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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

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

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3 **How can the uptake of preventive behavior during the COVID-19 outbreak be**
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5 **improved? An online survey of 4827 Chinese residents**
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29 **Abstract**
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32 **Objectives** The aims of this study were to assess the uptake of preventive behavior (UPB) during the
33 coronavirus disease 2019 (COVID-19) outbreak and to investigate the factors influencing the UPB based
34 on the theory of planned behavior.
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38 **Design, setting and participants** A cross-sectional online survey was conducted among Chinese
39 residents aged ≥ 18 years and 4827 participants from 31 provinces and autonomous regions were included
40 in the current study. UPB, attitude towards the spread of COVID-19 and preventive behavior (ATT),
41 subjective norms (SN), perceived behavioral control (PBC), demographic characteristics and the
42 information attention and processing mode were measured. Multivariate logistic regressions were used
43 to identify associations between the potential influencing factors and UPB.
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51 **Results** Of the respondents, 52.8% reported high UPB. Multivariate analyses demonstrated that ATT,
52 SN and PBC were significantly correlated with UPB, and PBC was the strongest influencing factor
53 (OR=3.58, $P < 0.001$). Furthermore, systematic information processing mode was positively associated
54 with high UPB compared with heuristic information processing mode (OR=2.08, $P < 0.001$).
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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

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3 studies have reported that transmission may occur early in the course of infection^[2] and that persons
4 who show no signs or symptoms of respiratory infection nevertheless shed SARS-CoV-2^[3-4]. In
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6 addition, the communicable period can be up to three weeks, and communicated patients could develop
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8 severe illness^[5]. Under such circumstances, several institutions, including the WHO, the Chinese CDC
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10 and the US CDC, recommend that the general public take preventive actions to prevent the spread of
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12 respiratory diseases, such as avoiding travel to high-risk areas and contact with individuals who are
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14 symptomatic, washing hands frequently with soap and water, and wearing a mask if coughing or
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16 sneezing^[6-8]. In China, considering that China's population density is much higher than that in most
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18 other countries, which increases the likelihood of virus transmission, the Chinese CDC and National
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20 Health Commission of the People's Republic of China additionally recommended wearing masks when
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22 out in public, decreasing communication and avoiding nonessential excursions^[9]. All these findings and
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24 official recommendations indicate that individual behavior is essential in controlling the pandemic.
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26 Hence, it is important to investigate the factors influencing people's uptake of preventive behavior
27
28 (UPB) to minimize the spread of COVID-19. The theory of planned behavior (TPB), which has been
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30 widely applied to explain many types of behaviors^[10-11], suggests that one's intention is the most
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32 important predictor leading to behavior and is determined by three direct factors: attitude towards the
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34 behavior (ATT, a favorable or unfavorable evaluation of the particular behavior), subjective norms
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36 (SN, perceived social pressure to perform or not perform the behavior), and perceived behavioral
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38 control (PBC, the perception of self-efficacy with respect to the ability to perform the behavior)<sup>[10, 12-
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40 13]</sup>. Previous studies based on the TPB have demonstrated that ATT, SN, and PBC have a significant
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42 positive influence on self-isolation during a pandemic emergency^[14]. Furthermore, the TPB model was
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44 reported to explain 51.7% ($p < .001$) of the variance in A/H1N1 vaccine intentions^[15], and the extended
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46 TPB could predict 60% of adults' intention to receive the swine flu vaccine^[16]. In addition, several
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48 other factors may affect the UPB. The information processing mode can interact with social media to
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50 influence people's perception formation^[17] and then affect behavior; sociodemographic characteristics
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52 such as gender^[18-20] and education^[21] were also reported to affect attitudes and behaviors related to
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54 pandemics.

55 To date, few studies in the health context have investigated the factors influencing UPB during the
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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 initially in pilot survey, but they were not involved in the recruitment, conduct, reporting or dissemination plans. The results of the survey have already been disseminated to all participants via website and WeChat, especially behavioral advice for prevention of COVID-19.

2.3 Conceptual Model and Measurements

We established a conceptual model to explore the factors correlated with the UPB based on the TPB. The resources and opportunities available to a person, such as the availability of masks, to some extent dictate the likelihood of intended and actual behavior^[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

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3 preventive behavior^[23-24]. We divided SN section into two levels of social pressure: concern about
4 COVID-19 among relatives and friends and public preventive action. Three questions related to self-
5 efficacy were used to assess PBC^[25].
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10 UPB, ATT, SN, PBC and the information attention and processing mode were measured by
11 questionnaires. The detailed information of survey questions, variable description and processing were
12 shown in Table 1.
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16 **2.4 Statistical analyses**

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

34 *Descriptive statistics*

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36 Among the 5,851 questionnaires returned, 4827 (82.5%) were valid, reflecting a response rate of
37 83.27%. We additionally excluded 294 participants who could not buy masks. Ultimately, 4,533
38 participants were included in the analysis. Table 2 provides descriptive statistics for the characteristics
39 of the respondents. Overall, the mean age of the respondents was 32.45 ± 9.971 years (range 18-85), and
40 almost half of respondents were between the ages of 21 and 30. Of the participants, 68.1% were
41 women. The majority of the respondents (62.1%) had a bachelor's degree or a college education. More
42 than half of respondents (55.0%) were married. Only 5.3% were medical staff, and 2.7% had a history
43 of travel to Hubei Province (the high risk areas of COVID-19 outbreak). Approximately 82.0% lived in
44 urban areas, and 18.0% reported that someone in their community was suspected or confirmed to have
45 COVID-19.
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3 Regarding preventive behavior, 75.1% of the respondents reported that they wore masks when
4 going outside, 66.1% washed their hands frequently, 66.0% avoiding talking to or touching others, and
5 73.0% avoided unnecessary use of public transportation. Overall, 52.8% of participants reported high
6 UPB. As shown in Table 2, the proportion of high UPB among men (51.0%) was lower than that
7 among women (53.6%). The UPB was also influenced by age, with those 31 to 50 years old accounting
8 for the highest proportion of high UPB and those younger than 20 accounting for the lowest proportion
9 of high UPB. Education was also an influencing factor, with the highest proportion of high UPB
10 observed among respondents with a high school education and the lowest proportion among
11 respondents with a master's degree. Respondents from urban areas reported a significantly higher
12 proportion of high UPB than those from rural areas (53.9% vs 47.5%). Respondents who had a history
13 of travel to Hubei Province (53.4%) reported a higher proportion of high UPB than others (45.7%).
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25 *Association of the UPB with influencing factors based on the TPB*

