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Journal:	*BMJ Open*
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

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

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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 ≥ 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[1]. 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[2] and that persons who show no signs or symptoms of respiratory infection nevertheless shed SARS-CoV-2[3-4]. In addition, the communicable period can be up to three weeks, and communicated patients could develop severe illness[5]. 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[6-8]. 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[9]. 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[10-11], 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)[10, 12-13]. 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 [14]. Furthermore, the TPB model was reported to explain 51.7% ($p < .001$) of the variance in A/HINI vaccine intentions[15], and the extended TPB could predict 60% of adults' intention to receive the swine flu vaccine[16]. In addition, several other factors may affect the UPB. The information processing mode can interact with social media to influence people's perception formation[17] and then affect behavior; sociodemographic characteristics such as gender[18-20] and education[21] 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 ≥ 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 initiall y 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[22]. 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[23-24]. 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[25].

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±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[14]. 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[26]. 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[27]. One possible reason is that the population is generally susceptible due to the highly contagious nature of the virus[28]; 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[29], 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[30]. 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[31]. 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[32]. Low literacy relates to less knowledge about health, which leads to decreased adherence to positive health behaviors[33-34]. Furthermore, marital status is an important social factor associated with human health and longevity[35-38]. 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[39], 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 ± SD	Range
Independent variable	Uptake of preventive behavior (UPB)	(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. (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.	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±0.505	1-5
Attitude towards the behavior (ATT)	Attitude towards preventive behavior	(1) Smoking can prevent COVID-19. (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.	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±0.807	0-6

	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. (2) I know how to avoid COVID-19. (3) I can recover from an infection even if I am infected by COVID-19.	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
Information attention and processing mode	Heuristic-systematic processing (HSM)	Heuristic information processing (HIP) (1) I am able to make decisions about COVID-19 based on my existing knowledge without seeking additional information.	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

	(2) I can make a fully informed decision about COVID-19 based on my previous experience. 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.		score > HIP score).		
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= 3–5 hours; 5=More than 5 hours;	Obtain the degree of attention: <1 hour = None/Less than an hour, 1–3 hours; >3 hours = 3–5 hours/more than 5 hours	3.34±1.038	1-5

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

	Total N(%)	Low UPB N(%)	High UPB N(%)	χ^2	*p*
Gender				2.752	0.097
Male	1444(31.9)	708(49.0)	736(51.0)		
Female	3089(68.1)	1433(46.4)	1656(53.6)		
Age(years)				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)		
Education				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)		
Marital status				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)		
Occupation				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)		
Province				0.982	0.322
Hubei	124(2.7)	64(51.6)	60(48.4)		
Other	4409(97.3)	2077(47.1)	2332(52.9)		
Area				10.87	0.001
Urban	3719(82.0)	1714(46.1)	2005(53.9)		
Rural	814(18.0)	427(52.5)	387(47.5)		
Community COVID-19 epidemic				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)		
Travel to Hubei				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(%)	χ^2	*p*
ATT	**Attitude towards preventive behavior**				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)		
	Risk perception of COVID-19				129.588	<0.001
	High	2586(57.0)	1032(39.9)	1554(60.1)		
	Low	1947(43.0)	1109(57.0)	838(43.0)		
	Perceived personal risk of self-infection				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	**Concern among relatives and friends**				29.264	<0.001
	High	3900(86.0)	1779(45.6)	2121(54.4)		
	Low	633(14.0)	362(57.2)	271(42.8)		
	Other people wearing masks in public places				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	**Self-efficacy**				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	**Attention on COVID-19**				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)		
	Information-processing				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	95% CI upper
Demographic characteristics	**Age(years)**							
	<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
	Education							
	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
	Area							
	Rural					1.000		
	Urban	0.188	0.090	4.403	0.036	1.207	1.012	1.439
	Marital status							
	Not married					1.000		
	Married	0.219	0.088	6.131	0.013	1.245	1.047	1.480
	Travel to Hubei							
	No					1.000		
	Yes	0.231	0.120	3.684	0.055	1.260	0.995	1.596
ATT	**Risk perception of COVID-19**							
	Low					1.000		
	High	0.529	0.067	62.378	<0.001	1.698	1.489	1.937
	Perceived personal risk of infection							
	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
	Attitude towards preventive behavior							
	Completely positive attitude					1.000		
	Partially positive attitude	0.340	0.085	16.142	<0.001	1.405	1.190	1.658
SN	**Concern among relatives and friends**							
	Low					1.000		
	High	0.356	0.095	14.047	<0.001	1.427	1.185	1.719
	Other people wearing masks in public places							
	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
	Unknown	0.486	0.203	5.735	0.017	1.625	1.092	2.419
PBC	**Self-efficacy**							
	Low					1.000		
	High	1.278	0.068	354.789	<0.001	3.588	3.142	4.098
Information attention and processing mode	**Information processing**							
	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)	χ^2	*p*
Gender				7.292	0.007
Male	1560(31.9)	1444(92.6)	116(7.4)		
Female	3089(68.1)	3089(94.6)	178(5.4)		
Age(years)				`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)		
Education				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)		
Marital status				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)		
Occupation				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)		
Province				0.508	0.476
Hubei	130(2.7)	124(95.4)	6(4.6)		
Other	4697(97.3)	4409(93.9)	288(6.1)		
Area				33.838	<0.001
Urban	3920(81.25)	3719(94.9)	201(5.1)		
Rural	907(18.8)	814(89.7)	93(10.3)		
Community COVID-19 epidemic				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)		

