensitivity analyses	20
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5
		(b) Give reasons for non-participation at each stage	5
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	5,

		(b) Indicate number of participants with missing data for each variable of interest	Didn't have missing data
Outcome data	15*	Report numbers of outcome events or summary measures	5-7, 16-20
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	5-7, 16-20
		(b) Report category boundaries when continuous variables were categorized	5-7, 16-20
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	5-7, 16-20
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	20
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	7-9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	9
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	7-9
Generalisability	21	Discuss the generalisability (external validity) of the study results	7-9
<b>Other information</b>			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	4

\*Give information separately for exposed and unexposed groups.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).

# BMJ Open

## How can the uptake of preventive behavior during the COVID-19 outbreak be improved? An online survey of 4827 Chinese residents

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2020-042954.R1
Article Type:	Original research
Date Submitted by the Author:	07-Oct-2020
Complete List of Authors:	Mao, Yimeng; Fudan University, School of Public Health Chen, Hao; Fudan University, School of Public Health Wang, Yi; Fudan University, School of Public Health Chen, Suhong; Fudan University, School of Public Health Gao, Junling; Fudan University, School of Public Health Dai, Junming; Fudan University, School of Public Health Jia, Yingnan; Fudan University, School of Public Health Xiao, Qianyi; Fudan University, School of Public Health Zheng, P; Fudan University, School of Public Health Fu, Hua; Fudan University, School of Public Health
<b>Primary Subject Heading</b>:	Public health
Secondary Subject Heading:	Infectious diseases, Public health, Epidemiology
Keywords:	PREVENTIVE MEDICINE, COVID-19, EPIDEMIOLOGY, PUBLIC HEALTH, Public health < INFECTIOUS DISEASES

SCHOLARONE™  
Manuscripts



I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our [licence](#).

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which [Creative Commons](#) licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

# How can the uptake of preventive behavior during the COVID-19 outbreak be improved? An online survey of 4827 Chinese residents

Yimeng Mao<sup>1</sup>, Hao Chen<sup>1</sup>, Yi Wang<sup>1</sup>, Suhong Chen<sup>1</sup>, Junling Gao<sup>1</sup>, Junming Dai<sup>1</sup>, yingnan Jia<sup>1</sup>, Qianyi Xiao<sup>1\*</sup>, Pinpin Zheng<sup>1\*</sup>, Hua Fu<sup>1</sup>,

<sup>1</sup> School of Public Health, Fudan University, Shanghai, China, 200032

\*co-corresponding author

Address correspondence to Qianyi Xiao, PhD, School of Public health, Fudan University, NO.130 Dongan Road, Shanghai 200032, P.R. China. or Pinpin Zheng, PhD, School of Public health, Fudan University, NO.130 Dongan Road, Shanghai 200032, P.R. China.

mail addresses: qianyi0505@163.com or zpinpin@shmu.edu.cn

## Abstract

**Objectives** The aims of this study were to assess the uptake of preventive behavior during the coronavirus disease 2019 (COVID-19) outbreak and to investigate the factors influencing the uptake of preventive behavior based on the theory of planned behavior.

**Design, setting and participants** A cross-sectional online survey was conducted among Chinese residents aged  $\geq 18$  years and 4827 participants from 31 provinces and autonomous regions were included in the current study. Uptake of preventive behavior, attitude towards the spread of COVID-19 and preventive behavior, subjective norms, perceived behavioral control, demographic characteristics and the information attention and processing mode were measured. Multivariate logistic regressions were used to identify associations between the potential influencing factors and uptake of preventive behavior.

**Results** There were 52.8% respondents reported high uptake of preventive behavior. Multivariate analyses demonstrated that attitude towards the behavior, subjective norms and perceived behavioral control were significantly correlated with uptake of preventive behavior, and perceived behavioral control was the strongest influencing factor (OR=4.09, 95%CI: 3.57-4.69). Furthermore, systematic

information processing mode was positively associated with high uptake of preventive behavior compared with heuristic information processing mode (OR=2.16, 95%CI: 1.66-2.81).

**Conclusions** These findings are helpful for developing education and interventions to promote high uptake of preventive behavior and enhance public health outcomes during a pandemic.

**Keywords:** COVID-19, uptake of preventive behavior, China, theory of planned behavior

**Strengths and limitations of this study**

- We referred to the item in the theory of planned behavior (TPB) to choose the potentially influencing factors of the uptake of preventive behavior and explore the predictor of uptake of preventive behavior during the COVID-19
- Information attention and systematic information processing mode regarding the pandemic were helpful for promoting high uptake of preventive behavior, which may provide references for epidemic control in other countries.
- Online survey was used for rapid assessment, which may lead to selection bias.
- The survey was completed in the relatively short-time period so the results may not reflect the long-term practice of preventive measures.
- The measurement accuracy heavily depends on respondents' ability or willingness to recall their behaviors, which may be underreported or overreported.

**1. Introduction:**

The World Health Organization (WHO) declared the coronavirus disease (COVID-19) outbreak a pandemic on March 11, 2020. By June 10, 2020, 7,805,148 confirmed cases of COVID-19 and 431,192 deaths had been reported globally<sup>[1]</sup>. In the absence of a vaccine to prevent COVID-19, the best way to prevent illness is to avoid being exposed to the virus. Early in the outbreak of COVID-19, the Chinese government, the Chinese Center for Disease Control and Prevention (CDC), and local health departments implemented measures to control the transmission of COVID-19, including isolation and quarantine, contact tracing of persons with COVID-19, and community containment.

54 These aggressive measures appear to be successful in reducing the number of deaths and  
55 hospitalizations [2-3], and could keep the disease at a level that does not exceed the capacity of the  
56 health care system[4].

57 Additionally, measures related to improved personal hygiene were widely publicized in the media  
58 as a way to prevent infection. An improved understanding of the drivers of refusal to engage in non-  
59 pharmaceutical interventions (NPIs) may help tailor messaging and increase the chances of eliciting  
60 behavioral change[5]. Several studies have reported that transmission may occur early in the course of  
61 infection[6] and that persons who show no signs or symptoms of respiratory infection nevertheless shed  
62 SARS-CoV-2, the virus that causes COVID-19 [2-3]. In addition, the communicable period, defined as  
63 the interval from the first day of positive nucleic acid tests to the first day of continuous negative tests,  
64 can be up to three weeks, and patients in this communicable period, could develop severe illness.[7].  
65 Under such circumstances, several institutions, including the WHO, the Chinese CDC and the US  
66 CDC, recommend that the general public take preventive actions to prevent the spread of respiratory  
67 diseases, such as avoiding travel to high-risk areas and contact with individuals who are symptomatic,  
68 washing hands frequently with soap and water, and wearing a mask if going out[8-10]. In China,  
69 considering that China's population density is much higher than that in most other countries, which  
70 increases the likelihood of virus transmission, the Chinese CDC and National Health Commission of  
71 the People's Republic of China additionally recommended wearing masks when out in public,  
72 decreasing communication and avoiding nonessential excursions[11]. All these findings and official  
73 recommendations indicate that individual behavior is essential in controlling the pandemic. Hence, it is  
74 important to investigate the factors influencing people's uptake of preventive behavior to minimize the  
75 spread of COVID-19. The theory of planned behavior (TPB), which has been widely applied to explain  
76 many types of behaviors[12-13], suggests that one's intention is the most important predictor leading to  
77 behavior and is determined by three direct factors: attitude towards the behavior (a favorable or  
78 unfavorable evaluation of the particular behavior), subjective norms (perceived social pressure to  
79 perform or not perform the behavior), and perceived behavioral control (the perception of self-efficacy  
80 with respect to the ability to perform the behavior)[12, 14-15]. Previous studies based on the TPB have  
81 demonstrated that attitude towards the behavior, subjective norms, and perceived behavioral control

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

82 have a significant positive influence on self-isolation during a pandemic emergency <sup>[16]</sup>. Furthermore,  
83 the TPB model was reported to explain 51.7% ( $p < .001$ ) of the variance in A/H1N1 vaccine  
84 intentions<sup>[17]</sup>, and the extended TPB could predict 60% of adults' intention to receive the swine flu  
85 vaccine<sup>[18]</sup>. In addition, several other factors may affect the uptake of preventive behavior. The  
86 information processing mode can interact with social media to influence people's perception  
87 formation<sup>[19]</sup> and then affect behavior; sociodemographic characteristics such as gender<sup>[20-22]</sup> and  
88 education<sup>[23]</sup> were also reported to affect attitudes and behaviors related to pandemics.

89 To date, few studies in the health context have investigated the factors influencing uptake of  
90 preventive behavior during the COVID-19 outbreak. Considering the global spread of COVID-19, we  
91 aim to investigate the factors related to uptake of preventive behavior referring to the items in TPB to  
92 identify ways to promote the uptake of preventive behavior among the public and provide a reference  
93 for epidemic control in other countries.

94 **2. Method**

95 ***2.1 Design and Participants***

96 This cross-sectional online survey was conducted through the Wenjuanxing platform  
97 (<https://www.wjx.cn/app/survey.aspx>) from Jan 31 to Feb 2, 2020. The survey took approximately 10  
98 minutes to complete, and an item with required answer was established to avoid the return of invalid  
99 questionnaires. Chinese residents aged  $\geq 18$  years were invited through social media to participate in  
100 the survey. Since this online survey was disseminated via website and WeChat, the number of  
101 people that were reached couldn't be acquired. In total, 5,851 surveys were returned. After  
102 information sorting and cleaning, we removed the invalid questionnaires, including those *spent less*  
103 *than 5 minutes completing the questionnaires which based on the entire large questionnaire*  
104 *included 97 items designed by our research team*, and those failed to answer the quality control  
105 questions. Finally, 4827 participants from 31 provinces and autonomous regions were included in the  
106 current study. The survey and consent documents were approved by the Institutional Review Board of  
107 Fudan University, School of Public Health (IRB#2020-01-0800).

## 108 **2.2 Patient and Public Involvement statement**

109 Some participants were invited to help design the questionnaires and attend the pilot survey  
110 separately, but they were not involved in the recruitment, conduct, reporting or dissemination plans.  
111 The results of the survey have already been disseminated to all participants via website and WeChat,  
112 especially behavioral advice for prevention of COVID-19.

## 113 **2.3 Selection of factors related to uptake of preventive behavior and Measurements**

114 Uptake of preventive behavior: As a dependent variable, CPB risk was included in the study to  
115 measure if people uptake the personal precaution against COVID-19. Scales ranging from 1 = I  
116 strongly disagree to 5 = I strongly agree measured people's recent uptake of preventive measures  
117 captured in these four statements: (1) "Since the outbreak of the COVID-19, I have been wearing a  
118 mask in public", (2) "Since the outbreak of the COVID-19, I have washed my hands more frequently  
119 and thoroughly with soap and water", (3) "Since the outbreak of the COVID-19, I have avoided non-  
120 essential conversation and personal contact with others, and (4) "Since the outbreak of the COVID-19,  
121 I have avoided non-essential going out or taking public transportation". Because all the 4 items were  
122 important behaviors to prevent COVID-19, therefore, in this study, only participants who chose 5  
123 (strongly agree) for all four questions were defined as having high uptake of preventive behavior.

124 We explored the factors related to uptake of preventive behavior referring to the items in TPB.  
125 The resources and opportunities available to a person, such as the availability of masks, to some extent  
126 dictate the likelihood of intended and actual behavior<sup>[24]</sup>. In addition, we added other potential  
127 influencing factors. As shown in Figure 1, we added "attitude towards COVID-19 outbreak" to the  
128 attitude towards the behavior section because it could directly influence the attitude towards preventive  
129 behavior<sup>[25-26]</sup>. We divided subjective norms section into two levels of social pressure: concern about  
130 COVID-19 among relatives and friends and public preventive action. Three questions related to self-  
131 efficacy were used to assess perceived behavioral control<sup>[27]</sup>.

132 Uptake of preventive behavior, attitude towards the behavior, subjective norms, perceived  
133 behavioral control and the information attention and processing mode were measured by  
134 questionnaires. The detailed information of survey questions, variable description and processing were

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

135 shown in Table 1. Referring to the items in TPB, the Cronbach’s alpha of all items is 0.6 and the results  
136 of factor analysis was showed in (Table 2). The ROC value is 0 .727 while put in all the factors of the  
137 regression.  
  