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28 Table 3 shows that ATT, SN and PBC are important factors influencing the UPB ($P < 0.001$).
29 However, regarding ATT, there was no difference in the UPB between respondents with completely
30 positive attitudes or partially positive attitudes ($P = 0.068$). Additionally, attention to COVID-19 and
31 the information processing mode were also significantly associated with UPB. Respondents who paid
32 more attention to COVID-19 or whose tendency was toward systematic information processing were
33 more likely to exhibit high UPB ($P < 0.001$).
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41 As shown in Table 4, multivariate logistic regression analysis was used to test the influencing
42 factors associated with the UPB. For ATT, compared with those with partially positive attitudes,
43 respondents with completely positive attitudes towards preventive behavior (OR=1.41, 95%CI: 1.19-
44 1.66) or towards the risk of COVID-19 (OR=1.70, 95%CI: 1.49-1.94) had increased adjusted odds of
45 high UPB. Regarding SN, greater concern about COVID-19 among relatives and friends (OR=1.43,
46 95%CI: 1.19-1.72) and a higher proportion of public precaution (Most vs Half and less than half:
47 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,
48 95%CI: 1.11-1.94, respectively) increased the adjusted odds of high UPB. PBC was the strongest
49 influencing factor of UPB. Respondents with high self-efficacy in preventing COVID-19 were 3.59
50 times more likely to have a high UPB than those with low self-efficacy (OR=3.59, 95%CI: 3.14-4.10).
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3 Furthermore, there are also several other influencing factors of UPB. Respondents who engaged more
4 in systematic information processing (SIP) mode were more likely to have high UPB than those
5 engaged more in Heuristic information processing (HIP) mode and HS-equivalent information
6 processing mode (SIP vs HIP: OR=2.08, 95%CI: 1.61-2.69, HS-equivalent vs HIP: OR=1.78, 95%CI:
7 1.35-2.34). Increased attention to COVID-19 was significantly associated with increased adjusted odds
8 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-
9 1.66). Additionally, married and urban respondents had higher UPB than those who were not married
10 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).

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

23 24 25 26 27 28 **4. Discussion**

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

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43 The results showed that ATT, SN, and PBC have significant positive influences on the UPB in the
44 context of COVID-19, which was consistent with a previous study that reported the positive influence
45 of ATT, SN, and PBC on self-isolation during the pandemic^[14]. Of these three considered factors, PBC
46 (self-efficacy with respect to preventing COVID-19) was the strongest predictor. Respondents with
47 high self-efficacy regarding preventing COVID-19 were 3.6 times more likely to have high UPB than
48 those with low self-efficacy. This result supports previous studies indicating that self-efficacy will
49 result in protection motivation leading to changes in attitudes, perceptions, or behaviors^[26]. For ATT,
50 compared with a partially positive attitude, a completely positive attitude towards preventive behavior
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3 or towards the risk of COVID-19 was significantly associated with high UPB. However, the degree of
4 agreement with the likelihood of self-infection was not associated with high UPB in a multivariable
5 analysis. Consistent with our findings, Kim also reported that the perceived likelihood of getting sick
6 (cognitive element) was not strongly associated with preventive behaviors, whereas perceived concern
7 (emotional element) was significantly associated with precautionary and preparatory behaviors^[27]. One
8 possible reason is that the population is generally susceptible due to the highly contagious nature of the
9 virus^[28]; therefore, people's judgments of the severity of the pandemic better reflect their awareness
10 and precautions.

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

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

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3 married people have more advantages related to family support, including psychological support and
4 health behavior support. Our results support the protective role of marriage in the UPB during the
5 pandemic. All these findings indicated that people living in rural areas and people who are not married
6 should be given more attention in terms of health education and health promotion, and their social,
7 psychological and physiological characteristics should be taken into account. In addition, the issue of
8 mask availability among those who are male, over 31 years old, not married or from rural areas should
9 be taken into account because in this survey, these people reported that masks were not available.
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17 The results of this study should be considered in the light of the following limitations. First, an
18 online survey was used for rapid assessment, which may have resulted in selection bias. For example,
19 some older people with low education levels or serious chronic diseases may not be included in the
20 survey, and more comprehensive investigations are needed. Second, this study relied on cross-sectional
21 survey data to examine the relationships. Therefore, the results of the analyses should be interpreted
22 with care because causal relationships between variables may exist. Third, the survey was completed in
23 the relatively short-time period so the results may not reflect the long-term practice of preventive
24 measures after the survey. Finally, although self-report measures are very convenient and common in
25 some fields of media research^[39], the measurement accuracy heavily depends on respondents' ability or
26 willingness to recall their behaviors, which may be underreported or overreported.
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37 **Conclusion**

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40 Despite the cited limitations, our results are helpful for developing education and interventions to
41 support health behaviors and enhance outcomes in the public during a pandemic emergency. The
42 results demonstrate that the TPB is a useful framework for future interventions to improve the UPB.
43 ATT, SN, and PBC have significant positive influences on the UPB during a pandemic, with PBC
44 (self-efficacy) playing the most important role. Furthermore, developing education programs focused
45 on improving awareness of SIP and attention to the pandemic are helpful for promoting high UPB
46 during pandemics. Moreover, we suggest that governments and policy makers give more attention and
47 support to people who live rural areas and who are not married, thereby improving their UPB in the
48 pandemic context.
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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.	1= Strongly disagree; 2= Disagree; 3=Neutral;	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
		(2) Since the outbreak of COVID-19, I have washed my hands more frequently and thoroughly with soap and water.	4=Agree; 5=Strongly agree;			
		(3) Since the outbreak of COVID-19, I have avoided nonessential conversation and personal contact with others.				
		(4) Since the outbreak of COVID-19, I have avoided nonessential excursions and public transportation.				
Attitude towards the behavior (ATT)	Attitude towards preventive behavior	(1) Smoking can prevent COVID-19.	1=correct;	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
		(2) Food must be cooked before it is eaten.	0=incorrect;			
		(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.				
					11	

		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
	Attitude towards COVID-19	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
		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
Subjective norms (SN)	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±0.643	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 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

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(2) I can make a fully informed decision about COVID-19 based on my previous experience.

score > HIP score).

Systematic information processing (SIP)

(1) When I encounter information about COVID-19, I make an effort to carefully analyze it.

(2) When I encounter information about COVID-19, I am likely to stop and think about it.

Degree of attention to COVID-19	In the past month, how much time did you spend focused on COVID-19 information every day?	1=None; 2= Less than an hour; 3= 1–3 hour; 4= 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
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Table 2. Participants' characteristics and uptake of preventive behavior (UPB)

	Total N(%)	Low UPB N(%)	High UPB N(%)	χ^2	<i>p</i>
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	<i>p</i>
	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
ATT	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)	
	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
SN	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)	
	Self-efficacy			443.284	<0.001
PBC	Low	2394(52.8)	1484(62.0)	910(38.0)	
	High	2139(47.2)	657(30.7)	1482(69.3)	
	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
Information attention and processing mode	HIP	316(7.0)	182(57.6)	134(42.4)	
	HS-equivalent	1057(23.3)	472(44.7)	585(55.3)	
	SIP	3160(69.7)	1487(47.1)	1673(52.9)	

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

	Variables	B	S.E.	Wald	p	OR	95% CI	
							lower	upper
Demographic characteristics	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	<i>p</i>
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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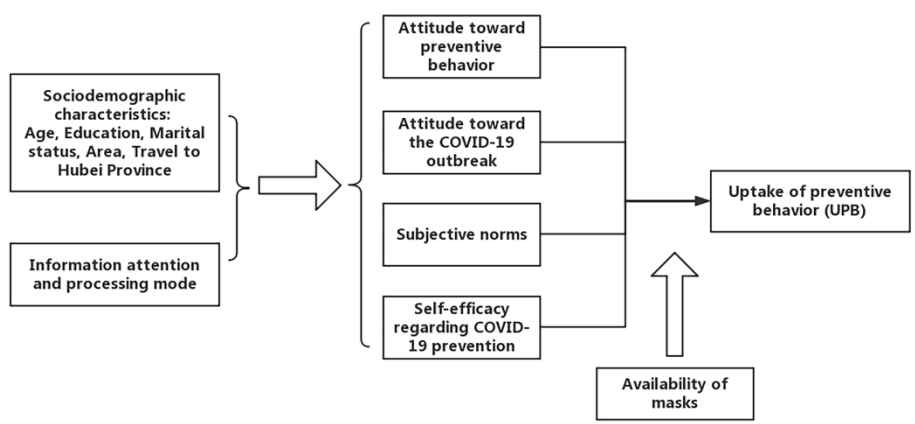