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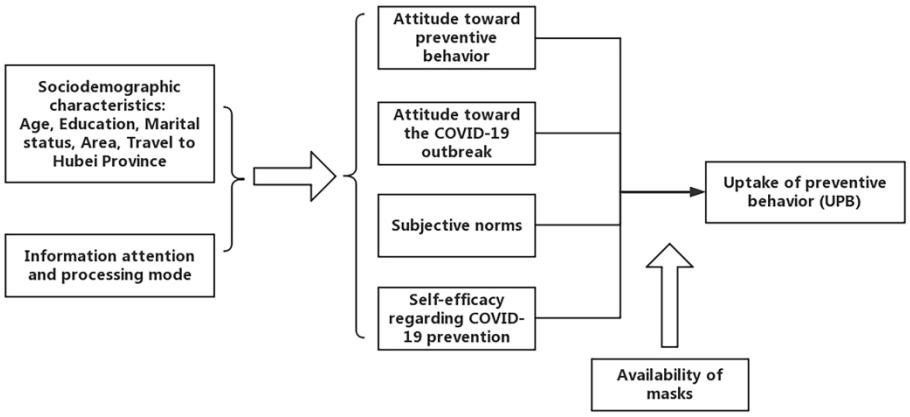

Figure 1. The Theory of Planned Behavior

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
Discussion			
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
Other information			
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.

BMJ Open

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

Journal:	*BMJ Open*
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
Primary Subject Heading:	Public health
Secondary Subject Heading:	Infectious diseases, Public health, Epidemiology
Keywords:	PREVENTIVE MEDICINE, COVID-19, EPIDEMIOLOGY, PUBLIC HEALTH, Public health < INFECTIOUS DISEASES

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

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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 ≥ 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[1]. 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 demonstrated that attitude towards the behavior, subjective norms, and perceived behavioral control

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

To date, few studies in the health context have investigated the factors influencing uptake of preventive behavior during the COVID-19 outbreak. Considering the global spread of COVID-19, we aim to investigate the factors related to uptake of preventive behavior referring to the items in TPB to identify ways to promote the uptake of preventive behavior 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 ≥ 18 years were invited through social media to participate in the survey. Since this online survey was disseminated via website and WeChat, the number of people that were reached couldn't be acquired. In total, 5,851 surveys were returned. After information sorting and cleaning, we removed the invalid questionnaires, including those *spent less than 5 minutes completing the questionnaires which based on the entire large questionnaire included 97 items designed by our research team*, and those failed to answer the quality control questions. 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 attend the pilot survey separately, 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 Selection of factors related to uptake of preventive behavior and Measurements

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

We explored the factors related to uptake of preventive behavior referring to the items in 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 [24]. In addition, we added other potential influencing factors. As shown in Figure 1, we added "attitude towards COVID-19 outbreak" to the attitude towards the behavior section because it could directly influence the attitude towards preventive behavior[25-26]. We divided subjective norms 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 perceived behavioral control[27].