138 **2.4 Statistical analyses**  
  
139 The chi-square test was applied to determine the prevalence of the uptake of preventive behavior  
140 by the categorical variables, including demographic characteristics, attitude towards the behavior,  
141 subjective norms, perceived behavioral control, degree of attention to COVID-19 and the information  
142 processing mode. Multivariate logistic regression analyses were applied to assess the association  
143 between the potential influencing factors and the uptake of preventive behavior after controlling for  
144 related characteristic covariates. Adjusted ORs and their 95% confidence intervals (CIs) were used to  
145 quantify the effects. SPSS software version 22.0 (SPSS, Inc., Chicago, Illinois, US) was used to carry  
146 out all analyses. All tests were two-sided, and P < 0.05 was considered statistically significant.  
  
147 **3. Results**  
  
148 *Descriptive statistics*  
  
149 Among the 5,851 questionnaires returned, 4827 (82.5%) were valid, reflecting a completion rate  
150 of 83.27%. We additionally excluded 294 participants who could not buy masks. Ultimately, 4,533  
151 participants were included in the analysis. Table 3 provides descriptive statistics for the characteristics  
152 of the respondents. Overall, the mean age of the respondents was 32.45±9.971 years (range 18-85,  
153 IQR=13), and almost half of respondents were between the ages of 21 and 30. Of the participants,  
154 68.1% were women. The majority of the respondents (62.1%) had a bachelor’s degree or a college  
155 education. More than half of respondents (55.0%) were married. Only 5.3% were medical staff, and  
156 2.7% had a history of travel to Hubei Province (the high risk areas of COVID-19 outbreak).  
157 Approximately 82.0% lived in urban areas, and 18.0% reported that someone in their community was  
158 suspected or confirmed to have COVID-19.  
  
159 Regarding preventive behavior, 75.1% of the respondents reported that they wore masks when  
160 going outside, 66.1% washed their hands frequently, 66.0% avoiding talking to or touching others, and

6

For peer review only - <http://bmjopen.bmj.com/site/about/guidelines.xhtml>

73.0% avoided unnecessary use of public transportation. Overall, 52.8% of participants reported high uptake of preventive behavior. As shown in Table 3, the proportion of high uptake of preventive behavior among men (51.0%) was lower than that among women (53.6%). The uptake of preventive behavior was also influenced by age, with those 31 to 50 years old accounting for the highest proportion of high uptake of preventive behavior and those younger than 20 accounting for the lowest proportion of high uptake of preventive behavior. Education was also an influencing factor, with the highest proportion of high uptake of preventive behavior observed among respondents with a high school education and the lowest proportion among respondents with a master's degree. Respondents from urban areas reported a significantly higher proportion of high uptake of preventive behavior than those from rural areas (53.9% vs 47.5%). Respondents who had a history of travel to Hubei Province (53.4%) reported a higher proportion of high uptake of preventive behavior than others (45.7%).

#### *Association of the uptake of preventive behavior with influencing factors*

As shown in Table 4, multivariable logistic regression analysis was used to test the influencing factors associated with the uptake of preventive behavior. For attitude towards the behavior, compared with those with partially positive attitudes, respondents with completely positive attitudes towards preventive behavior (OR=1.42, 95%CI: 1.16-1.73) or paid attention towards the risk of COVID-19 (OR=1.73, 95%CI: 1.52-1.97) had increased adjusted odds of high uptake of preventive behavior. Regarding subjective norms, a higher proportion of public precaution (Most vs Half and less than half: OR=1.52, 95%CI: 1.15-2.00, All vs Half and less than half: OR=1.67, 95%CI: 1.24-2.25, Unknown vs Half and less than half: OR=1.62, 95%CI: 1.09-2.42, respectively) increased the adjusted odds of high uptake of preventive behavior. Perceived behavioral control was the strongest influencing factor of uptake of preventive behavior. Respondents with high self-efficacy in preventing COVID-19 were 4.09 times more likely to have a high uptake of preventive behavior than those with low self-efficacy (OR=4.09, 95%CI: 3.57-4.69). Furthermore, there are also several other influencing factors of uptake of preventive behavior. Respondents who engaged more in systematic information processing (SIP) mode were more likely to have high uptake of preventive behavior than those engaged more in Heuristic information processing (HIP) mode and HS-equivalent information processing mode (SIP vs HIP: OR=2.16, 95%CI: 1.66-2.81, HS-equivalent vs HIP: OR=1.78, 95%CI: 1.34-2.35). Increased

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

attention to COVID-19 was significantly associated with increased adjusted odds of high uptake of preventive behavior (1-3 h vs <1 h: OR=1.19, 95%CI: 1.01-1.41 and > 3 h vs <1 h: OR=1.39, 95%CI: 1.18-1.65). Additionally, married and urban respondents had higher uptake of preventive behavior than those who were not married (OR=1.25, 95%CI: 1.05-1.49).

We also compared the characteristics of the respondents reporting that they could obtain masks and those reporting that they could not (Table 5). The results indicated that respondents who were male, over 31 years old, not married or from a rural area were more likely to report that masks were not available ( $P < 0.05$ ).

**4. Discussion**

In the present study, we demonstrate that 52.8% of participants reported high uptake of preventive behavior, with full compliance with wearing masks in public, frequent hand washing, avoidance of talking to or touching others and avoidance of unnecessary public transportation use. We explored the potential factors influencing the uptake of preventive behavior during a pandemic referring to the items in TPB. The results show that attitude towards the behavior, subjective norms, and perceived behavioral control have significant influences on uptake of preventive behavior. Information processing mode, attention to the pandemic and several sociodemographic characteristics also influenced high uptake of preventive behavior.

The results showed that attitude towards the behavior, subjective norms, and perceived behavioral control have significant positive influences on the uptake of preventive behavior in the context of COVID-19, which was consistent with a previous study that reported the positive influence of attitude towards the behavior, subjective norms, and perceived behavioral control on self-isolation during the pandemic<sup>[14]</sup>. Of these three considered factors, perceived behavioral control (self-efficacy with respect to preventing COVID-19) was the strongest predictor. Respondents with high self-efficacy regarding preventing COVID-19 were 3.6 times more likely to have high uptake of preventive behavior than those with low self-efficacy. This result supports previous studies indicating that self-efficacy will result in protection motivation leading to changes in attitudes, perceptions, or behaviors<sup>[28]</sup>. For attitude towards the behavior, compared with a partially positive attitude, a completely positive attitude towards

preventive behavior or paid attention towards the risk of COVID-19 was significantly associated with high uptake of preventive behavior. However, the degree of agreement with the likelihood of self-infection was not associated with high uptake of preventive behavior in a multivariable analysis. Consistent with our findings, Kim also reported that the perceived likelihood of getting sick (cognitive element) was not strongly associated with preventive behaviors, whereas perceived concern (emotional element) was significantly associated with precautionary and preparatory behaviors<sup>[29]</sup>. One possible reason is that the population is generally susceptible due to the highly contagious nature of the virus<sup>[30]</sup>; therefore, people's judgments of the severity of the pandemic better reflect their awareness and precautions.

It is worth noting that the information processing mode was a pivotal factor influencing the uptake of preventive behavior during the COVID-19 outbreak. Respondents who engaged more in SIP were twice as likely to intend to take a high level of preventive behavior against COVID-19 than those who engaged in HIP. SIP requires greater attention to acquiring information<sup>[31]</sup>, so people engaged more in SIP will have greater risk awareness due to the evaluation of information and then uptake of preventive actions. However, this result should be interpreted in a specific context or situation, such as the COVID-19 pandemic, as people were unfamiliar and uninformed regarding the infectious disease. As Trumbo mentioned, the notion that only rational and systematic judgement can lead to suitable actions, avoidance of inadequate actions or unnecessary overreactions to risk needs to be reexamined<sup>[32]</sup>. Additionally, information processing is an important component of health literacy, which can be understood as the capacity of individuals to obtain, process, and understand basic health information to make decisions to maintain health and improve quality of life<sup>[33]</sup>. Hence, it may be an effective way to improve the health literacy and in turn uptake of preventive behavior regarding the pandemic through educate the public to evaluate and analyze information (SIP mode) of pandemic.

The sociodemographic characteristic factors should also be given more attention. Our findings suggested that people living in rural areas have a lower proportion of high uptake of preventive behavior than those living in urban areas, which may be due to poorer health literacy related to infectious diseases in rural areas than in urban areas<sup>[34]</sup>. Low literacy relates to less knowledge about health, which leads to decreased adherence to positive health behaviors<sup>[35-36]</sup>. Furthermore, marital

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

status is an important social factor associated with human health and longevity<sup>[37-40]</sup>. The marriage protection effect refers to the fact that married people have more advantages related to family support, including psychological support and health behavior support. Our results support the protective role of marriage in the uptake of preventive behavior during the pandemic. All these findings indicated that people living in rural areas and people who are not married should be given more attention in terms of health education and health promotion, and their social, psychological and physiological characteristics should be taken into account. In addition, the issue of mask availability among those who are male, over 31 years old, not married or from rural areas should be taken into account because in this survey, these people reported that masks were not available.

The results of this study should be considered in the light of the following limitations. Firstly, an online survey was used for rapid assessment, which may have resulted in selection bias. For example, some older people with low education levels or serious chronic diseases may not be included in the survey, and more comprehensive investigations are needed. Secondly, this study relied on cross-sectional survey data to examine the relationships. Therefore, the results of the analyses should be interpreted with care because causal relationships between variables may exist. Thirdly, the survey was completed in the relatively short-time period so the results may not reflect the long-term practice of preventive measures after the survey. Fourthly, although self-report measures are very convenient and common in some fields of media research<sup>[41]</sup>, the measurement accuracy heavily depends on respondents' ability or willingness to recall their behaviors, which may be underreported or overreported. Finally, our survey was based on social-media, which may skew younger, educated, and urban people, in turn may affect the generalizability.

**Conclusion**

Despite the cited limitations, our results are helpful for developing education and interventions to support health behaviors and enhance outcomes in the public during a pandemic emergency. Attitude towards the behavior, subjective norms, and perceived behavioral control have significant positive influences on the uptake of preventive behavior during a pandemic, with perceived behavioral control (self-efficacy) playing the most important role. Therefore, developing education programs focused on improving awareness of SIP and attention to the pandemic are helpful in promoting high uptake of preventive behavior during pandemics.

**274 Declarations**

**275 Funding**

276 This work was supported by the National Natural Science Foundation of China [71573047].

**277 Conflict of interest**

278 There are no any conflicts.

**279 Ethics approval and consent to participate**

280 The Institutional Review Board of Fudan University, School of Public Health (IRB#2020-01-0800),  
281 approved the study protocol.

**282 Availability of data and materials**

283 The data that support the findings of this study are available from school of public health, Fudan  
284 University but restrictions apply to the availability of these data, which were used under license for the  
285 current study, and so are not publicly available. Data are however available from the authors upon  
286 reasonable request and with permission of school of public health, Fudan University.

**287 Code availability**

288 SPSS version 22.0 (SPSS, Chicago, IL, USA);

**289 Authors' contributions**

290 Pinpin Zheng, Junling Gao, Junming Dai, Yingnan Jia and Hua Fu designed the study and obtained the  
291 data. Junling Gao and Junming Dai organized. Yimeng Mao, Yi Wang, Suhong Chen and Hao Chen  
292 performed the survey. Yimeng Mao and Qianyi Xiao undertook the data analysis and interpretation  
293 supervised by Pinpin Zheng. Qianyi Xiao and Yimeng Mao wrote the manuscript. Pinpin Zheng reviewed  
294 and commented on the manuscript. All authors read the final manuscript and agree with the text.

**295 Acknowledgements:**

296 We gratefully thank all participants for their cooperation.

bmjopen-2020-042954 on 16 February 2021. Downloaded from <http://bmjopen.bmj.com/> on April 10, 2024 by guest. Protected by copyright.

Table 1. Description of the variables

Variable		Indicators	Variable Description	Variable processing	Mean ± SD	Range
Independent variable	Uptake of preventive behavior	(1) Since the outbreak of COVID-19, I have been wearing a mask in public.				
		(2) Since the outbreak of COVID-19, I have washed my hands more frequently and thoroughly with soap and water.	1= Strongly disagree;	Obtain the degree of agreement.		
		(3) Since the outbreak of COVID-19, I have avoided nonessential conversation and personal contact with others.	2= Disagree;	Participants who chose 5 (strongly agree) for all four questions were defined as having high uptake of preventive behavior.	4.64±0.505	1-2
		(4) Since the outbreak of COVID-19, I have avoided nonessential excursions and public transportation.	3=Neutral;			
Attitude towards the behavior	Attitude towards preventive behavior	(1) The virus mainly infects the elderly, and young people need not be concerned about it.	4=Agree;			
		(2) If you do not eat wild animals or seafood, you will not be infected with COVID-19.	5=Strongly agree;	Obtain binary categorical classification of attitude: completely positive attitude or partially positive attitude. A completely positive attitude was indicated by agree answers to all 4 items.	0.87±0.334	1-2
		(3) You must wash your hands when you come in from outside.				