Figure 1. The Theory of Planned Behavior

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	
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
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:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2020-042954.R1
Article Type:	Original research
Date Submitted by the Author:	07-Oct-2020
Complete List of Authors:	Mao, Yimeng; Fudan University, School of Public Health Chen, Hao; Fudan University, School of Public Health Wang, Yi; Fudan University, School of Public Health Chen, Suhong; Fudan University, School of Public Health Gao, Junling; Fudan University, School of Public Health Dai, Junming; Fudan University, School of Public Health Jia, Yingnan; Fudan University, School of Public Health Xiao, Qianyi; Fudan University, School of Public Health Zheng, P; Fudan University, School of Public Health Fu, Hua; Fudan University, School of Public Health
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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1 **How can the uptake of preventive behavior during the COVID-19 outbreak be**
2 **improved? An online survey of 4827 Chinese residents**

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12
13 **Abstract**

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

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

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

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

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

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

33 **Strengths and limitations of this study**

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

46 **1. Introduction:**

47 The World Health Organization (WHO) declared the coronavirus disease (COVID-19) outbreak a
48 pandemic on March 11, 2020. By June 10, 2020, 7,805,148 confirmed cases of COVID-19 and
49 431,192 deaths had been reported globally^[1]. In the absence of a vaccine to prevent COVID-19, the
50 best way to prevent illness is to avoid being exposed to the virus. Early in the outbreak of COVID-19,
51 the Chinese government, the Chinese Center for Disease Control and Prevention (CDC), and local
52 health departments implemented measures to control the transmission of COVID-19, including
53 isolation and quarantine, contact tracing of persons with COVID-19, and community containment.

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3 54 These aggressive measures appear to be successful in reducing the number of deaths and
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5 55 hospitalizations [2-3], and could keep the disease at a level that does not exceed the capacity of the
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7 56 health care system[4].
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11 57 Additionally, measures related to improved personal hygiene were widely publicized in the media
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13 58 as a way to prevent infection. An improved understanding of the drivers of refusal to engage in non-
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15 59 pharmaceutical interventions (NPIs) may help tailor messaging and increase the chances of eliciting
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17 60 behavioral change[5]. Several studies have reported that transmission may occur early in the course of
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19 61 infection[6] and that persons who show no signs or symptoms of respiratory infection nevertheless shed
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21 62 SARS-CoV-2, the virus that causes COVID-19 [2-3]. In addition, the communicable period, defined as
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23 63 the interval from the first day of positive nucleic acid tests to the first day of continuous negative tests,
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25 64 can be up to three weeks, and patients in this communicable period, could develop severe illness.[7].
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27 65 Under such circumstances, several institutions, including the WHO, the Chinese CDC and the US
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29 66 CDC, recommend that the general public take preventive actions to prevent the spread of respiratory
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31 67 diseases, such as avoiding travel to high-risk areas and contact with individuals who are symptomatic,
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33 68 washing hands frequently with soap and water, and wearing a mask if going out[8-10]. In China,
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35 69 considering that China's population density is much higher than that in most other countries, which
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37 70 increases the likelihood of virus transmission, the Chinese CDC and National Health Commission of
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39 71 the People's Republic of China additionally recommended wearing masks when out in public,
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41 72 decreasing communication and avoiding nonessential excursions[11]. All these findings and official
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43 73 recommendations indicate that individual behavior is essential in controlling the pandemic. Hence, it is
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45 74 important to investigate the factors influencing people's uptake of preventive behavior to minimize the
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47 75 spread of COVID-19. The theory of planned behavior (TPB), which has been widely applied to explain
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49 76 many types of behaviors[12-13], suggests that one's intention is the most important predictor leading to
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51 77 behavior and is determined by three direct factors: attitude towards the behavior (a favorable or
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53 78 unfavorable evaluation of the particular behavior), subjective norms (perceived social pressure to
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55 79 perform or not perform the behavior), and perceived behavioral control (the perception of self-efficacy
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57 80 with respect to the ability to perform the behavior)[12, 14-15]. Previous studies based on the TPB have
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59 81 demonstrated that attitude towards the behavior, subjective norms, and perceived behavioral control
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3 82 have a significant positive influence on self-isolation during a pandemic emergency^[16]. Furthermore,
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5 83 the TPB model was reported to explain 51.7% ($p < .001$) of the variance in A/H1N1 vaccine
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7 84 intentions^[17], and the extended TPB could predict 60% of adults' intention to receive the swine flu
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9 85 vaccine^[18]. In addition, several other factors may affect the uptake of preventive behavior. The
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11 86 information processing mode can interact with social media to influence people's perception
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13 87 formation^[19] and then affect behavior; sociodemographic characteristics such as gender^[20-22] and
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15 88 education^[23] were also reported to affect attitudes and behaviors related to pandemics.

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17 89 To date, few studies in the health context have investigated the factors influencing uptake of
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19 90 preventive behavior during the COVID-19 outbreak. Considering the global spread of COVID-19, we
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21 91 aim to investigate the factors related to uptake of preventive behavior referring to the items in TPB to
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23 92 identify ways to promote the uptake of preventive behavior among the public and provide a reference
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25 93 for epidemic control in other countries.

28 94 **2. Method**

30 95 **2.1 Design and Participants**

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33 96 This cross-sectional online survey was conducted through the Wenjuanxing platform
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35 97 (<https://www.wjx.cn/app/survey.aspx>) from Jan 31 to Feb 2, 2020. The survey took approximately 10
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37 98 minutes to complete, and an item with required answer was established to avoid the return of invalid
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39 99 questionnaires. Chinese residents aged ≥ 18 years were invited through social media to participate in
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41 100 the survey. Since this online survey was disseminated via website and WeChat, the number of
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43 101 people that were reached couldn't be acquired. In total, 5,851 surveys were returned. After
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45 102 information sorting and cleaning, we removed the invalid questionnaires, including those *spent less*
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47 103 *than 5 minutes completing the questionnaires which based on the entire large questionnaire*
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49 104 *included 97 items designed by our research team*, and those failed to answer the quality control
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51 105 questions. Finally, 4827 participants from 31 provinces and autonomous regions were included in the
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53 106 current study. The survey and consent documents were approved by the Institutional Review Board of
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55 107 Fudan University, School of Public Health (IRB#2020-01-0800).