Uptake of preventive behavior, attitude towards the behavior, subjective norms, perceived 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. Referring to the items in TPB, the Cronbach's alpha of all items is 0.6 and the results of factor analysis was showed in (Table 2). The ROC value is 0 .727 while put in all the factors of the regression.

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. 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. 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 3 provides descriptive statistics for the characteristics of the respondents. Overall, the mean age of the respondents was 32.45±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 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 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 payed 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

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[14]. 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[28]. For attitude towards the behavior, compared with a partially positive attitude, a completely positive attitude towards

preventive behavior or payed 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[29]. One possible reason is that the population is generally susceptible due to the highly contagious nature of the virus[30]; 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[31], 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[32]. 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[33]. 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[34]. Low literacy relates to less knowledge about health, which leads to decreased adherence to positive health behaviors[35-36]. Furthermore, marital

status is an important social factor associated with human health and longevity[37-40]. 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[41], 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.

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 ± 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. (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.	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±0.505	1-2
Attitude towards the behavior	Attitude towards preventive behavior	(1) The virus mainly infects the elderly, and young people need not be concerned about it. (2) If you do not eat wild animals or seafood, you will not be infected with COVID-19. (3) You must wash your hands when you come in from outside.	1=agree; 0=disagree;	Obtain a binary categorical classification of attitude: completely positive attitude or partially positive attitude. A completely positive attitudes was indicated by agree answers to all 4 items.	0.87±0.334	1-2

		(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. (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).	4.20±0.643	1-2

Information attention and processing mode	Heuristic-systematic processing (HSM)	Heuristic information processing (HIP) (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. 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=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 score > HIP score).	3.61±0.734	1-3
	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= 3–5 hours; 5=More than 5 hours;	Obtain the degree of attention: <1 hour = None/Less than an hour, 1-3 hours = 1–3 hours, >3 hours = 3–5 hours/more than 5 hours	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	**0.882**
How great do you perceive the risk of infection?	0.071	-0.209	0.406	-0.049	0.393	**0.446**
The proportion of others wearing masks in public places.	-0.048	-0.065	-0.083	-0.034	**0.801**	0.120
I am able to make decisions about COVID-19 based on my existing knowledge without seeking additional information.	-0.092	**0.931**	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	**0.926**	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	**0.887**	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	**0.885**	-0.050	-0.057
The virus mainly infects the elderly, and young people need not be concerned about it.	**0.695**	-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.	**0.476**	0.012	-0.122	0.001	0.490	-0.185
You must wash your hands when you come in from outside.	**0.798**	-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.	**0.810**	-0.061	0.042	0.029	-0.082	0.079
I can avoid COVID-19 infection.	-0.019	0.134	**0.850**	0.115	-0.072	-0.025
I know how to avoid COVID-19.	-0.006	0.174	**0.804**	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(%)	χ^2	*p*
Gender				2.752	0.097
Male	1444(31.9)	708(49.0)	736(51.0)		
Female	3089(68.1)	1433(46.4)	1656(53.6)		
Age(years)				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)		
Education				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)		
Marital status				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)		
Occupation				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)		
Province				0.982	0.322
Hubei	124(2.7)	64(51.6)	60(48.4)		
Other	4409(97.3)	2077(47.1)	2332(52.9)		
Area				10.87	0.001
Urban	3719(82.0)	1714(46.1)	2005(53.9)		
Rural	814(18.0)	427(52.5)	387(47.5)		
Community COVID-19 epidemic				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)		
Travel to Hubei				7.861	0.005
No	4176(92.1)	1947(46.6)	2229(53.4)		
Yes	357(7.9)	194(54.3)	163(45.7)		
Self-rate health					
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

	Variables	B	S.E.	Wald	*p*	OR	95% CI	
							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 personelity 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
	Area							
	Rural					1.000		
	Urban	0.170	0.091	3.511	0.061	1.186	0.992	1.417
	Marriage							
	No married					1.000		
	Married	0.221	0.089	6.147	**0.013**	1.247	1.047	1.486
	Travel to Hubei							
	No					1.000		
	Yes	0.201	0.146	1.905	0.168	1.222	0.919	1.626
	Information-processing							
	Heuristic processing			35.270	**<0.001**	1.000		
	Heuristic- systematic-equivalent processing	0.574	0.142	16.304	**<0.001**	1.776	1.344	2.346
	Systematic processing	0.772	0.133	33.544	**<0.001**	2.164	1.666	2.809
	Attention on COVID-19							
	<1 hour			14.925	**0.001**	1.000		
	1-3hour	0.177	0.086	4.217	**0.040**	1.194	1.008	1.414
	>3hour	0.332	0.087	14.694	**<0.001**	1.394	1.176	1.652
Attitude towards the behavior	**Risk perception of COVID-19**							
	Low					1.000		
	High	0.547	0.067	66.614	**<0.001**	1.729	1.516	1.972
	Perceived risk of self-infection							
	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