		(4) It is important to eat a balanced diet and maintain a positive mood to prevent infection.		
	Attitude towards COVID-19	How great do you perceive the overall risk of the COVID-19 pandemic to be?	1=No risk at all; 2=Low risk; 3=General risk; 4=Relatively high risk; 5=Very high risk;	Obtain the degree of risk perception of COVID-19: Completely positive attitude = Very high; Partially positive attitude = Relatively high/General/Low/None
		How great do you perceive the risk of infection?		Obtain the degree of perceived personal infection risk: High = Very high/Relatively high; Moderate = General/Low = Low/None
Subjective norms	Subjective norms	The proportion of others wearing masks in public places.	1=No one; 2=Less than half; 3=Half; 4=Most; 5=All;	Obtain the proportion: Half and less than half = Half/Less than half/No one; Most; All; and Unknown.
Perceived behavioral control	Self-efficacy regarding COVID-19 prevention	(1) I can avoid COVID-19 infection. (2) I know how to avoid COVID-19.	1=Strongly disagree; 2=Disagree; 3=Neutral; 4=Agree; 5=Strongly agree;	The median of respondents' average index (median = .0) was used for binary categorical classification (high/low level).

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46

Heuristic information processing ( HIP )				
Information attention and processing mode	Heuristic-systematic processing (HSM)	(1) I am able to make decisions about COVID-19 based on my existing knowledge without seeking additional information.		
		(2) I can make a fully informed decision about COVID-19 based on my previous experience.	1=Strongly disagree; 2=Disagree; 3=Neutral; 4=Agree; 5=Strongly agree;	By comparing the means of the two corresponding items, information processing was classified as HIP ( HIP score > SIP score), HS- equivalent (HIP score = SIP score), or SIP (HIP score > HIP score).
		Systematic information processing ( SIP )		
		(1) When I encounter information about COVID-19, I make an effort to carefully analyze it.		
		(2) When I encounter information about COVID-19, I am likely to stop and think about it.		
			1=None; 2= Less than an hour; 3= 1–3 hour; 4= 3–5 hours; 5=More hours; than 5 hours;	Obtain the degree of attention: <1 hour = None/Less than an hour, 1-3 hours = 3–5 hours/more than 5 hours
Degree of attention to COVID-19	In the past month, how much time did you spend focused on COVID- 19 information every day?			3.34±1.038 1-3

Table 2. the results of factor analysis *referring to the items in TPB*

Indicators	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
How great do you perceive the overall risk of the COVID-19 pandemic to be?	0.029	0.045	-0.146	-0.041	0.026	<b>0.882</b>
How great do you perceive the risk of infection?	0.071	-0.209	0.406	-0.049	0.393	<b>0.446</b>
The proportion of others wearing masks in public places.	-0.048	-0.065	-0.083	-0.034	<b>0.801</b>	0.120
I am able to make decisions about COVID-19 based on my existing knowledge without seeking additional information.	-0.092	<b>0.931</b>	0.122	0.087	-0.048	0.002
I can make a fully informed decision about COVID-19 based on my previous experience.	-0.074	<b>0.926</b>	0.152	0.110	-0.059	-0.008
When I encounter information about COVID-19, I make an effort to carefully analyze it.	0.016	0.136	0.108	<b>0.887</b>	0.003	-0.005
When I encounter information about COVID-19, I am likely to stop and think about it.	-0.006	0.050	0.155	<b>0.885</b>	-0.050	-0.057
The virus mainly infects the elderly, and young people need not be concerned about it.	<b>0.695</b>	-0.049	-0.020	-0.001	0.278	-0.120
If you do not eat wild animals or seafood, you will not be infected with COVID-19.	<b>0.476</b>	0.012	-0.122	0.001	0.490	-0.185
You must wash your hands when you come in from outside.	<b>0.798</b>	-0.075	0.000	-0.021	-0.100	0.127
It is important to eat a balanced diet and maintain a positive mood to prevent infection.	<b>0.810</b>	-0.061	0.042	0.029	-0.082	0.079
I can avoid COVID-19 infection.	-0.019	0.134	<b>0.850</b>	0.115	-0.072	-0.025
I know how to avoid COVID-19.	-0.006	0.174	<b>0.804</b>	0.183	-0.080	-0.105

Table 3. Participants’ characteristics and uptake of preventive behavior

	Total N(%)	Low uptake of preventive behavior N(%)	High uptake of preventive behavior N(%)	$\chi^2$	<i>p</i>
<b>Gender</b>				2.752	0.097
Male	1444(31.9)	708(49.0)	736(51.0)		
Female	3089(68.1)	1433(46.4)	1656(53.6)		
<b>Age(years)</b>				30.255	<0.001
<20	234(5.2)	140(59.8)	94(40.2)		
21-30	2145(47.3)	1058(49.3)	1087(50.7)		
31-40	1236(27.3)	538(43.5)	698(56.5)		
41-50	705(15.6)	304(43.1)	401(56.9)		
>51	213(4.7)	101(47.4)	112(52.6)		
<b>Education</b>				31.925	<0.001
Middle school	240(5.3)	113(47.1)	127(52.9)		
High School	742(16.4)	301(40.6)	441(59.4)		
College	2817(62.1)	1322(46.9)	1495(53.1)		
Master’s degree	734(16.2)	405(55.2)	329(44.8)		
<b>Marital status</b>				55.88	<0.001
Married	2492(55.0)	1052(42.2)	1440(57.8)		
Not married	2041(45.0)	1089(53.4)	952(46.6)		
<b>Occupation</b>				0.014	0.906
Health care worker	239(5.3)	112(46.9)	127(53.1)		
Other	4294(94.7)	2029(47.3)	2265(52.7)		
<b>Province</b>				0.982	0.322
Hubei	124(2.7)	64(51.6)	60(48.4)		
Other	4409(97.3)	2077(47.1)	2332(52.9)		
<b>Area</b>				10.87	0.001
Urban	3719(82.0)	1714(46.1)	2005(53.9)		
Rural	814(18.0)	427(52.5)	387(47.5)		
<b>Community COVID-19 epidemic</b>				4.844	0.184
No COVID-19 cases	3488(76.9)	1626(46.6)	1862(53.4)		
Under medical observation	376(8.3)	191(50.8)	185(49.2)		
Suspected case	242(5.3)	126(52.1)	116(57.9)		
Confirmed case	427(9.4)	198(46.4)	229(53.6)		
<b>Travel to Hubei</b>				7.861	0.005
No	4176(92.1)	1947(46.6)	2229(53.4)		
Yes	357(7.9)	194(54.3)	163(45.7)		
<b>Self-rate health</b>					
Poor	254(11.9)	208(8.7)	462(10.2)	12.387	<0.001
Good	1887(88.1)	2184(91.3)	4071(89.8)		

Table 4. Logistic regression of uptake of preventive behavior

		95% CI						
Variables		B	S.E.	Wald	p	OR	lower	upper
Province								
Other						1.000		
Hubei		0.134	0.236	0.322	0.570	1.143	0.720	1.816
Self-rate health								
Poor						1.000		
Good		0.099	0.108	0.845	0.358	1.105	0.893	1.365
Occupation								
Other						1.000		
Health care worker		0.131	0.146	0.805	0.370	1.140	0.856	1.519
Community COVID-19 epidemic								
No COVID-19 cases				2.625	0.453	1.000		
External personality factors	Under medical observation	-0.151	0.119	1.599	0.206	0.860	0.681	1.086
	Suspected case	-0.158	0.147	1.152	0.283	0.854	0.640	1.139
	Confirmed case	0.008	0.113	0.005	0.942	1.008	0.808	1.258
Gender								
Male						1.000		
Female		0.175	0.071	6.174	0.013	1.192	1.038	1.368
Age(years)								
-20				4.397	0.355	1.000		
21-30		0.265	0.154	2.975	0.085	1.304	0.965	1.762
31-40		0.148	0.175	0.720	0.396	1.160	0.823	1.634
41-50		0.219	0.186	1.381	0.240	1.245	0.864	1.794
51-		0.143	0.226	0.400	0.527	1.153	0.741	1.795
Education								

	Middle school			5.479	0.140	1.000		
	High School	0.143	0.166	0.744	0.389	1.153	0.834	1.595
	College	0.034	0.156	0.046	0.829	1.034	0.762	1.404
	Master	-0.136	0.174	0.612	0.434	0.873	0.620	1.228
	<b>Area</b>							
	Rural					1.000		
	Urban	0.170	0.091	3.511	0.061	1.186	0.992	1.417
	<b>Marriage</b>							
	No married					1.000		
	Married	0.221	0.089	6.147	<b>0.013</b>	1.247	1.047	1.486
	<b>Travel to Hubei</b>							
	No					1.000		
	Yes	0.201	0.146	1.905	0.168	1.222	0.919	1.626
	<b>Information-processing</b>							
	Heuristic processing			35.270	<b>&lt;0.001</b>	1.000		
	Heuristic- systematic-equivalent processing	0.574	0.142	16.304	<b>&lt;0.001</b>	1.776	1.344	2.346
	Systematic processing	0.772	0.133	33.544	<b>&lt;0.001</b>	2.164	1.666	2.809
	<b>Attention on COVID-19</b>							
	<1 hour			14.925	<b>0.001</b>	1.000		
	1-3hour	0.177	0.086	4.217	<b>0.040</b>	1.194	1.008	1.414
	>3hour	0.332	0.087	14.694	<b>&lt;0.001</b>	1.394	1.176	1.652
	<b>Risk perception of COVID-19</b>							
	Low					1.000		
Attitude towards the behavior	High	0.547	0.067	66.614	<b>&lt;0.001</b>	1.729	1.516	1.972
	<b>Perceived risk of self-infection</b>							
	Low			0.085	0.959	1.000		
	Moderate	0.012	0.079	0.024	0.877	1.012	0.866	1.183
	High	0.024	0.083	0.084	0.772	1.024	0.871	1.204

<b>Attitude toward preventive behavior</b>								
Subjective norms	Completely positive attitude					1.000		
	Partially positive attitude	0.349	0.103	11.584	<b>0.001</b>	1.418	1.160	1.733
	<b>Other people wearing masks in public places</b>							
Subjective norms	Half and less than half			11.475	<b>0.009</b>	1.000		
	Most	0.417	0.142	8.655	<b>0.003</b>	1.517	1.149	2.003
	All	0.510	0.153	11.197	<b>0.001</b>	1.666	1.235	2.246
	Unknown	0.485	0.204	5.639	<b>0.018</b>	1.624	1.088	2.424
<b>Self-efficacy</b>								
Perceived behavioral control	Low					1.000		
	High	1.408	0.070	407.497	<b>&lt;0.001</b>	4.090	3.567	4.689
	<b>Constant</b>	-3.281	0.338	94.066	<b>&lt;0.001</b>	0.038		

Table 5. Characteristics of respondents reporting the availability or unavailability of masks

	Total (n= 4649)	Masks are available (n=4533)	Masks are not available (n=294)	$\chi^2$	<i>p</i>
<b>Gender</b>				7.292	0.007
Male	1560(31.9)	1444(92.6)	116(7.4)		
Female	3089(68.1)	3089(94.6)	178(5.4)		
<b>Age(years)</b>				19.154	0.001
<20	256(5.3)	234(91.4)	22(8.6)		
21-30	2312(47.9)	2145(92.8)	167(7.2)		
31-40	1288(26.7)	1236(96.0)	52(4.0)		
41-50	749(15.5)	705(94.1)	44(5.9)		
>51	222(4.6)	213(95.9)	9(4.1)		
<b>Education</b>				1.832	0.608
Middle school	257(5.3)	240(93.4)	17(6.6)		
High School	782(16.2)	742(94.9)	40(5.1)		
College	3002(62.2)	2817(93.8)	185(6.2)		
Master's degree	786(16.3)	734(93.4)	52(6.6)		
<b>Marital status</b>				27.955	<0.001

Married	2607(54.0)	2492(95.5)	115(4.4)		
Not married	2220(46.0)	2041(91.9)	179(8.1)		
<b>Occupation</b>				0.794	0.373
Health care worker	251(5.2)	239(95.2)	12(4.8)		
Other	4576(94.5)	4294(93.8)	282(6.2)		
<b>Province</b>				0.508	0.476
Hubei	130(2.7)	124(95.4)	6(4.6)		
Other	4697(97.3)	4409(93.9)	288(6.1)		
<b>Area</b>				33.838	<0.001
Urban	3920(81.25)	3719(94.9)	201(5.1)		
Rural	907(18.8)	814(89.7)	93(10.3)		
<b>Community COVID-19 epidemic</b>				1.822	0.610
No COVID-19 cases	3707(76.80)	3488(94.1)	219(5.9)		
Under medical observation	404(8.37)	376(93.1)	28(6.9)		
Suspected case	262(5.43)	242(92.4)	20(7.6)		
Confirmed case	454(9.41)	427(94.1)	27(5.9)		

Fig legend

Figure 1 Application of the Theory of Planned Behavior to investigate predictors of uptake of protective behaviors in the context of COVID-19 pandemic.