108 **2.2 Patient and Public Involvement statement**

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

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

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

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

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

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3 135 shown in Table 1. Referring to the items in TPB, the Cronbach's alpha of all items is 0.6 and the results
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5 136 of factor analysis was showed in (Table 2). The ROC value is 0 .727 while put in all the factors of the
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7 137 regression.
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9 138 **2.4 Statistical analyses**

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12 139 The chi-square test was applied to determine the prevalence of the uptake of preventive behavior
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14 140 by the categorical variables, including demographic characteristics, attitude towards the behavior,
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16 141 subjective norms, perceived behavioral control, degree of attention to COVID-19 and the information
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18 142 processing mode. Multivariate logistic regression analyses were applied to assess the association
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20 143 between the potential influencing factors and the uptake of preventive behavior after controlling for
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22 144 related characteristic covariates. Adjusted ORs and their 95% confidence intervals (CIs) were used to
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24 145 quantify the effects. SPSS software version 22.0 (SPSS, Inc., Chicago, Illinois, US) was used to carry
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26 146 out all analyses. All tests were two-sided, and $P < 0.05$ was considered statistically significant.
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28 147 **3. Results**

30 148 *Descriptive statistics*

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34 149 Among the 5,851 questionnaires returned, 4827 (82.5%) were valid, reflecting a completion rate
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36 150 of 83.27%. We additionally excluded 294 participants who could not buy masks. Ultimately, 4,533
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38 151 participants were included in the analysis. Table 3 provides descriptive statistics for the characteristics
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40 152 of the respondents. Overall, the mean age of the respondents was 32.45 ± 9.971 years (range 18-85,
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42 153 IQR=13), and almost half of respondents were between the ages of 21 and 30. Of the participants,
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44 154 68.1% were women. The majority of the respondents (62.1%) had a bachelor's degree or a college
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46 155 education. More than half of respondents (55.0%) were married. Only 5.3% were medical staff, and
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48 156 2.7% had a history of travel to Hubei Province (the high risk areas of COVID-19 outbreak).
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50 157 Approximately 82.0% lived in urban areas, and 18.0% reported that someone in their community was
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52 158 suspected or confirmed to have COVID-19.
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54 159 Regarding preventive behavior, 75.1% of the respondents reported that they wore masks when
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56 160 going outside, 66.1% washed their hands frequently, 66.0% avoiding talking to or touching others, and
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3 161 73.0% avoided unnecessary use of public transportation. Overall, 52.8% of participants reported high
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5 162 uptake of preventive behavior. As shown in Table 3, the proportion of high uptake of preventive
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7 163 behavior among men (51.0%) was lower than that among women (53.6%). The uptake of preventive
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9 164 behavior was also influenced by age, with those 31 to 50 years old accounting for the highest
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11 165 proportion of high uptake of preventive behavior and those younger than 20 accounting for the lowest
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13 166 proportion of high uptake of preventive behavior. Education was also an influencing factor, with the
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15 167 highest proportion of high uptake of preventive behavior observed among respondents with a high
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17 168 school education and the lowest proportion among respondents with a master's degree. Respondents
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19 169 from urban areas reported a significantly higher proportion of high uptake of preventive behavior than
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21 170 those from rural areas (53.9% vs 47.5%). Respondents who had a history of travel to Hubei Province
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23 171 (53.4%) reported a higher proportion of high uptake of preventive behavior than others (45.7%).
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25 172 *Association of the uptake of preventive behavior with influencing factors*
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28 173 As shown in Table 4, multivariable logistic regression analysis was used to test the influencing
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30 174 factors associated with the uptake of preventive behavior. For attitude towards the behavior, compared
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32 175 with those with partially positive attitudes, respondents with completely positive attitudes towards
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34 176 preventive behavior (OR=1.42, 95%CI: 1.16-1.73) or paid attention towards the risk of COVID-19
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36 177 (OR=1.73, 95%CI: 1.52-1.97) had increased adjusted odds of high uptake of preventive behavior.
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38 178 Regarding subjective norms, a higher proportion of public precaution (Most vs Half and less than half:
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40 179 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
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42 180 Half and less than half: OR=1.62, 95%CI: 1.09-2.42, respectively) increased the adjusted odds of high
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44 181 uptake of preventive behavior. Perceived behavioral control was the strongest influencing factor of
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46 182 uptake of preventive behavior. Respondents with high self-efficacy in preventing COVID-19 were 4.09
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48 183 times more likely to have a high uptake of preventive behavior than those with low self-efficacy
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50 184 (OR=4.09, 95%CI: 3.57-4.69). Furthermore, there are also several other influencing factors of uptake
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52 185 of preventive behavior. Respondents who engaged more in systematic information processing (SIP)
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54 186 mode were more likely to have high uptake of preventive behavior than those engaged more in
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56 187 Heuristic information processing (HIP) mode and HS-equivalent information processing mode (SIP vs
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58 188 HIP: OR=2.16, 95%CI: 1.66-2.81, HS-equivalent vs HIP: OR=1.78, 95%CI: 1.34-2.35). Increased
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3 189 attention to COVID-19 was significantly associated with increased adjusted odds of high uptake of
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5 190 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:
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7 191 1.18-1.65). Additionally, married and urban respondents had higher uptake of preventive behavior than
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9 192 those who were not married (OR=1.25, 95%CI: 1.05-1.49).

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11 193 We also compared the characteristics of the respondents reporting that they could obtain masks
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13 194 and those reporting that they could not (Table 5). The results indicated that respondents who were
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15 195 male, over 31 years old, not married or from a rural area were more likely to report that masks were not
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17 196 available ($P < 0.05$).

197 4. Discussion

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

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

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3 216 preventive behavior or payed attention towards the risk of COVID-19 was significantly associated with
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5 217 high uptake of preventive behavior. However, the degree of agreement with the likelihood of self-
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7 218 infection was not associated with high uptake of preventive behavior in a multivariable analysis.
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9 219 Consistent with our findings, Kim also reported that the perceived likelihood of getting sick (cognitive
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11 220 element) was not strongly associated with preventive behaviors, whereas perceived concern (emotional
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13 221 element) was significantly associated with precautionary and preparatory behaviors^[29]. One possible
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15 222 reason is that the population is generally susceptible due to the highly contagious nature of the virus^[30];
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17 223 therefore, people's judgments of the severity of the pandemic better reflect their awareness and
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19 224 precautions.

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21 225 It is worth noting that the information processing mode was a pivotal factor influencing the uptake
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23 226 of preventive behavior during the COVID-19 outbreak. Respondents who engaged more in SIP were
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25 227 twice as likely to intend to take a high level of preventive behavior against COVID-19 than those who
26
27 228 engaged in HIP. SIP requires greater attention to acquiring information^[31], so people engaged more in
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29 229 SIP will have greater risk awareness due to the evaluation of information and then uptake of preventive
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31 230 actions. However, this result should be interpreted in a specific context or situation, such as the
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33 231 COVID-19 pandemic, as people were unfamiliar and uninformed regarding the infectious disease. As
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35 232 Trumbo mentioned, the notion that only rational and systematic judgement can lead to suitable actions,
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37 233 avoidance of inadequate actions or unnecessary overreactions to risk needs to be reexamined^[32].
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39 234 Additionally, information processing is an important component of health literacy, which can be
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41 235 understood as the capacity of individuals to obtain, process, and understand basic health information to
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43 236 make decisions to maintain health and improve quality of life^[33]. Hence, it may be an effective way to
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45 237 improve the health literacy and in turn uptake of preventive behavior regarding the pandemic through
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47 238 educate the public to evaluate and analyze information (SIP mode) of pandemic.