	Attitude toward preventive behavior							
	Completely positive attitude					1.000		
	Partially positive atteitude	0.349	0.103	11.584	**0.001**	1.418	1.160	1.733
	Other people wearing marks in public places							
	Half and less than half			11.475	**0.009**	1.000		
Subjective norms	Most	0.417	0.142	8.655	**0.003**	1.517	1.149	2.003
	All	0.510	0.153	11.197	**0.001**	1.666	1.235	2.246
	Unknown	0.485	0.204	5.639	**0.018**	1.624	1.088	2.424
	Self-efficacy							
Perceived behavioral control	Low					1.000		
	High	1.408	0.070	407.497	**<0.001**	4.090	3.567	4.689
	Constant	-3.281	0.338	94.066	<0.001	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)	χ^2	*p*
Gender				7.292	0.007
Male	1560(31.9)	1444(92.6)	116(7.4)		
Female	3089(68.1)	3089(94.6)	178(5.4)		
Age(years)				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)		
Education				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)		
Marital status				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)		
Occupation				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)		
Province				0.508	0.476
Hubei	130(2.7)	124(95.4)	6(4.6)		
Other	4697(97.3)	4409(93.9)	288(6.1)		
Area				33.838	<0.001
Urban	3920(81.25)	3719(94.9)	201(5.1)		
Rural	907(18.8)	814(89.7)	93(10.3)		
Community COVID-19 epidemic				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.

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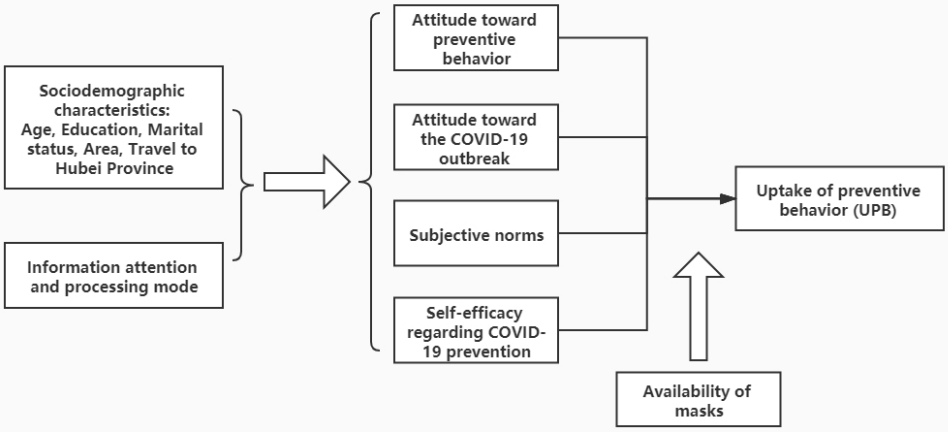

Figure 1 Application of the Theory of Planned Behavior to investigate predictors of uptake of protective behaviors in the context of COVID-19 pandemic.

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
Discussion			
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
Other information			
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.

BMJ Open

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

Journal:	*BMJ Open*
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
Primary Subject Heading:	Public health
Secondary Subject Heading:	Infectious diseases, Public health, Epidemiology
Keywords:	PREVENTIVE MEDICINE, COVID-19, EPIDEMIOLOGY, PUBLIC HEALTH, Public health < INFECTIOUS DISEASES

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

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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 ≥ 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[1]. 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