References:

1. WHO. Coronavirus(COVID-19) Situation Report. 2020 2020 2020/4/10]https://who.sprinklr.com/

2. Hoehl S, Berger A, Kortenbusch M, Cinatl J, Bojkova D, Rabenau H, Behrens P, Böddinghaus B, Götsch U, Naujoks F. Evidence of SARS-CoV-2 infection in returning travelers from Wuhan, China. NEW ENGL J MED 2020.

3. Zou L, Ruan F, Huang M, Liang L, Huang H, Hong Z, Yu J, Kang M, Song Y, Xia J. SARS-CoV-2 viral load in upper respiratory specimens of infected patients. NEW ENGL J MED 2020.

4. Aleta A, Martín-Corral D, Piontti A, Ajelli M, Litvinova M, Chinazzi M, Dean NE, Halloran ME, Longini IJ, Merler S, Pentland A, Vespignani A, Moro E, Moreno Y. Modeling the impact of social distancing, testing, contact tracing and household quarantine on second-wave scenarios of the COVID-19 epidemic. medRxiv 2020.

5. Kantor BN, Kantor J. Non-pharmaceutical Interventions for Pandemic COVID-19: A Cross-Sectional Investigation of US General Public Beliefs, Attitudes, and Actions. Front Med (Lausanne) 2020, 7: 384.

6. Rothe C, Schunk M, Sothmann P, Bretzel G, Froeschl G, Wallrauch C, Zimmer T, Thiel V, Janke

- C, Guggemos W. Transmission of 2019-nCoV infection from an asymptomatic contact in Germany. NEW ENGL J MED 2020.
7. Hu Z, Song C, Xu C, Jin G, Chen Y, Xu X, Ma H, Chen W, Lin Y, Zheng Y. Clinical characteristics of 24 asymptomatic infections with COVID-19 screened among close contacts in Nanjing, China. Science China Life Sciences 2020: 1-6.
8. Chinses Centers Disease Control and prevention, Prevention of coronavirus: an authoritative tip from China CDC. ] [http://www.chinacdc.cn/jkzt/crb/zl/szkb\\_11803/jszl\\_2275/202001/t20200125\\_211423.html](http://www.chinacdc.cn/jkzt/crb/zl/szkb_11803/jszl_2275/202001/t20200125_211423.html)
9. Centers for Disease Control and Prevention (2020) 2019 Novel Coronavirus. ]<https://www.cdc.gov/coronavirus/2019-ncov/about/transmission.html>.
10. WHO. Novel Coronavirus (2019-nCoV) advice for the public. 2020 ]<https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public>
11. China NHCO. Health education manual for novel coronavirus infection pneumonia. ][http://www.gov.cn/fuwu/2020-02/10/content\\_5476794.html](http://www.gov.cn/fuwu/2020-02/10/content_5476794.html)
10. Ajzen I. The theory of planned behavior. ORGAN BEHAV HUM DEC 1991, **50**(2): 179-211.
12. Ajzen I. The theory of planned behavior. ORGAN BEHAV HUM DEC 1991, **50**(2): 179-211.
13. Armitage CJ, Conner M. Efficacy of the Theory of Planned Behaviour: a meta-analytic review. Br J Soc Psychol 2001, **40**(Pt 4): 471-499.
14. Connor M SP. Theory of Planned Behaviour and Health Behaviour. In: Connor M NPB (ed). *In Predicting Health Behaviour*, 2 edition ed. Oxford University Press, 2005, pp 170-222.
15. Bandura A. Self-efficacy : Toward a Unifying Theory of Behavioral Change. PSYCHOL REV 1977, **84**(2): 191-215.
16. Zhang X, Wang F, Zhu C, Wang Z. Willingness to Self-Isolate When Facing a Pandemic Risk: Model, Empirical Test, and Policy Recommendations. Int J Environ Res Public Health 2019, **17**(1).
17. Agarwal V. A/H1N1 vaccine intentions in college students: An application of the theory of planned behavior. J AM COLL HEALTH 2014, **62**(6): 416-424.
18. Myers LB, Goodwin R. Determinants of adults' intention to vaccinate against pandemic swine flu. BMC PUBLIC HEALTH 2011, **11**(1): 15.
19. Lee E, Oh SY. Seek and you shall find? How need for orientation moderates knowledge gain from Twitter use. J COMMUN 2013, **63**(4): 745-765.
20. DeLay P. Gender and Monitoring the Response to HIV/AIDS Pandemic. EMERG INFECT DIS 2004, **10**(11): 1979-1983.
21. Park JH, Cheong H, Son D, Kim S, Ha C. Perceptions and behaviors related to hand hygiene for the prevention of H1N1 influenza transmission among Korean university students during the peak pandemic period. BMC INFECT DIS 2010, **10**(1): 222.
22. Ek S. Gender differences in health information behaviour: a Finnish population-based survey. HEALTH PROMOT INT 2015, **30**(3): 736-745.
23. Wong LP, Sam I. Public Sources of Information and Information Needs for Pandemic Influenza A(H1N1). J COMMUN HEALTH 2010, **35**(6): 676-682.
24. Terry DJ, O'Leary JE. The theory of planned behaviour: The effects of perceived behavioural control and self - efficacy. BRIT J SOC PSYCHOL 1995, **34**(2): 199-220.
25. Fazio RH, Zanna MP. Direct Experience And Attitude-Behavior Consistency. ADV EXP SOC PSYCHOL 1981, **14**: 161-202.
26. Torre GL, Semyonov L, Mannocci A, Boccia A. Knowledge, attitude, and behaviour of public

health doctors towards pandemic influenza compared to the general population in Italy. SCAND J PUBLIC HEALT 2012, **40**(1): 69-75.

27. Choi D, Yoo W, Noh G, Park K. The impact of social media on risk perceptions during the MERS outbreak in South Korea. COMPUT HUM BEHAV 2017, **72**: 422-431.

28. Dorsey AM, Miller KI, Scherer CW. Communication, risk behavior, and perceptions of threat and efficacy: A test of a reciprocal model. 1999.

29. Kim Y, Zhong W, Jehn M, Walsh L. Public risk perceptions and preventive behaviors during the 2009 H1N1 influenza pandemic. DISASTER MED PUBLIC 2015, **9**(2): 145-154.

30. Zhao S, Lin Q, Ran J, Musa SS, Yang G, Wang W, Lou Y, Gao D, Yang L, He D. Preliminary estimation of the basic reproduction number of novel coronavirus (2019-nCoV) in China, from 2019 to 2020: A data-driven analysis in the early phase of the outbreak. INT J INFECT DIS 2020, **92**: 214-217.

31. Eagly A, Chaiken S. The psychology of attitudes. Fort Worth, TX: HBJ.: Inc; 1993.

32. Trumbo CW. Heuristic - systematic information processing and risk judgment. RISK ANAL 1999, **19**(3): 391-400.

33. Parker RM, Ratzan SC, Lurie N. Health literacy: a policy challenge for advancing high-quality health care. HEALTH AFFAIR 2003, **22**(4): 147-153.

34. WU Shuang-sheng YPLH. Analysis of status and influence factors of health literacy related to infections diseases in residents of Beijing. Beijing Daxue Xuebao Yi Xue Ban 2012, **44**(04): 607-611.

35. Guo Y, Logan HL, Dodd VJ, Muller KE, Marks JG, Riley III JL. Health literacy: a pathway to better oral health. AM J PUBLIC HEALTH 2014, **104**(7): e85-e91.

36. Fleary SA, Joseph P, Pappagianopoulos JE. Adolescent health literacy and health behaviors: a systematic review. J ADOLESCENCE 2018, **62**: 116-127.

37. Goldman N, Hu Y. Excess mortality among the unmarried: a case study of Japan. SOC SCI MED 1993, **36**(4): 533-546.

38. Shor E, Roelfs DJ, Bugyi P, Schwartz JE. Meta-analysis of marital dissolution and mortality: Reevaluating the intersection of gender and age. SOC SCI MED 2012, **75**(1): 46-59.

39. Sorlie PD, Backlund E, Keller JB. US mortality by economic, demographic, and social characteristics: the National Longitudinal Mortality Study. AM J PUBLIC HEALTH 1995, **85**(7): 949-956.

40. Davis MA, Murphy SP, Neuhaus JM, Gee L, Quiroga SS. Living arrangements affect dietary quality for US adults aged 50 years and older: NHANES III 1988 - 1994. The Journal of nutrition 2000, **130**(9): 2256-2264.

41. De Vreese CH, Neijens P. Measuring media exposure in a changing communications environment.: Taylor & Francis; 2016.

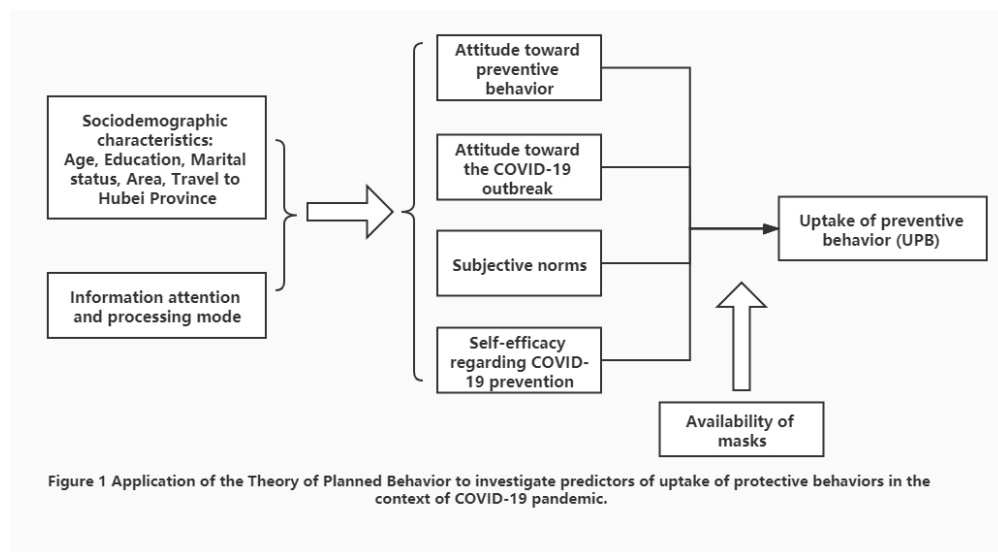


Figure 1. Application of the Theory of Planned Behavior to investigate predictors of uptake of protective behaviors in the context of COVID-19 pandemic

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	1-2
<b>Introduction</b>			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2-3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
<b>Methods</b>			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4-5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	9
Study size	10	Explain how the study size was arrived at	4-5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5, 13-15
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	5
		(b) Describe any methods used to examine subgroups and interactions	5
		(c) Explain how missing data were addressed	Didn't have missing data
		(d) If applicable, describe analytical methods taking account of sampling strategy	Not applicable
		(e) Describe any sensitivity analyses	20
<b>Results</b>			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5
		(b) Give reasons for non-participation at each stage	5
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	5,

		(b) Indicate number of participants with missing data for each variable of interest	Didn't have missing data
Outcome data	15*	Report numbers of outcome events or summary measures	5-7, 16-20
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	5-7, 16-20
		(b) Report category boundaries when continuous variables were categorized	5-7, 16-20
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	5-7, 16-20
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	20
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	7-9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	9
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	7-9
Generalisability	21	Discuss the generalisability (external validity) of the study results	7-9
<b>Other information</b>			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	4

\*Give information separately for exposed and unexposed groups.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).