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49 239 The sociodemographic characteristic factors should also be given more attention. Our findings
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51 240 suggested that people living in rural areas have a lower proportion of high uptake of preventive
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53 241 behavior than those living in urban areas, which may be due to poorer health literacy related to
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55 242 infectious diseases in rural areas than in urban areas^[34]. Low literacy relates to less knowledge about
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57 243 health, which leads to decreased adherence to positive health behaviors^[35-36]. Furthermore, marital

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3 244 status is an important social factor associated with human health and longevity^[37-40]. The marriage
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5 245 protection effect refers to the fact that married people have more advantages related to family support,
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7 246 including psychological support and health behavior support. Our results support the protective role of
8
9 247 marriage in the uptake of preventive behavior during the pandemic. All these findings indicated that
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11 248 people living in rural areas and people who are not married should be given more attention in terms of
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13 249 health education and health promotion, and their social, psychological and physiological characteristics
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15 250 should be taken into account. In addition, the issue of mask availability among those who are male,
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17 251 over 31 years old, not married or from rural areas should be taken into account because in this survey,
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19 252 these people reported that masks were not available.

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21 253 The results of this study should be considered in the light of the following limitations. Firstly, an
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23 254 online survey was used for rapid assessment, which may have resulted in selection bias. For example,
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25 255 some older people with low education levels or serious chronic diseases may not be included in the
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27 256 survey, and more comprehensive investigations are needed. Secondly, this study relied on cross-
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29 257 sectional survey data to examine the relationships. Therefore, the results of the analyses should be
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31 258 interpreted with care because causal relationships between variables may exist. Thirdly, the survey was
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33 259 completed in the relatively short-time period so the results may not reflect the long-term practice of
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35 260 preventive measures after the survey. Fourthly, although self-report measures are very convenient and
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37 261 common in some fields of media research^[41], the measurement accuracy heavily depends on
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39 262 respondents' ability or willingness to recall their behaviors, which may be underreported or
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41 263 overreported. Finally, our survey was based on social-media, which may skew younger, educated, and
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43 264 urban people, in turn may affect the generalizability.

44 45 265 **Conclusion**

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48 266 Despite the cited limitations, our results are helpful for developing education and interventions to
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50 267 support health behaviors and enhance outcomes in the public during a pandemic emergency. Attitude
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52 268 towards the behavior, subjective norms, and perceived behavioral control have significant positive
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54 269 influences on the uptake of preventive behavior during a pandemic, with perceived behavioral control
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56 270 (self-efficacy) playing the most important role. Therefore, developing education programs focused on
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58 271 improving awareness of SIP and attention to the pandemic are helpful in promoting high uptake of
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60 272 preventive behavior during pandemics.

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4 274 **Declarations**

5
6 275 **Funding**

7
8
9 276 This work was supported by the National Natural Science Foundation of China [71573047].

10
11 277 **Conflict of interest**

12
13 278 There are no any conflicts.

14
15
16 279 **Ethics approval and consent to participate**

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18 280 The Institutional Review Board of Fudan University, School of Public Health (IRB#2020-01-0800),
19 281 approved the study protocol.

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22 282 **Availability of data and materials**

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24 283 The data that support the findings of this study are available from school of public health, Fudan
25 284 University but restrictions apply to the availability of these data, which were used under license for the
26 285 current study, and so are not publicly available. Data are however available from the authors upon
27 286 reasonable request and with permission of school of public health, Fudan University.

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31 287 **Code availability**

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33 288 SPSS version 22.0 (SPSS, Chicago, IL, USA);

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37 289 **Authors' contributions**

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39 290 Pinpin Zheng, Junling Gao, Junming Dai, Yingnan Jia and Hua Fu designed the study and obtained the
40 291 data. Junling Gao and Junming Dai organized. Yimeng Mao, Yi Wang, Suhong Chen and Hao Chen
41 292 performed the survey. Yimeng Mao and Qianyi Xiao undertook the data analysis and interpretation
42 293 supervised by Pinpin Zheng. Qianyi Xiao and Yimeng Mao wrote the manuscript. Pinpin Zheng reviewed
43 294 and commented on the manuscript. All authors read the final manuscript and agree with the text.

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47 295 **Acknowledgements:**

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50 296 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.	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
		(2) Since the outbreak of COVID-19, I have washed my hands more frequently and thoroughly with soap and water.				
		(3) Since the outbreak of COVID-19, I have avoided nonessential conversation and personal contact with others.				
		(4) Since the outbreak of COVID-19, I have avoided nonessential excursions and public transportation.				
Attitude towards the behavior	Attitude towards preventive behavior	(1) The virus mainly infects the elderly, and young people need not be concerned about it.	1=agree; 0=disagree;	Obtain binary categorical classification of attitude: completely positive attitude or partially positive attitude. A completely positive attitude was indicated by agree answers to all 4 items.	0.87±0.334	1-2
		(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.				

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

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		Heuristic information processing (HIP)				
Information attention and processing mode	Heuristic-systematic processing (HSM)	(1) I am able to make decisions about COVID-19 based on my existing knowledge without seeking additional information.				
		(2) I can make a fully informed decision about COVID-19 based on my previous experience.	1=Strongly disagree; 2=Disagree; 3= Neutral; 4=Agree; 5= Strongly agree;	By comparing the means of the two corresponding items, information processing was classified as HIP (HIP score > SIP score), HS- equivalent (HIP score = SIP score), or SIP (HIP score > HIP score).	3.61±0.734 1-3	
		Systematic information processing (SIP)				
	Degree of attention to COVID-19	(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.				
		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 hours; than 5 hours;	Obtain the degree of attention: <1 None/Less than an hour, 1-3 hours = 3–5 hours/more than 5 hours	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	<i>p</i>
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				12.387	<0.001
Poor	254(11.9)	208(8.7)	462(10.2)		
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 personality factors	Under medical observation	-0.151	0.119	1.599	0.206	0.860	0.681	1.086
	Suspected case	-0.158	0.147	1.152	0.283	0.854	0.640	1.139
	Confirmed case	0.008	0.113	0.005	0.942	1.008	0.808	1.258
Gender								
Male					1.000			
Female	0.175	0.071	6.174	0.013	1.192	1.038	1.368	
Age(years)								
-20			4.397	0.355	1.000			
21-30	0.265	0.154	2.975	0.085	1.304	0.965	1.762	
31-40	0.148	0.175	0.720	0.396	1.160	0.823	1.634	
41-50	0.219	0.186	1.381	0.240	1.245	0.864	1.794	
51-	0.143	0.226	0.400	0.527	1.153	0.741	1.795	
Education								