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

To date, few studies in the health context have investigated the factors influencing uptake of preventive behavior during the COVID-19 outbreak. Considering the global spread of COVID-19, we aim to investigate the factors related to uptake of preventive behavior referring to the items in TPB to identify ways to promote the uptake of preventive behavior 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 ≥ 18 years were invited through social media to participate in the survey. Since this online survey was disseminated via website and WeChat, the number of people that were reached couldn't be acquired. In total, 5,851 surveys were returned. After information sorting and cleaning, we removed the invalid questionnaires, including those *spent less than 5 minutes completing the questionnaires which based on the entire large questionnaire included 97 items designed by our research team*, and those failed to answer the quality control questions. 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 attend the pilot survey separately, 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 Selection of factors related to uptake of preventive behavior and Measurements

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

We explored the factors related to uptake of preventive behavior referring to the items in TPB. In addition, 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 [24]. Moreover, we added other potential influencing factors. As shown in Figure 1, we added "attitude towards COVID-19 outbreak" to the attitude towards the behavior section because it could directly influence the attitude towards preventive behavior[25-26]. Subjective norms were measured using the perception about the public preventive action, which directly bring the social pressure. Three questions related to self-efficacy were used to assess perceived behavioral control[27].

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

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±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

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 uptake of preventive behavior. As shown in Table 2, 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

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

As shown in Table 4, multivariable logistic regression analysis was used to test the influencing factors associated with the uptake of preventive behavior. The fully fitted model had a ROC value of 0.727 while put in all the factors of the regression. 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 payed 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, 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

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[14]. 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[28]. For attitude towards the behavior, compared with a partially positive attitude, a completely positive attitude towards preventive behavior or payed 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[29]. One possible reason is that the population is generally susceptible due to the highly contagious nature of the virus[30]; 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[31], 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[32]. 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[33]. 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[34]. Low literacy relates to less knowledge about health, which leads to decreased adherence to positive health behaviors[35-36]. Furthermore, marital status is an important social factor associated with human health and longevity[37-40]. 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[41], the measurement accuracy heavily depends on 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.

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 ± 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. (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.	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±0.505	1-2
Attitude towards the behavior	Attitude towards preventive behavior	(1) The virus mainly infects the elderly, and young people need not be concerned about it. (2) If you do not eat wild animals or seafood, you will not be infected with COVID-19. (3) You must wash your hands when you come in from outside.	1=agree; 0=disagree;	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.	0.87±0.334	1-2

		(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. (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).	4.20±0.643	1-2

Information attention and processing mode	Heuristic-systematic processing (HSM)	Heuristic information processing (HIP) (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. 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=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 score > HIP score).	3.61±0.734	1-3
	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= 3–5 hours； 5=More 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	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(%)	χ^2	*p*
Gender				2.752	0.097
Male	1444(31.9)	708(49.0)	736(51.0)		
Female	3089(68.1)	1433(46.4)	1656(53.6)		
Age(years)				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)		
Education				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)		
Marital status				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)		
Occupation				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)		
Province				0.982	0.322
Hubei	124(2.7)	64(51.6)	60(48.4)		
Other	4409(97.3)	2077(47.1)	2332(52.9)		
Area				10.87	0.001
Urban	3719(82.0)	1714(46.1)	2005(53.9)		
Rural	814(18.0)	427(52.5)	387(47.5)		
Community COVID-19 epidemic				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)		
Travel to Hubei				7.861	0.005
No	4176(92.1)	1947(46.6)	2229(53.4)		
Yes	357(7.9)	194(54.3)	163(45.7)		
Self-rate health					
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	**0.882**
How great do you perceive the risk of infection?	0.071	-0.209	0.406	-0.049	0.393	**0.446**
The proportion of others wearing masks in public places.	-0.048	-0.065	-0.083	-0.034	**0.801**	0.120
I am able to make decisions about COVID-19 based on my existing knowledge without seeking additional information.	-0.092	**0.931**	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	**0.926**	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	**0.887**	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	**0.885**	-0.050	-0.057
The virus mainly infects the elderly, and young people need not be concerned about it.	**0.695**	-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.	**0.476**	0.012	-0.122	0.001	0.490	-0.185
You must wash your hands when you come in from outside.	**0.798**	-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.	**0.810**	-0.061	0.042	0.029	-0.082	0.079
I can avoid COVID-19 infection.	-0.019	0.134	**0.850**	0.115	-0.072	-0.025
I know how to avoid COVID-19.	-0.006	0.174	**0.804**	0.183	-0.080	-0.105