# BMJ Open

## How can the uptake of preventive behavior during the COVID-19 outbreak be improved? An online survey of 4827 Chinese residents

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2020-042954.R2
Article Type:	Original research
Date Submitted by the Author:	20-Nov-2020
Complete List of Authors:	Mao, Yimeng; Fudan University, School of Public Health Chen, Hao; Fudan University, School of Public Health Wang, Yi; Fudan University, School of Public Health Chen, Suhong; Fudan University, School of Public Health Gao, Junling; Fudan University, School of Public Health Dai, Junming; Fudan University, School of Public Health Jia, Yingnan; Fudan University, School of Public Health Xiao, Qianyi; Fudan University, School of Public Health Zheng, P; Fudan University, School of Public Health Fu, Hua; Fudan University, School of Public Health
<b>Primary Subject Heading</b>:	Public health
Secondary Subject Heading:	Infectious diseases, Public health, Epidemiology
Keywords:	PREVENTIVE MEDICINE, COVID-19, EPIDEMIOLOGY, PUBLIC HEALTH, Public health < INFECTIOUS DISEASES

SCHOLARONE™  
Manuscripts



I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our [licence](#).

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which [Creative Commons](#) licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

# How can the uptake of preventive behavior during the COVID-19 outbreak be improved? An online survey of 4827 Chinese residents

Yimeng Mao<sup>1</sup>, Hao Chen<sup>1</sup>, Yi Wang<sup>1</sup>, Suhong Chen<sup>1</sup>, Junling Gao<sup>1</sup>, Junming Dai<sup>1</sup>, yingnan Jia<sup>1</sup>, Qianyi Xiao<sup>1\*</sup>, Pinpin Zheng<sup>1\*</sup>, Hua Fu<sup>1</sup>,

<sup>1</sup> School of Public Health, Institute of Health Communication, Key Lab of Public Health Safety of Ministry of Education, Fudan University, Shanghai China, 200032

\*co-corresponding author

Address correspondence to Qianyi Xiao, PhD, School of Public health, Fudan University, 138 Yixueyuan Road, Shanghai 200032, P.R. China. or Pinpin Zheng, PhD, School of Public health, Fudan University, 138 Yixueyuan Road, Shanghai 200032, P.R. China.

mail addresses: qianyi0505@163.com or zpinpin@shmu.edu.cn

## Abstract

**Objectives** The aims of this study were to assess the uptake of preventive behavior during the coronavirus disease 2019 (COVID-19) outbreak and to investigate the factors influencing the uptake of preventive behavior based on the theory of planned behavior (TPB) .

**Design, setting and participants** A cross-sectional online survey was conducted among Chinese residents aged  $\geq 18$  years and 4827 participants from 31 provinces and autonomous regions were included in the current study. Uptake of preventive behavior, attitude towards the spread of COVID-19 and preventive behavior, subjective norms, perceived behavioral control, demographic characteristics and the information attention and processing mode were measured. Multivariate logistic regressions were used to identify associations between the potential influencing factors and uptake of preventive behavior.

**Results** There were 2393 (52.8%) respondents reported high uptake of preventive behavior. Multivariate analyses demonstrated that attitude towards the behavior, subjective norms and perceived behavioral control were significantly correlated with uptake of preventive behavior, and perceived behavioral

control was the strongest influencing factor (OR=4.09, 95%CI: 3.57-4.69). Furthermore, systematic information processing mode was positively associated with high uptake of preventive behavior compared with heuristic information processing mode (OR=2.16, 95%CI: 1.66-2.81).

**Conclusions** These findings are helpful for developing education and interventions to promote high uptake of preventive behavior and enhance public health outcomes during a pandemic.

**Keywords:** COVID-19, uptake of preventive behavior, China, theory of planned behavior

**Strengths and limitations of this study**

- We referred to the item in the theory of planned behavior (TPB) to choose the potentially influencing factors of the uptake of preventive behavior and explore the predictor of uptake of preventive behavior during the COVID-19
- Information attention and systematic information processing mode regarding the pandemic were helpful for promoting high uptake of preventive behavior, which may provide references for epidemic control in other countries.
- Online survey was used for rapid assessment, which may lead to selection bias.
- The survey was completed in the relatively short-time period so the results may not reflect the long-term practice of preventive measures.
- The measurement accuracy heavily depends on respondents' ability or willingness to recall their behaviors, which may be underreported or overreported.

**1. Introduction:**

The World Health Organization (WHO) declared the coronavirus disease (COVID-19) outbreak a pandemic on March 11, 2020. By June 10, 2020, 7,805,148 confirmed cases of COVID-19 and 431,192 deaths had been reported globally<sup>[1]</sup>. In the absence of a vaccine to prevent COVID-19, the best way to prevent illness is to avoid being exposed to the virus. Early in the outbreak of COVID-19, the Chinese government, the Chinese Center for Disease Control and Prevention (CDC), and local health departments implemented measures to control the transmission of COVID-19, including

isolation and quarantine, contact tracing of persons with COVID-19, and community containment. These aggressive measures appear to be successful in reducing the number of deaths and hospitalizations [2-3], and could keep the disease at a level that does not exceed the capacity of the health care system[4].

Additionally, measures related to improved personal hygiene were widely publicized in the media as a way to prevent infection. An improved understanding of the drivers of refusal to engage in non-pharmaceutical interventions (NPIs) may help tailor messaging and increase the chances of eliciting behavioral change[5]. Several studies have reported that transmission may occur early in the course of infection[6] and that persons who show no signs or symptoms of respiratory infection nevertheless shed SARS-CoV-2, the virus that causes COVID-19 [2-3]. In addition, the communicable period, defined as the interval from the first day of positive nucleic acid tests to the first day of continuous negative tests, can be up to three weeks, and patients in this communicable period, could develop severe illness.[7]. Under such circumstances, several institutions, including the WHO, the Chinese CDC and the US CDC, recommend that the general public take preventive actions to prevent the spread of respiratory diseases, such as avoiding travel to high-risk areas and contact with individuals who are symptomatic, washing hands frequently with soap and water, and wearing a mask if going out[8-10]. In China, considering that China's population density is much higher than that in most other countries, which increases the likelihood of virus transmission, the Chinese CDC and National Health Commission of the People's Republic of China additionally recommended wearing masks when out in public, decreasing communication and avoiding nonessential excursions[11]. All these findings and official recommendations indicate that individual behavior is essential in controlling the pandemic. Hence, it is important to investigate the factors influencing people's uptake of preventive behavior to minimize the spread of COVID-19. The theory of planned behavior (TPB), which has been widely applied to explain many types of behaviors[12-13], suggests that one's intention is the most important predictor leading to behavior and is determined by three direct factors: attitude towards the behavior (a favorable or unfavorable evaluation of the particular behavior), subjective norms (perceived social pressure to perform or not perform the behavior), and perceived behavioral control (the perception of self-efficacy with respect to the ability to perform the behavior)[12, 14-15]. Previous studies based on the TPB have

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

82 demonstrated that attitude towards the behavior, subjective norms, and perceived behavioral control  
83 have a significant positive influence on self-isolation during a pandemic emergency [16]. Furthermore,  
84 the TPB model was reported to explain 51.7% ( $p < .001$ ) of the variance in A/H1N1 vaccine  
85 intentions[17], and the extended TPB could predict 60% of adults' intention to receive the swine flu  
86 vaccine[18]. In addition, several other factors may affect the uptake of preventive behavior. The  
87 information processing mode can interact with social media to influence people's perception  
88 formation[19] and then affect behavior; sociodemographic characteristics such as gender[20-22] and  
89 education[23] were also reported to affect attitudes and behaviors related to pandemics.

90 To date, few studies in the health context have investigated the factors influencing uptake of  
91 preventive behavior during the COVID-19 outbreak. Considering the global spread of COVID-19, we  
92 aim to investigate the factors related to uptake of preventive behavior referring to the items in TPB to  
93 identify ways to promote the uptake of preventive behavior among the public and provide a reference  
94 for epidemic control in other countries.

95 **2. Method**

96 **2.1 Design and Participants**

97 This cross-sectional online survey was conducted through the Wenjuanxing platform  
98 (<https://www.wjx.cn/app/survey.aspx>) from Jan 31 to Feb 2, 2020. The survey took approximately 10  
99 minutes to complete, and an item with required answer was established to avoid the return of invalid  
100 questionnaires. Chinese residents aged  $\geq 18$  years were invited through social media to participate in  
101 the survey. Since this online survey was disseminated via website and WeChat, the number of  
102 people that were reached couldn't be acquired. In total, 5,851 surveys were returned. After  
103 information sorting and cleaning, we removed the invalid questionnaires, including those *spent less*  
104 *than 5 minutes completing the questionnaires which based on the entire large questionnaire*  
105 *included 97 items designed by our research team*, and those failed to answer the quality control  
106 questions. Finally, 4827 participants from 31 provinces and autonomous regions were included in the  
107 current study. The survey and consent documents were approved by the Institutional Review Board of  
108 Fudan University, School of Public Health (IRB#2020-01-0800).

## 109 **2.2 Patient and Public Involvement statement**

110 Some participants were invited to help design the questionnaires and attend the pilot survey  
 111 separately, but they were not involved in the recruitment, conduct, reporting or dissemination plans.  
 112 The results of the survey have already been disseminated to all participants via website and WeChat,  
 113 especially behavioral advice for prevention of COVID-19.

## 114 **2.3 Selection of factors related to uptake of preventive behavior and Measurements**

115 Uptake of preventive behavior: As a dependent variable, the degree of uptake of preventive  
 116 behavior was included in the study to measure if people uptake the personal precaution against  
 117 COVID-19. Scales ranging from 1 = I strongly disagree to 5 = I strongly agree measured people's  
 118 recent uptake of preventive measures captured in these four statements: (1) "Since the outbreak of the  
 119 COVID-19, I have been wearing a mask in public", (2) "Since the outbreak of the COVID-19, I have  
 120 washed my hands more frequently and thoroughly with soap and water", (3) "Since the outbreak of the  
 121 COVID-19, I have avoided non-essential conversation and personal contact with others, and (4) "Since  
 122 the outbreak of the COVID-19, I have avoided non-essential going out or taking public transportation".  
 123 Because all the 4 items were referred to the guidelines published by China CDC and WHO, and were  
 124 all important and basic individual behaviors to prevent COVID-19, therefore, in this study, only  
 125 participants who chose 5 (strongly agree) for all four questions were defined as having high uptake of  
 126 preventive behavior.

127 We explored the factors related to uptake of preventive behavior referring to the items in TPB. In  
 128 addition, the resources and opportunities available to a person, such as the availability of masks, to  
 129 some extent dictate the likelihood of intended and actual behavior [24]. Moreover, we added other  
 130 potential influencing factors. As shown in Figure 1, we added "attitude towards COVID-19 outbreak"  
 131 to the attitude towards the behavior section because it could directly influence the attitude towards  
 132 preventive behavior<sup>[25-26]</sup>. Subjective norms were measured using the perception about the public  
 133 preventive action, which directly bring the social pressure. Three questions related to self-efficacy were  
 134 used to assess perceived behavioral control<sup>[27]</sup>.

135 Uptake of preventive behavior, attitude towards the behavior, subjective norms, perceived

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

behavioral control and the information attention and processing mode were measured by questionnaires. The detailed information of survey questions, variable description and processing were shown in Table 1.

**2.4 Statistical analyses**

The chi-square test was applied to determine the prevalence of the uptake of preventive behavior by the categorical variables, including demographic characteristics, attitude towards the behavior, subjective norms, perceived behavioral control, degree of attention to COVID-19 and the information processing mode. The underlying structure of the items and their factor loadings was identified by using the exploratory factor analysis (EFA); the extraction was made using the principal components and the rotation using the Varimax method. Multivariate logistic regression analyses were applied to assess the association between the potential influencing factors and the uptake of preventive behavior after controlling for related characteristic covariates. Adjusted ORs and their 95% confidence intervals (CIs) were used to quantify the effects. The sensitivity, specificity and the area under the receiver operating characteristic (ROC) curve were calculated to evaluate the logistic regression model. SPSS software version 22.0 (SPSS, Inc., Chicago, Illinois, US) was used to carry out all analyses. All tests were two-sided, and  $P < 0.05$  was considered statistically significant.

**3. Results**

*Descriptive statistics*

Among the 5,851 questionnaires returned, 4827 (82.5%) were valid, reflecting a completion rate of 83.27%. We additionally excluded 294 participants who could not buy masks. Ultimately, 4,533 participants were included in the analysis. Table 2 provides descriptive statistics for the characteristics of the respondents. Overall, the mean age of the respondents was  $32.45 \pm 9.971$  years (range 18-85, IQR=13), and almost half of respondents were between the ages of 21 and 30. Of the participants, 68.1% were women. The majority of the respondents (62.1%) had a bachelor's degree or a college education. More than half of respondents (55.0%) were married. Only 5.3% were medical staff, and 2.7% had a history of travel to Hubei Province (the high risk areas of COVID-19 outbreak). Approximately 82.0% lived in urban areas, and 18.0% reported that someone in their community was

163 suspected or confirmed to have COVID-19.