	Middle school			5.479	0.140	1.000		
	High School	0.143	0.166	0.744	0.389	1.153	0.834	1.595
	College	0.034	0.156	0.046	0.829	1.034	0.762	1.404
	Master	-0.136	0.174	0.612	0.434	0.873	0.620	1.228
	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
	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
Other people wearing marks in public places								
Subjective norms	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
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	<i>p</i>
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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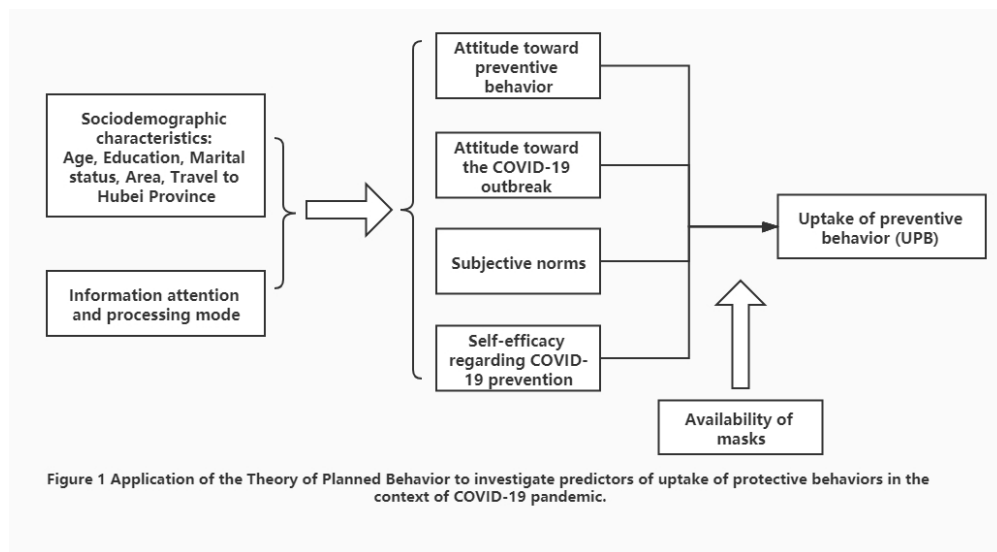


Figure 1 Application of the Theory of Planned Behavior to investigate predictors of uptake of protective behaviors in the context of COVID-19 pandemic.

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	
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
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:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2020-042954.R2
Article Type:	Original research
Date Submitted by the Author:	20-Nov-2020
Complete List of Authors:	Mao, Yimeng; Fudan University, School of Public Health Chen, Hao; Fudan University, School of Public Health Wang, Yi; Fudan University, School of Public Health Chen, Suhong; Fudan University, School of Public Health Gao, Junling; Fudan University, School of Public Health Dai, Junming; Fudan University, School of Public Health Jia, Yingnan; Fudan University, School of Public Health Xiao, Qianyi; Fudan University, School of Public Health Zheng, P; Fudan University, School of Public Health Fu, Hua; Fudan University, School of Public Health
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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1
2
3 **1 How can the uptake of preventive behavior during the COVID-19 outbreak be**
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5 **2 improved? An online survey of 4827 Chinese residents**
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30
31 14 **Abstract**

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33 15 **Objectives** The aims of this study were to assess the uptake of preventive behavior during the
34 16 coronavirus disease 2019 (COVID-19) outbreak and to investigate the factors influencing the uptake of
35 17 preventive behavior based on the theory of planned behavior (TPB) .
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40 18 **Design, setting and participants** A cross-sectional online survey was conducted among Chinese
41 19 residents aged ≥ 18 years and 4827 participants from 31 provinces and autonomous regions were included
42 20 in the current study. Uptake of preventive behavior, attitude towards the spread of COVID-19 and
43 21 preventive behavior, subjective norms, perceived behavioral control, demographic characteristics and
44 22 the information attention and processing mode were measured. Multivariate logistic regressions were
45 23 used to identify associations between the potential influencing factors and uptake of preventive behavior.
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52 24 **Results** There were 2393 (52.8%) respondents reported high uptake of preventive behavior. Multivariate
53 25 analyses demonstrated that attitude towards the behavior, subjective norms and perceived behavioral
54 26 control were significantly correlated with uptake of preventive behavior, and perceived behavioral
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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

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3 54 isolation and quarantine, contact tracing of persons with COVID-19, and community containment.
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5 55 These aggressive measures appear to be successful in reducing the number of deaths and
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7 56 hospitalizations [2-3], and could keep the disease at a level that does not exceed the capacity of the
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9 57 health care system[4].
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12 58 Additionally, measures related to improved personal hygiene were widely publicized in the media
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14 59 as a way to prevent infection. An improved understanding of the drivers of refusal to engage in non-
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16 60 pharmaceutical interventions (NPIs) may help tailor messaging and increase the chances of eliciting
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18 61 behavioral change[5]. Several studies have reported that transmission may occur early in the course of
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20 62 infection[6] and that persons who show no signs or symptoms of respiratory infection nevertheless shed
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22 63 SARS-CoV-2, the virus that causes COVID-19 [2-3]. In addition, the communicable period, defined as
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24 64 the interval from the first day of positive nucleic acid tests to the first day of continuous negative tests,
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26 65 can be up to three weeks, and patients in this communicable period, could develop severe illness.[7].
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28 66 Under such circumstances, several institutions, including the WHO, the Chinese CDC and the US
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30 67 CDC, recommend that the general public take preventive actions to prevent the spread of respiratory
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32 68 diseases, such as avoiding travel to high-risk areas and contact with individuals who are symptomatic,
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34 69 washing hands frequently with soap and water, and wearing a mask if going out[8-10]. In China,
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36 70 considering that China's population density is much higher than that in most other countries, which
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38 71 increases the likelihood of virus transmission, the Chinese CDC and National Health Commission of
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40 72 the People's Republic of China additionally recommended wearing masks when out in public,
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42 73 decreasing communication and avoiding nonessential excursions[11]. All these findings and official
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44 74 recommendations indicate that individual behavior is essential in controlling the pandemic. Hence, it is
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46 75 important to investigate the factors influencing people's uptake of preventive behavior to minimize the
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48 76 spread of COVID-19. The theory of planned behavior (TPB), which has been widely applied to explain
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50 77 many types of behaviors[12-13], suggests that one's intention is the most important predictor leading to
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52 78 behavior and is determined by three direct factors: attitude towards the behavior (a favorable or
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54 79 unfavorable evaluation of the particular behavior), subjective norms (perceived social pressure to
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56 80 perform or not perform the behavior), and perceived behavioral control (the perception of self-efficacy
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58 81 with respect to the ability to perform the behavior)[12, 14-15]. Previous studies based on the TPB have

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3 82 demonstrated that attitude towards the behavior, subjective norms, and perceived behavioral control
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5 83 have a significant positive influence on self-isolation during a pandemic emergency [16]. Furthermore,
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7 84 the TPB model was reported to explain 51.7% ($p < .001$) of the variance in A/H1N1 vaccine
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9 85 intentions[17], and the extended TPB could predict 60% of adults' intention to receive the swine flu
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11 86 vaccine[18]. In addition, several other factors may affect the uptake of preventive behavior. The
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13 87 information processing mode can interact with social media to influence people's perception
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15 88 formation[19] and then affect behavior; sociodemographic characteristics such as gender[20-22] and
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17 89 education[23] were also reported to affect attitudes and behaviors related to pandemics.

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19 90 To date, few studies in the health context have investigated the factors influencing uptake of
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21 91 preventive behavior during the COVID-19 outbreak. Considering the global spread of COVID-19, we
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23 92 aim to investigate the factors related to uptake of preventive behavior referring to the items in TPB to
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25 93 identify ways to promote the uptake of preventive behavior among the public and provide a reference
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27 94 for epidemic control in other countries.