Table 4. Logistic regression of uptake of preventive behavior

	Variables	B	S.E.	Wald	*p*	OR	95% CI	
							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		
	Under medical observation	-0.151	0.119	1.599	0.206	0.860	0.681	1.086
External personality factors	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
	Area							
	Rural					1.000		
	Urban	0.170	0.091	3.511	0.061	1.186	0.992	1.417
	Marriage							
	No married					1.000		
	Married	0.221	0.089	6.147	**0.013**	1.247	1.047	1.486
	Travel to Hubei							
	No					1.000		
	Yes	0.201	0.146	1.905	0.168	1.222	0.919	1.626
	Information-processing							
	Heuristic processing			35.270	**<0.001**	1.000		
	Heuristic- systematic-equivalent processing	0.574	0.142	16.304	**<0.001**	1.776	1.344	2.346
	Systematic processing	0.772	0.133	33.544	**<0.001**	2.164	1.666	2.809
	Attention on COVID-19							
	<1 hour			14.925	**0.001**	1.000		
	1-3hour	0.177	0.086	4.217	**0.040**	1.194	1.008	1.414
	>3hour	0.332	0.087	14.694	**<0.001**	1.394	1.176	1.652
Attitude towards the behavior	**Risk perception of COVID-19**							
	Low					1.000		
	High	0.547	0.067	66.614	**<0.001**	1.729	1.516	1.972
	Perceived risk of self-infection							
	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

	Attitude toward preventive behavior							
	Completely positive attitude					1.000		
	Partially positive attitude	0.349	0.103	11.584	**0.001**	1.418	1.160	1.733
Subjective norms	**Other people wearing marks in public places**							
	Half and less than half			11.475	**0.009**	1.000		
	Most	0.417	0.142	8.655	**0.003**	1.517	1.149	2.003
	All	0.510	0.153	11.197	**0.001**	1.666	1.235	2.246
	Unknown	0.485	0.204	5.639	**0.018**	1.624	1.088	2.424
Perceived behavioral control	**Self-efficacy**							
	Low					1.000		
	High	1.408	0.070	407.497	**<0.001**	4.090	3.567	4.689
	Constant	-3.281	0.338	94.066	<0.001	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)	χ^2	*p*
Gender				7.292	0.007
Male	1560(32.3)	1444(92.6)	116(7.4)		
Female	3267(67.7)	3089(94.6)	178(5.4)		
Age(years)				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)		
Education				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)		
Marital status				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)		
Occupation				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)		
Province				0.508	0.476
Hubei	130(2.7)	124(95.4)	6(4.6)		
Other	4697(97.3)	4409(93.9)	288(6.1)		
Area				33.838	<0.001
Urban	3920(81.25)	3719(94.9)	201(5.1)		
Rural	907(18.8)	814(89.7)	93(10.3)		
Community COVID-19 epidemic				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.

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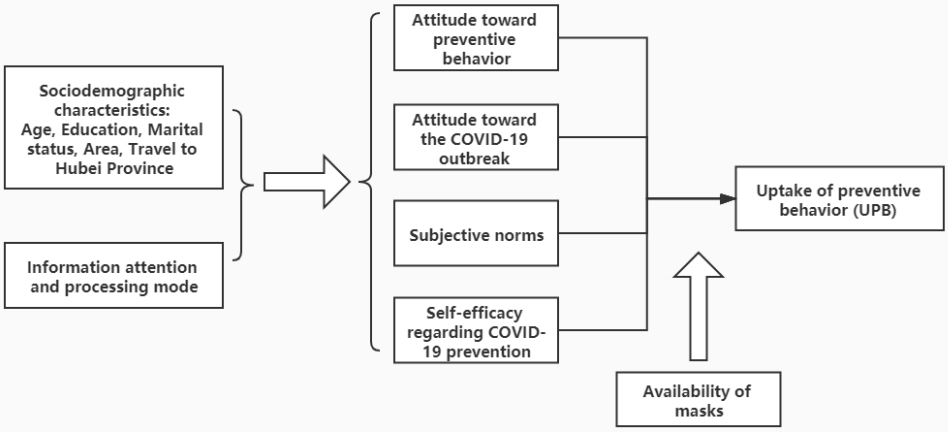

Figure 1 Application of the Theory of Planned Behavior to investigate predictors of uptake of protective behaviors in the context of COVID-19 pandemic.

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
Discussion			
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
Other information			
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.