164       Regarding preventive behavior, 75.1% of the respondents reported that they wore masks when  
165 going outside, 66.1% washed their hands frequently, 66.0% avoiding talking to or touching others, and  
166 73.0% avoided unnecessary use of public transportation. Overall, 52.8% of participants reported high  
167 uptake of preventive behavior. As shown in Table 2, the proportion of high uptake of preventive  
168 behavior among men (51.0%) was lower than that among women (53.6%). The uptake of preventive  
169 behavior was also influenced by age, with those 31 to 50 years old accounting for the highest  
170 proportion of high uptake of preventive behavior and those younger than 20 accounting for the lowest  
171 proportion of high uptake of preventive behavior. Education was also an influencing factor, with the  
172 highest proportion of high uptake of preventive behavior observed among respondents with a high  
173 school education and the lowest proportion among respondents with a master's degree. Respondents  
174 from urban areas reported a significantly higher proportion of high uptake of preventive behavior than  
175 those from rural areas (53.9% vs 47.5%). Respondents who had a history of travel to Hubei Province  
176 (53.4%) reported a higher proportion of high uptake of preventive behavior than others (45.7%).

#### 177 *Association of the uptake of preventive behavior with influencing factors*

178       Considering that potential influencing factors of uptake of preventive behavior were designed  
179 referring to the items in TPB, exploratory factor analysis(EFA) was first performed to examine the  
180 underlying structure of the items and their factor loadings to support and strengthen the following  
181 association analysis of the uptake of preventive behavior with influencing factors. As shown in Table 3,  
182 the EFA result was in accordance with items been grouped into constructs in Table 1. The proportion  
183 of the variance explained by the retained factors was 72.2% and the Cronbach's alpha of all items is  
184 0.6.

185       As shown in Table 4, multivariable logistic regression analysis was used to test the influencing  
186 factors associated with the uptake of preventive behavior. The fully fitted model had a ROC value of  
187 0.727 while put in all the factors of the regression. For attitude towards the behavior, compared with  
188 those with partially positive attitudes, respondents with completely positive attitudes towards  
189 preventive behavior (OR=1.42, 95%CI: 1.16-1.73) or paid attention towards the risk of COVID-19

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

(OR=1.73, 95%CI: 1.52-1.97) had increased adjusted odds of high uptake of preventive behavior. Regarding subjective norms, perceptions of a higher proportion of public precaution increased the adjusted odds of high uptake of preventive behavior (Most vs Half and less than half: OR=1.52, 95%CI: 1.15-2.00, All vs Half and less than half: OR=1.67, 95%CI: 1.24-2.25, Unknown vs Half and less than half: OR=1.62, 95%CI: 1.09-2.42, respectively). Perceived behavioral control was the strongest influencing factor of uptake of preventive behavior. Respondents with high self-efficacy in preventing COVID-19 were 4.09 times more likely to have a high uptake of preventive behavior than those with low self-efficacy (OR=4.09, 95%CI: 3.57-4.69). Furthermore, there are also several other influencing factors of uptake of preventive behavior. Respondents who engaged more in systematic information processing (SIP) mode were more likely to have high uptake of preventive behavior than those engaged more in Heuristic information processing (HIP) mode and HS-equivalent information processing mode (SIP vs HIP: OR=2.16, 95%CI: 1.66-2.81, HS-equivalent vs HIP: OR=1.78, 95%CI: 1.34-2.35). Increased attention to COVID-19 was significantly associated with increased adjusted odds of high uptake of preventive behavior (1-3 h vs <1 h: OR=1.19, 95%CI: 1.01-1.41 and > 3 h vs <1 h: OR=1.39, 95%CI: 1.18-1.65). Additionally, married and urban respondents had higher uptake of preventive behavior than those who were not married (OR=1.25, 95%CI: 1.05-1.49).

We also compared the characteristics of the respondents reporting that they could obtain masks and those reporting that they could not (Table 5). The results indicated that respondents who were male (OR=1.39, 95%CI: 1.09-1.78), not married (OR=1.90, 95%CI: 1.49-2.42) or from a rural area (OR=2.11, 95%CI: 1.64-2.73) were more likely to report that masks were not available.

**4. Discussion**

In the present study, we demonstrate that 52.8% of participants reported high uptake of preventive behavior, with full compliance with wearing masks in public, frequent hand washing, avoidance of talking to or touching others and avoidance of unnecessary public transportation use. We explored the potential factors influencing the uptake of preventive behavior during a pandemic referring to the items in TPB. The results show that attitude towards the behavior, subjective norms, and perceived behavioral control have significant influences on uptake of preventive behavior. Information processing mode, attention to the pandemic and several sociodemographic characteristics also

218 influenced high uptake of preventive behavior.

219 The results showed that attitude towards the behavior, subjective norms, and perceived behavioral  
220 control have significant positive influences on the uptake of preventive behavior in the context of  
221 COVID-19, which was consistent with a previous study that reported the positive influence of attitude  
222 towards the behavior, subjective norms, and perceived behavioral control on self-isolation during the  
223 pandemic<sup>[14]</sup>. Of these three considered factors, perceived behavioral control (self-efficacy with respect  
224 to preventing COVID-19) was the strongest predictor. Respondents with high self-efficacy regarding  
225 preventing COVID-19 were 3.6 times more likely to have high uptake of preventive behavior than  
226 those with low self-efficacy. This result supports previous studies indicating that self-efficacy will  
227 result in protection motivation leading to changes in attitudes, perceptions, or behaviors<sup>[28]</sup>. For attitude  
228 towards the behavior, compared with a partially positive attitude, a completely positive attitude towards  
229 preventive behavior or payed attention towards the risk of COVID-19 was significantly associated with  
230 high uptake of preventive behavior. However, the degree of agreement with the likelihood of self-  
231 infection was not associated with high uptake of preventive behavior in a multivariable analysis.  
232 Consistent with our findings, Kim also reported that the perceived likelihood of getting sick (cognitive  
233 element) was not strongly associated with preventive behaviors, whereas perceived concern (emotional  
234 element) was significantly associated with precautionary and preparatory behaviors<sup>[29]</sup>. One possible  
235 reason is that the population is generally susceptible due to the highly contagious nature of the virus<sup>[30]</sup>;  
236 therefore, people's judgments of the severity of the pandemic better reflect their awareness and  
237 precautions.

238 It is worth noting that the information processing mode was a pivotal factor influencing the uptake  
239 of preventive behavior during the COVID-19 outbreak. Respondents who engaged more in SIP were  
240 twice as likely to intend to take a high level of preventive behavior against COVID-19 than those who  
241 engaged in HIP. SIP requires greater attention to acquiring information<sup>[31]</sup>, so people engaged more in  
242 SIP will have greater risk awareness due to the evaluation of information and then uptake of preventive  
243 actions. However, this result should be interpreted in a specific context or situation, such as the  
244 COVID-19 pandemic, as people were unfamiliar and uninformed regarding the infectious disease. As  
245 Trumbo mentioned, the notion that only rational and systematic judgement can lead to suitable actions,

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

246 avoidance of inadequate actions or unnecessary overreactions to risk needs to be reexamined<sup>[32]</sup>.  
247 Additionally, information processing is an important component of health literacy, which can be  
248 understood as the capacity of individuals to obtain, process, and understand basic health information to  
249 make decisions to maintain health and improve quality of life<sup>[33]</sup>. Hence, it may be an effective way to  
250 improve the health literacy and in turn uptake of preventive behavior regarding the pandemic through  
251 educate the public to evaluate and analyze information (SIP mode) of pandemic.

252 The sociodemographic characteristic factors should also be given more attention. Our findings  
253 suggested that people living in rural areas have a lower proportion of high uptake of preventive  
254 behavior than those living in urban areas, which may be due to poorer health literacy related to  
255 infectious diseases in rural areas than in urban areas<sup>[34]</sup>. Low literacy relates to less knowledge about  
256 health, which leads to decreased adherence to positive health behaviors<sup>[35-36]</sup>. Furthermore, marital  
257 status is an important social factor associated with human health and longevity<sup>[37-40]</sup>. The marriage  
258 protection effect refers to the fact that married people have more advantages related to family support,  
259 including psychological support and health behavior support. Our results support the protective role of  
260 marriage in the uptake of preventive behavior during the pandemic. All these findings indicated that  
261 people living in rural areas and people who are not married should be given more attention in terms of  
262 health education and health promotion, and their social, psychological and physiological characteristics  
263 should be taken into account. In addition, the issue of mask availability among those who are male,  
264 over 31 years old, not married or from rural areas should be taken into account because in this survey,  
265 these people reported that masks were not available.

266 The results of this study should be considered in the light of the following limitations. Firstly, an  
267 online survey was used for rapid assessment, which may have resulted in selection bias. For example,  
268 some older people with low education levels or serious chronic diseases may not be included in the  
269 survey, and more comprehensive investigations are needed. Secondly, this study relied on cross-  
270 sectional survey data to examine the relationships. Therefore, the results of the analyses should be  
271 interpreted with care because causal relationships between variables may exist. Thirdly, the survey was  
272 completed in the relatively short-time period so the results may not reflect the long-term practice of  
273 preventive measures after the survey. Fourthly, although self-report measures are very convenient and  
274 common in some fields of media research<sup>[41]</sup>, the measurement accuracy heavily depends on  
275 respondents' ability or willingness to recall their behaviors, which may be underreported or

overreported. Fifthly, although our findings indicated the potential way of referring to the TPB theory to explore influencing factors of uptake of preventive behavior in the early stage of COVID-19, the theoretical application is insufficient, which needs the further research with the modeling approach in the future study. Finally, our survey was based on social-media, which may skew younger, educated, and urban people, in turn may affect the generalizability.

## **Conclusion**

Despite the cited limitations, our results are helpful for developing education and interventions to support health behaviors and enhance outcomes in the public during a pandemic emergency. Attitude towards the behavior, subjective norms, and perceived behavioral control have significant positive influences on the uptake of preventive behavior during a pandemic, with perceived behavioral control (self-efficacy) playing the most important role. Therefore, developing education programs focused on improving awareness of SIP and attention to the pandemic are helpful in promoting high uptake of preventive behavior during pandemics.

## **Declarations**

## **Funding**

This work was supported by the National Natural Science Foundation of China [71573047].

## **Conflict of interest**

There are no any conflicts.

## **Ethics approval and consent to participate**

The Institutional Review Board of Fudan University, School of Public Health (IRB#2020-01-0800), approved the study protocol.

## **Availability of data and materials**

The data that support the findings of this study are available from school of public health, Fudan University but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of school of public health, Fudan University.

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

303     **Code availability**

304     SPSS version 22.0 (SPSS, Chicago, IL, USA);

305     **Authors' contributions**

306     Pinpin Zheng, Junling Gao, Junming Dai, Yingnan Jia and Hua Fu designed the study and obtained the  
307     data. Junling Gao and Junming Dai organized. Yimeng Mao, Yi Wang, Suhong Chen and Hao Chen  
308     performed the survey. Yimeng Mao and Qianyi Xiao undertook the data analysis and interpretation  
309     supervised by Pinpin Zheng. Qianyi Xiao and Yimeng Mao wrote the manuscript. Pinpin Zheng reviewed  
310     and commented on the manuscript. All authors read the final manuscript and agree with the text.

311     **Acknowledgements:**

312     We gratefully thank all participants for their cooperation.

Table 1. Description of the variables

Variable	Indicators	Variable Description	Variable processing	Mean $\pm$ SD	Range
Independent variable	Uptake of preventive behavior	(1) Since the outbreak of COVID-19, I have been wearing a mask in public.			
		(2) Since the outbreak of COVID-19, I have washed my hands more frequently and thoroughly with soap and water.	1= Strongly disagree; 2= Disagree; 3=Neutral; 4=Agree; 5=Strongly agree;	Obtain the degree of agreement. Participants who chose 5 (strongly agree) for all four questions were defined as having high uptake of preventive behavior.	4.64 $\pm$ 0.505 1-2
		(3) Since the outbreak of COVID-19, I have avoided nonessential conversation and personal contact with others.			
		(4) Since the outbreak of COVID-19, I have avoided nonessential excursions and public transportation.			
Attitude towards the behavior	Attitude towards preventive behavior	(1) The virus mainly infects the elderly, and young people need not be concerned about it.		Obtain a binary categorical classification of attitude: completely positive attitude or partially positive attitude. A completely positive attitude was indicated by agree answers to all 4 items.	
		(2) If you do not eat wild animals or seafood, you will not be infected with COVID-19.	1=agree; 0=disagree;		0.87 $\pm$ 0.334 1-2
		(3) You must wash your hands when you come in from outside.			