30 95 2. Method

32 96 2.1 Design and Participants

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35 97 This cross-sectional online survey was conducted through the Wenjuanxing platform
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37 98 (<https://www.wjx.cn/app/survey.aspx>) from Jan 31 to Feb 2, 2020. The survey took approximately 10
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39 99 minutes to complete, and an item with required answer was established to avoid the return of invalid
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41 100 questionnaires. Chinese residents aged ≥ 18 years were invited through social media to participate in
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43 101 the survey. Since this online survey was disseminated via website and WeChat, the number of
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45 102 people that were reached couldn't be acquired. In total, 5,851 surveys were returned. After
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47 103 information sorting and cleaning, we removed the invalid questionnaires, including those *spent less*
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49 104 *than 5 minutes completing the questionnaires which based on the entire large questionnaire*
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51 105 *included 97 items designed by our research team*, and those failed to answer the quality control
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53 106 questions. Finally, 4827 participants from 31 provinces and autonomous regions were included in the
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55 107 current study. The survey and consent documents were approved by the Institutional Review Board of
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57 108 Fudan University, School of Public Health (IRB#2020-01-0800).

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3 109 **2.2 Patient and Public Involvement statement**
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6 110 Some participants were invited to help design the questionnaires and attend the pilot survey
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8 111 separately, but they were not involved in the recruitment, conduct, reporting or dissemination plans.
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10 112 The results of the survey have already been disseminated to all participants via website and WeChat,
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12 113 especially behavioral advice for prevention of COVID-19.
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14 114 **2.3 Selection of factors related to uptake of preventive behavior and Measurements**
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17 115 Uptake of preventive behavior: As a dependent variable, the degree of uptake of preventive
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19 116 behavior was included in the study to measure if people uptake the personal precaution against
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21 117 COVID-19. Scales ranging from 1 = I strongly disagree to 5 = I strongly agree measured people's
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23 118 recent uptake of preventive measures captured in these four statements: (1) "Since the outbreak of the
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25 119 COVID-19, I have been wearing a mask in public", (2) "Since the outbreak of the COVID-19, I have
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27 120 washed my hands more frequently and thoroughly with soap and water", (3) "Since the outbreak of the
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29 121 COVID-19, I have avoided non-essential conversation and personal contact with others, and (4) "Since
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31 122 the outbreak of the COVID-19, I have avoided non-essential going out or taking public transportation".
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33 123 Because all the 4 items were referred to the guidelines published by China CDC and WHO, and were
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35 124 all important and basic individual behaviors to prevent COVID-19, therefore, in this study, only
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37 125 participants who chose 5 (strongly agree) for all four questions were defined as having high uptake of
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39 126 preventive behavior.
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41 127 We explored the factors related to uptake of preventive behavior referring to the items in TPB. In
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43 128 addition, the resources and opportunities available to a person, such as the availability of masks, to
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45 129 some extent dictate the likelihood of intended and actual behavior [24]. Moreover, we added other
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47 130 potential influencing factors. As shown in Figure 1, we added "attitude towards COVID-19 outbreak"
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49 131 to the attitude towards the behavior section because it could directly influence the attitude towards
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51 132 preventive behavior^[25-26]. Subjective norms were measured using the perception about the public
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53 133 preventive action, which directly bring the social pressure. Three questions related to self-efficacy were
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55 134 used to assess perceived behavioral control^[27].
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57 135 Uptake of preventive behavior, attitude towards the behavior, subjective norms, perceived
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3 136 behavioral control and the information attention and processing mode were measured by
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5 137 questionnaires. The detailed information of survey questions, variable description and processing were
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7 138 shown in Table 1.
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10 139 **2.4 Statistical analyses**

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12 140 The chi-square test was applied to determine the prevalence of the uptake of preventive behavior
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14 141 by the categorical variables, including demographic characteristics, attitude towards the behavior,
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16 142 subjective norms, perceived behavioral control, degree of attention to COVID-19 and the information
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18 143 processing mode. The underlying structure of the items and their factor loadings was identified by
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20 144 using the exploratory factor analysis (EFA); the extraction was made using the principal components
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22 145 and the rotation using the Varimax method. Multivariate logistic regression analyses were applied to
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24 146 assess the association between the potential influencing factors and the uptake of preventive behavior
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26 147 after controlling for related characteristic covariates. Adjusted ORs and their 95% confidence intervals
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28 148 (CIs) were used to quantify the effects. The sensitivity, specificity and the area under the receiver
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30 149 operating characteristic (ROC) curve were calculated to evaluate the logistic regression model. SPSS
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32 150 software version 22.0 (SPSS, Inc., Chicago, Illinois, US) was used to carry out all analyses. All tests
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34 151 were two-sided, and $P < 0.05$ was considered statistically significant.
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36 152 **3. Results**

37 38 39 153 *Descriptive statistics*

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42 154 Among the 5,851 questionnaires returned, 4827 (82.5%) were valid, reflecting a completion rate
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44 155 of 83.27%. We additionally excluded 294 participants who could not buy masks. Ultimately, 4,533
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46 156 participants were included in the analysis. Table 2 provides descriptive statistics for the characteristics
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48 157 of the respondents. Overall, the mean age of the respondents was 32.45 ± 9.971 years (range 18-85,
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50 158 IQR=13), and almost half of respondents were between the ages of 21 and 30. Of the participants,
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52 159 68.1% were women. The majority of the respondents (62.1%) had a bachelor's degree or a college
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54 160 education. More than half of respondents (55.0%) were married. Only 5.3% were medical staff, and
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56 161 2.7% had a history of travel to Hubei Province (the high risk areas of COVID-19 outbreak).
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58 162 Approximately 82.0% lived in urban areas, and 18.0% reported that someone in their community was
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3 163 suspected or confirmed to have COVID-19.
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6 164 Regarding preventive behavior, 75.1% of the respondents reported that they wore masks when
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8 165 going outside, 66.1% washed their hands frequently, 66.0% avoiding talking to or touching others, and
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10 166 73.0% avoided unnecessary use of public transportation. Overall, 52.8% of participants reported high
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12 167 uptake of preventive behavior. As shown in Table 2, the proportion of high uptake of preventive
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14 168 behavior among men (51.0%) was lower than that among women (53.6%). The uptake of preventive
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16 169 behavior was also influenced by age, with those 31 to 50 years old accounting for the highest
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18 170 proportion of high uptake of preventive behavior and those younger than 20 accounting for the lowest
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20 171 proportion of high uptake of preventive behavior. Education was also an influencing factor, with the
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22 172 highest proportion of high uptake of preventive behavior observed among respondents with a high
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24 173 school education and the lowest proportion among respondents with a master's degree. Respondents
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26 174 from urban areas reported a significantly higher proportion of high uptake of preventive behavior than
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28 175 those from rural areas (53.9% vs 47.5%). Respondents who had a history of travel to Hubei Province
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30 176 (53.4%) reported a higher proportion of high uptake of preventive behavior than others (45.7%).

31 177 *Association of the uptake of preventive behavior with influencing factors*

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34 178 Considering that potential influencing factors of uptake of preventive behavior were designed
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36 179 referring to the items in TPB, exploratory factor analysis(EFA) was first performed to examine the
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38 180 underlying structure of the items and their factor loadings to support and strengthen the following
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40 181 association analysis of the uptake of preventive behavior with influencing factors. As shown in Table 3,
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42 182 the EFA result was in accordance with items been grouped into constructs in Table 1. The proportion
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44 183 of the variance explained by the retained factors was 72.2% and the Cronbach's alpha of all items is
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46 184 0.6.