(4) It is important to eat a balanced diet and maintain a positive mood to prevent infection.					
Attitude towards COVID-19		How great do you perceive the overall risk of the COVID-19 pandemic to be?	1=No risk at all; 2=Low risk; 3=General risk; 4=Relatively high risk; 5=Very high risk;	Obtain the degree of risk perception of COVID-19: Completely positive attitude = Very high; Partially positive attitude = Relatively high/General/Low/None	4.51±0.647 1-5
		How great do you perceive the risk of infection?		Obtain the degree of perceived personal infection risk: High = Very high/Relatively high; Moderate = General/Low = Low/None	3.00±1.268 1-5
Subjective norms	Subjective norms	The proportion of others wearing masks in public places.	1=No one; 2=Less than half; 3=Half; 4=Most; 5=All;	Obtain the proportion: Half and less than half = Half/Less than half/No one; Most; All; and Unknown.	4.20±0.719 1-5
Perceived behavioral control	Self-efficacy regarding COVID-19 prevention	(1) I can avoid COVID-19 infection.	1=Strongly disagree; 2=Disagree; 3=Neutral; 4=Agree; 5=Strongly agree;	The median of respondents' averaged index (median = .0) was used for binary categorical classification (high/low level).	4.20±0.643 1-2
		(2) I know how to avoid COVID-19.			

Heuristic information processing ( HIP )				
Information attention and processing mode	Heuristic-systematic processing (HSM)	(1) I am able to make decisions about COVID-19 based on my existing knowledge without seeking additional information.		
		(2) I can make a fully informed decision about COVID-19 based on my previous experience.	1=Strongly disagree; 2=Disagree; 3= Neutral; 4=Agree; 5= Strongly agree;	By comparing the means of the two corresponding items, information processing was classified as HIP ( HIP score > SIP score), HS- equivalent (HIP score = SIP score), or SIP (HIP score > HIP score).
		Systematic information processing ( SIP )		3.61±0.734 1-3
		(1) When I encounter information about COVID-19, I make an effort to carefully analyze it.		
		(2) When I encounter information about COVID-19, I am likely to stop and think about it.		
			1=None; 2= Less than an hour; 3= 1–3 hour; 4= 3–5 hours; 5=More hours; than 5 hours;	Obtain the degree of attention: <1 None/Less than an hour, 1-3 hours = 3–5 hours/more than 5 hours
Degree of attention to COVID-19	In the past month, how much time did you spend focused on COVID- 19 information every day?			3.34±1.038 1-3

Table 2. Participants’ characteristics and uptake of preventive behavior

	Total N(%)	Low uptake of preventive behavior N(%)	High uptake of preventive behavior N(%)	$\chi^2$	<i>p</i>
<b>Gender</b>				2.752	0.097
Male	1444(31.9)	708(49.0)	736(51.0)		
Female	3089(68.1)	1433(46.4)	1656(53.6)		
<b>Age(years)</b>				30.255	<0.001
<20	234(5.2)	140(59.8)	94(40.2)		
21-30	2145(47.3)	1058(49.3)	1087(50.7)		
31-40	1236(27.3)	538(43.5)	698(56.5)		
41-50	705(15.6)	304(43.1)	401(56.9)		
>51	213(4.7)	101(47.4)	112(52.6)		
<b>Education</b>				31.925	<0.001
Middle school	240(5.3)	113(47.1)	127(52.9)		
High School	742(16.4)	301(40.6)	441(59.4)		
College	2817(62.1)	1322(46.9)	1495(53.1)		
Master’s degree	734(16.2)	405(55.2)	329(44.8)		
<b>Marital status</b>				55.88	<0.001
Married	2492(55.0)	1052(42.2)	1440(57.8)		
Not married	2041(45.0)	1089(53.4)	952(46.6)		
<b>Occupation</b>				0.014	0.906
Health care worker	239(5.3)	112(46.9)	127(53.1)		
Other	4294(94.7)	2029(47.3)	2265(52.7)		
<b>Province</b>				0.982	0.322
Hubei	124(2.7)	64(51.6)	60(48.4)		
Other	4409(97.3)	2077(47.1)	2332(52.9)		
<b>Area</b>				10.87	0.001
Urban	3719(82.0)	1714(46.1)	2005(53.9)		
Rural	814(18.0)	427(52.5)	387(47.5)		
<b>Community COVID-19 epidemic</b>				4.844	0.184
No COVID-19 cases	3488(76.9)	1626(46.6)	1862(53.4)		
Under medical observation	376(8.3)	191(50.8)	185(49.2)		
Suspected case	242(5.3)	126(52.1)	116(57.9)		
Confirmed case	427(9.4)	198(46.4)	229(53.6)		
<b>Travel to Hubei</b>				7.861	0.005
No	4176(92.1)	1947(46.6)	2229(53.4)		
Yes	357(7.9)	194(54.3)	163(45.7)		
<b>Self-rate health</b>					
Poor	254(11.9)	208(8.7)	462(10.2)	12.387	<0.001
Good	1887(88.1)	2184(91.3)	4071(89.8)		

Table 3. the results of factor analysis referring to the items in TPB

Indicators	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
How great do you perceive the overall risk of the COVID-19 pandemic to be?	0.029	0.045	-0.146	-0.041	0.026	<b>0.882</b>
How great do you perceive the risk of infection?	0.071	-0.209	0.406	-0.049	0.393	<b>0.446</b>
The proportion of others wearing masks in public places.	-0.048	-0.065	-0.083	-0.034	<b>0.801</b>	0.120
I am able to make decisions about COVID-19 based on my existing knowledge without seeking additional information.	-0.092	<b>0.931</b>	0.122	0.087	-0.048	0.002
I can make a fully informed decision about COVID-19 based on my previous experience.	-0.074	<b>0.926</b>	0.152	0.110	-0.059	-0.008
When I encounter information about COVID-19, I make an effort to carefully analyze it.	0.016	0.136	0.108	<b>0.887</b>	0.003	-0.005
When I encounter information about COVID-19, I am likely to stop and think about it.	-0.006	0.050	0.155	<b>0.885</b>	-0.050	-0.057
The virus mainly infects the elderly, and young people need not be concerned about it.	<b>0.695</b>	-0.049	-0.020	-0.001	0.278	-0.120
If you do not eat wild animals or seafood, you will not be infected with COVID-19.	<b>0.476</b>	0.012	-0.122	0.001	0.490	-0.185
You must wash your hands when you come in from outside.	<b>0.798</b>	-0.075	0.000	-0.021	-0.100	0.127
It is important to eat a balanced diet and maintain a positive mood to prevent infection.	<b>0.810</b>	-0.061	0.042	0.029	-0.082	0.079
I can avoid COVID-19 infection.	-0.019	0.134	<b>0.850</b>	0.115	-0.072	-0.025
I know how to avoid COVID-19.	-0.006	0.174	<b>0.804</b>	0.183	-0.080	-0.105

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

Table 4. Logistic regression of uptake of preventive behavior

Variables		B	S.E.	Wald	p	OR	95% CI	
							lower	upper
External personality factors	Province							
	Other					1.000		
	Hubei	0.134	0.236	0.322	0.570	1.143	0.720	1.816
	Self-rate health							
	Poor					1.000		
	Good	0.099	0.108	0.845	0.358	1.105	0.893	1.365
	Occupation							
	Other					1.000		
	Health care worker	0.131	0.146	0.805	0.370	1.140	0.856	1.519
	Community COVID-19 epidemic							
	No COVID-19 cases			2.625	0.453	1.000		
	Under medical observation	-0.151	0.119	1.599	0.206	0.860	0.681	1.086
	Suspected case	-0.158	0.147	1.152	0.283	0.854	0.640	1.139
	Confirmed case	0.008	0.113	0.005	0.942	1.008	0.808	1.258
	Gender							
	Male					1.000		
	Female	0.175	0.071	6.174	0.013	1.192	1.038	1.368
	Age(years)							
	-20			4.397	0.355	1.000		
21-30	0.265	0.154	2.975	0.085	1.304	0.965	1.762	
31-40	0.148	0.175	0.720	0.396	1.160	0.823	1.634	
41-50	0.219	0.186	1.381	0.240	1.245	0.864	1.794	
51-	0.143	0.226	0.400	0.527	1.153	0.741	1.795	
Education								
Middle school			5.479	0.140	1.000			

	High School	0.143	0.166	0.744	0.389	1.153	0.834	1.595
	College	0.034	0.156	0.046	0.829	1.034	0.762	1.404
	Master	-0.136	0.174	0.612	0.434	0.873	0.620	1.228
	<b>Area</b>							
	Rural					1.000		
	Urban	0.170	0.091	3.511	0.061	1.186	0.992	1.417
	<b>Marriage</b>							
	No married					1.000		
	Married	0.221	0.089	6.147	<b>0.013</b>	1.247	1.047	1.486
	<b>Travel to Hubei</b>							
	No					1.000		
	Yes	0.201	0.146	1.905	0.168	1.222	0.919	1.626
	<b>Information-processing</b>							
	Heuristic processing			35.270	<b>&lt;0.001</b>	1.000		
	Heuristic- systematic-equivalent processing	0.574	0.142	16.304	<b>&lt;0.001</b>	1.776	1.344	2.346
	Systematic processing	0.772	0.133	33.544	<b>&lt;0.001</b>	2.164	1.666	2.809
	<b>Attention on COVID-19</b>							
	<1 hour			14.925	<b>0.001</b>	1.000		
	1-3hour	0.177	0.086	4.217	<b>0.040</b>	1.194	1.008	1.414
	>3hour	0.332	0.087	14.694	<b>&lt;0.001</b>	1.394	1.176	1.652
	<b>Risk perception of COVID-19</b>							
	Low					1.000		
	High	0.547	0.067	66.614	<b>&lt;0.001</b>	1.729	1.516	1.972
Attitude towards the behavior	<b>Perceived risk of self-infection</b>							
	Low			0.085	0.959	1.000		
	Moderate	0.012	0.079	0.024	0.877	1.012	0.866	1.183
	High	0.024	0.083	0.084	0.772	1.024	0.871	1.204

<b>Attitude toward preventive behavior</b>								
	Completely positive attitude	1.000						
	Partially positive attitude	0.349	0.103	11.584	<b>0.001</b>	1.418	1.160	1.733
<b>Other people wearing marks in public places</b>								
Subjective norms	Half and less than half	11.475 <b>0.009</b> 1.000						
	Most	0.417	0.142	8.655	<b>0.003</b>	1.517	1.149	2.003
	All	0.510	0.153	11.197	<b>0.001</b>	1.666	1.235	2.246
	Unknown	0.485	0.204	5.639	<b>0.018</b>	1.624	1.088	2.424
<b>Self-efficacy</b>								
Perceived behavioral control	Low	1.000						
	High	1.408	0.070	407.497	<b>&lt;0.001</b>	4.090	3.567	4.689
<b>Constant</b>		-3.281	0.338	94.066	<b>&lt;0.001</b>	0.038		

Note: All the variables shown in Table 4 included in a single model.

Table 5. Characteristics of respondents reporting the availability or unavailability of masks

	Total (n= 4649)	Masks are available (n=4533)	Masks are not available (n=294)	$\chi^2$	<i>p</i>
<b>Gender</b>				7.292	0.007
Male	1560(32.3)	1444(92.6)	116(7.4)		
Female	3267(67.7)	3089(94.6)	178(5.4)		
<b>Age(years)</b>				19.154	0.001
<20	256(5.3)	234(91.4)	22(8.6)		
21-30	2312(47.9)	2145(92.8)	167(7.2)		
31-40	1288(26.7)	1236(96.0)	52(4.0)		
41-50	749(15.5)	705(94.1)	44(5.9)		
>51	222(4.6)	213(95.9)	9(4.1)		
<b>Education</b>				1.832	0.608
Middle school	257(5.3)	240(93.4)	17(6.6)		
High School	782(16.2)	742(94.9)	40(5.1)		
College	3002(62.2)	2817(93.8)	185(6.2)		
Master's degree	786(16.3)	734(93.4)	52(6.6)		
<b>Marital status</b>				27.955	<0.001
Married	2607(54.0)	2492(95.5)	115(4.4)		

Not married	2220(46.0)	2041(91.9)	179(8.1)		
<b>Occupation</b>				0.794	0.373
Health care worker	251(5.2)	239(95.2)	12(4.8)		
Other	4576(94.5)	4294(93.8)	282(6.2)		
<b>Province</b>				0.508	0.476
Hubei	130(2.7)	124(95.4)	6(4.6)		
Other	4697(97.3)	4409(93.9)	288(6.1)		
<b>Area</b>				33.838	<0.001
Urban	3920(81.25)	3719(94.9)	201(5.1)		
Rural	907(18.8)	814(89.7)	93(10.3)		
<b>Community COVID-19 epidemic</b>				1.822	0.610
No COVID-19 cases	3707(76.80)	3488(94.1)	219(5.9)		
Under medical observation	404(8.37)	376(93.1)	28(6.9)		
Suspected case	262(5.43)	242(92.4)	20(7.6)		
Confirmed case	454(9.41)	427(94.1)	27(5.9)		

### Fig legend

Figure 1 Application of the Theory of Planned Behavior to investigate predictors of uptake of protective behaviors in the context of COVID-19 pandemic.

## References:

1. WHO. Coronavirus(COVID-19) Situation Report. 2020 2020/4/10]https://who.sprinklr.com/
2. Hoehl S, Berger A, Kortenbusch M, Cinatl J, Bojkova D, Rabenau H, Behrens P, Böddinghaus B, Götsch U, Naujoks F. Evidence of SARS-CoV-2 infection in returning travelers from Wuhan, China. NEW ENGL J MED 2020.
3. Zou L, Ruan F, Huang M, Liang L, Huang H, Hong Z, Yu J, Kang M, Song Y, Xia J. SARS-CoV-2 viral load in upper respiratory specimens of infected patients. NEW ENGL J MED 2020.
4. Aleta A, Martín-Corral D, Piontti A, Ajelli M, Litvinova M, Chinazzi M, Dean NE, Halloran ME, Longini IJ, Merler S, Pentland A, Vespignani A, Moro E, Moreno Y. Modeling the impact of social distancing, testing, contact tracing and household quarantine on second-wave scenarios of the COVID-19 epidemic. medRxiv 2020.
5. Kantor BN, Kantor J. Non-pharmaceutical Interventions for Pandemic COVID-19: A Cross-Sectional Investigation of US General Public Beliefs, Attitudes, and Actions. Front Med (Lausanne) 2020, 7: 384.
6. Rothe C, Schunk M, Sothmann P, Bretzel G, Froeschl G, Wallrauch C, Zimmer T, Thiel V, Janke C, Guggemos W. Transmission of 2019-nCoV infection from an asymptomatic contact in Germany.

NEW ENGL J MED 2020.

7. Hu Z, Song C, Xu C, Jin G, Chen Y, Xu X, Ma H, Chen W, Lin Y, Zheng Y. Clinical characteristics of 24 asymptomatic infections with COVID-19 screened among close contacts in Nanjing, China. *Science China Life Sciences* 2020: 1-6.

8. Chinses Centers Disease Control and prevention, Prevention of coronavirus: an authoritative tip from China CDC. ] [http://www.chinacdc.cn/jkzt/crb/zl/szkb\\_11803/jszl\\_2275/202001/t20200125\\_211423.html](http://www.chinacdc.cn/jkzt/crb/zl/szkb_11803/jszl_2275/202001/t20200125_211423.html)

9. Centers for Disease Control and Prevention (2020) 2019 Novel Coronavirus. ] <https://www.cdc.gov/coronavirus/2019-ncov/about/transmission.html>.

10. WHO. Novel Coronavirus (2019-nCoV) advice for the public. 2020 ] <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public>

11. China NHCO. Health education manual for novel coronavirus infection pneumonia. ] [http://www.gov.cn/fuwu/2020-02/10/content\\_5476794.html](http://www.gov.cn/fuwu/2020-02/10/content_5476794.html)

10. Ajzen I. The theory of planned behavior. *ORGAN BEHAV HUM DEC* 1991, **50**(2): 179-211.

12. Ajzen I. The theory of planned behavior. *ORGAN BEHAV HUM DEC* 1991, **50**(2): 179-211.

13. Armitage CJ, Conner M. Efficacy of the Theory of Planned Behaviour: a meta-analytic review. *Br J Soc Psychol* 2001, **40**(Pt 4): 471-499.

14. Connor M SP. Theory of Planned Behaviour and Health Behaviour. In: Connor M NPB (ed). *In Predicting Health Behaviour*, 2 edition ed. Oxford University Press, 2005, pp 170-222.

15. Bandura A. Self-efficacy : Toward a Unifying Theory of Behavioral Change. *PSYCHOL REV* 1977, **84**(2): 191-215.

16. Zhang X, Wang F, Zhu C, Wang Z. Willingness to Self-Isolate When Facing a Pandemic Risk: Model, Empirical Test, and Policy Recommendations. *Int J Environ Res Public Health* 2019, **17**(1).

17. Agarwal V. A/H1N1 vaccine intentions in college students: An application of the theory of planned behavior. *J AM COLL HEALTH* 2014, **62**(6): 416-424.

18. Myers LB, Goodwin R. Determinants of adults' intention to vaccinate against pandemic swine flu. *BMC PUBLIC HEALTH* 2011, **11**(1): 15.

19. Lee E, Oh SY. Seek and you shall find? How need for orientation moderates knowledge gain from Twitter use. *J COMMUN* 2013, **63**(4): 745-765.

20. DeLay P. Gender and Monitoring the Response to HIV/AIDS Pandemic. *EMERG INFECT DIS* 2004, **10**(11): 1979-1983.

21. Park JH, Cheong H, Son D, Kim S, Ha C. Perceptions and behaviors related to hand hygiene for the prevention of H1N1 influenza transmission among Korean university students during the peak pandemic period. *BMC INFECT DIS* 2010, **10**(1): 222.

22. Ek S. Gender differences in health information behaviour: a Finnish population-based survey. *HEALTH PROMOT INT* 2015, **30**(3): 736-745.

23. Wong LP, Sam I. Public Sources of Information and Information Needs for Pandemic Influenza A(H1N1). *J COMMUN HEALTH* 2010, **35**(6): 676-682.

24. Terry DJ, O'Leary JE. The theory of planned behaviour: The effects of perceived behavioural control and self - efficacy. *BRIT J SOC PSYCHOL* 1995, **34**(2): 199-220.

25. Fazio RH, Zanna MP. Direct Experience And Attitude-Behavior Consistency. *ADV EXP SOC PSYCHOL* 1981, **14**: 161-202.

26. Torre GL, Semyonov L, Mannocci A, Boccia A. Knowledge, attitude, and behaviour of public health doctors towards pandemic influenza compared to the general population in Italy. *SCAND J*

PUBLIC HEALTH 2012, **40**(1): 69-75.

27. Choi D, Yoo W, Noh G, Park K. The impact of social media on risk perceptions during the MERS outbreak in South Korea. *COMPUT HUM BEHAV* 2017, **72**: 422-431.

28. Dorsey AM, Miller KI, Scherer CW. Communication, risk behavior, and perceptions of threat and efficacy: A test of a reciprocal model. 1999.

29. Kim Y, Zhong W, Jehn M, Walsh L. Public risk perceptions and preventive behaviors during the 2009 H1N1 influenza pandemic. *DISASTER MED PUBLIC* 2015, **9**(2): 145-154.

30. Zhao S, Lin Q, Ran J, Musa SS, Yang G, Wang W, Lou Y, Gao D, Yang L, He D. Preliminary estimation of the basic reproduction number of novel coronavirus (2019-nCoV) in China, from 2019 to 2020: A data-driven analysis in the early phase of the outbreak. *INT J INFECT DIS* 2020, **92**: 214-217.

31. Eagly A, Chaiken S. The psychology of attitudes. Fort Worth, TX: HBJ.: Inc; 1993.

32. Trumbo CW. Heuristic - systematic information processing and risk judgment. *RISK ANAL* 1999, **19**(3): 391-400.

33. Parker RM, Ratzan SC, Lurie N. Health literacy: a policy challenge for advancing high-quality health care. *HEALTH AFFAIR* 2003, **22**(4): 147-153.

34. WU Shuang-sheng YPLH. Analysis of status and influence factors of health literacy related to infectious diseases in residents of Beijing. *Beijing Daxue Xuebao Yi Xue Ban* 2012, **44**(04): 607-611.

35. Guo Y, Logan HL, Dodd VJ, Muller KE, Marks JG, Riley III JL. Health literacy: a pathway to better oral health. *AM J PUBLIC HEALTH* 2014, **104**(7): e85-e91.

36. Fleary SA, Joseph P, Pappagianopoulos JE. Adolescent health literacy and health behaviors: a systematic review. *J ADOLESCENCE* 2018, **62**: 116-127.

37. Goldman N, Hu Y. Excess mortality among the unmarried: a case study of Japan. *SOC SCI MED* 1993, **36**(4): 533-546.

38. Shor E, Roelfs DJ, Bugyi P, Schwartz JE. Meta-analysis of marital dissolution and mortality: Reevaluating the intersection of gender and age. *SOC SCI MED* 2012, **75**(1): 46-59.

39. Sorlie PD, Backlund E, Keller JB. US mortality by economic, demographic, and social characteristics: the National Longitudinal Mortality Study. *AM J PUBLIC HEALTH* 1995, **85**(7): 949-956.

40. Davis MA, Murphy SP, Neuhaus JM, Gee L, Quiroga SS. Living arrangements affect dietary quality for US adults aged 50 years and older: NHANES III 1988 - 1994. *The Journal of nutrition* 2000, **130**(9): 2256-2264.

41. De Vreese CH, Neijens P. Measuring media exposure in a changing communications environment.: Taylor & Francis; 2016.

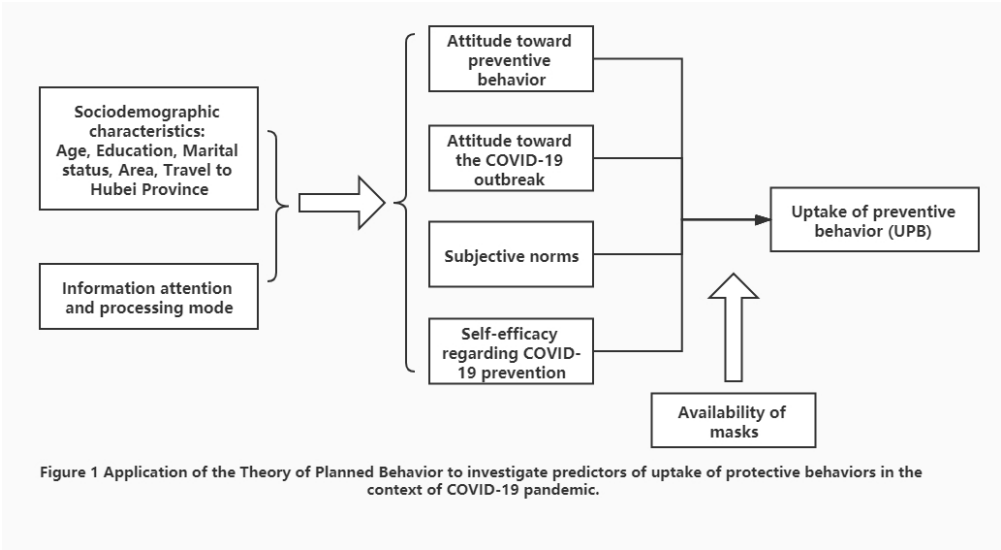


Figure 1. Application of the Theory of Planned Behavior to investigate predictors of uptake of protective behaviors in the context of COVID-19 pandemic

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page No
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	1-2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2-3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4-5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	9
Study size	10	Explain how the study size was arrived at	4-5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5, 13-15
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	5
		(b) Describe any methods used to examine subgroups and interactions	5
		(c) Explain how missing data were addressed	Didn’t have missing data
		(d) If applicable, describe analytical methods taking account of sampling strategy	Not applicable
		(e) Describe any sensitivity analyses	20
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5
		(b) Give reasons for non-participation at each stage	5
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	5,

		(b) Indicate number of participants with missing data for each variable of interest	Didn't have missing data
Outcome data	15*	Report numbers of outcome events or summary measures	5-7, 16-20
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	5-7, 16-20
		(b) Report category boundaries when continuous variables were categorized	5-7, 16-20
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	5-7, 16-20
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	20
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	7-9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	9
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	7-9
Generalisability	21	Discuss the generalisability (external validity) of the study results	7-9
<b>Other information</b>			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	4

\*Give information separately for exposed and unexposed groups.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).