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49 185 As shown in Table 4, multivariable logistic regression analysis was used to test the influencing
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51 186 factors associated with the uptake of preventive behavior. The fully fitted model had a ROC value of
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53 187 0.727 while put in all the factors of the regression. For attitude towards the behavior, compared with
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55 188 those with partially positive attitudes, respondents with completely positive attitudes towards
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57 189 preventive behavior (OR=1.42, 95%CI: 1.16-1.73) or payed attention towards the risk of COVID-19

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3 190 (OR=1.73, 95%CI: 1.52-1.97) had increased adjusted odds of high uptake of preventive behavior.
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5 191 Regarding subjective norms, perceptions of a higher proportion of public precaution increased the
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7 192 adjusted odds of high uptake of preventive behavior (Most vs Half and less than half: OR=1.52,
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9 193 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
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11 194 less than half: OR=1.62, 95%CI: 1.09-2.42, respectively). Perceived behavioral control was the
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13 195 strongest influencing factor of uptake of preventive behavior. Respondents with high self-efficacy in
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15 196 preventing COVID-19 were 4.09 times more likely to have a high uptake of preventive behavior than
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17 197 those with low self-efficacy (OR=4.09, 95%CI: 3.57-4.69). Furthermore, there are also several other
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19 198 influencing factors of uptake of preventive behavior. Respondents who engaged more in systematic
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21 199 information processing (SIP) mode were more likely to have high uptake of preventive behavior than
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23 200 those engaged more in Heuristic information processing (HIP) mode and HS-equivalent information
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25 201 processing mode (SIP vs HIP: OR=2.16, 95%CI: 1.66-2.81, HS-equivalent vs HIP: OR=1.78, 95%CI:
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27 202 1.34-2.35). Increased attention to COVID-19 was significantly associated with increased adjusted odds
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29 203 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:
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31 204 OR=1.39, 95%CI: 1.18-1.65). Additionally, married and urban respondents had higher uptake of
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33 205 preventive behavior than those who were not married (OR=1.25, 95%CI: 1.05-1.49).

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35 206 We also compared the characteristics of the respondents reporting that they could obtain masks
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37 207 and those reporting that they could not (Table 5). The results indicated that respondents who were male
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39 208 (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
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41 209 (OR=2.11, 95%CI: 1.64-2.73) were more likely to report that masks were not available.

43 210 **4. Discussion**

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46 211 In the present study, we demonstrate that 52.8% of participants reported high uptake of preventive
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48 212 behavior, with full compliance with wearing masks in public, frequent hand washing, avoidance of
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50 213 talking to or touching others and avoidance of unnecessary public transportation use. We explored the
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52 214 potential factors influencing the uptake of preventive behavior during a pandemic referring to the items
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54 215 in TPB. The results show that attitude towards the behavior, subjective norms, and perceived
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56 216 behavioral control have significant influences on uptake of preventive behavior. Information
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58 217 processing mode, attention to the pandemic and several sociodemographic characteristics also

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3 218 influenced high uptake of preventive behavior.
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6 219 The results showed that attitude towards the behavior, subjective norms, and perceived behavioral
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8 220 control have significant positive influences on the uptake of preventive behavior in the context of
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10 221 COVID-19, which was consistent with a previous study that reported the positive influence of attitude
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12 222 towards the behavior, subjective norms, and perceived behavioral control on self-isolation during the
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14 223 pandemic^[14]. Of these three considered factors, perceived behavioral control (self-efficacy with respect
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16 224 to preventing COVID-19) was the strongest predictor. Respondents with high self-efficacy regarding
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18 225 preventing COVID-19 were 3.6 times more likely to have high uptake of preventive behavior than
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20 226 those with low self-efficacy. This result supports previous studies indicating that self-efficacy will
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22 227 result in protection motivation leading to changes in attitudes, perceptions, or behaviors^[28]. For attitude
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24 228 towards the behavior, compared with a partially positive attitude, a completely positive attitude towards
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26 229 preventive behavior or payed attention towards the risk of COVID-19 was significantly associated with
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28 230 high uptake of preventive behavior. However, the degree of agreement with the likelihood of self-
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30 231 infection was not associated with high uptake of preventive behavior in a multivariable analysis.
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32 232 Consistent with our findings, Kim also reported that the perceived likelihood of getting sick (cognitive
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34 233 element) was not strongly associated with preventive behaviors, whereas perceived concern (emotional
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36 234 element) was significantly associated with precautionary and preparatory behaviors^[29]. One possible
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38 235 reason is that the population is generally susceptible due to the highly contagious nature of the virus^[30];
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40 236 therefore, people's judgments of the severity of the pandemic better reflect their awareness and
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42 237 precautions.

43 238 It is worth noting that the information processing mode was a pivotal factor influencing the uptake
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45 239 of preventive behavior during the COVID-19 outbreak. Respondents who engaged more in SIP were
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47 240 twice as likely to intend to take a high level of preventive behavior against COVID-19 than those who
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49 241 engaged in HIP. SIP requires greater attention to acquiring information^[31], so people engaged more in
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51 242 SIP will have greater risk awareness due to the evaluation of information and then uptake of preventive
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53 243 actions. However, this result should be interpreted in a specific context or situation, such as the
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55 244 COVID-19 pandemic, as people were unfamiliar and uninformed regarding the infectious disease. As
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57 245 Trumbo mentioned, the notion that only rational and systematic judgement can lead to suitable actions,

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3 246 avoidance of inadequate actions or unnecessary overreactions to risk needs to be reexamined^[32].
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5 247 Additionally, information processing is an important component of health literacy, which can be
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7 248 understood as the capacity of individuals to obtain, process, and understand basic health information to
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9 249 make decisions to maintain health and improve quality of life^[33]. Hence, it may be an effective way to
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11 250 improve the health literacy and in turn uptake of preventive behavior regarding the pandemic through
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13 251 educate the public to evaluate and analyze information (SIP mode) of pandemic.

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15 252 The sociodemographic characteristic factors should also be given more attention. Our findings
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17 253 suggested that people living in rural areas have a lower proportion of high uptake of preventive
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19 254 behavior than those living in urban areas, which may be due to poorer health literacy related to
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21 255 infectious diseases in rural areas than in urban areas^[34]. Low literacy relates to less knowledge about
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23 256 health, which leads to decreased adherence to positive health behaviors^[35-36]. Furthermore, marital
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25 257 status is an important social factor associated with human health and longevity^[37-40]. The marriage
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27 258 protection effect refers to the fact that married people have more advantages related to family support,
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29 259 including psychological support and health behavior support. Our results support the protective role of
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31 260 marriage in the uptake of preventive behavior during the pandemic. All these findings indicated that
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33 261 people living in rural areas and people who are not married should be given more attention in terms of
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35 262 health education and health promotion, and their social, psychological and physiological characteristics
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37 263 should be taken into account. In addition, the issue of mask availability among those who are male,
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39 264 over 31 years old, not married or from rural areas should be taken into account because in this survey,
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41 265 these people reported that masks were not available.

42
43 266 The results of this study should be considered in the light of the following limitations. Firstly, an
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45 267 online survey was used for rapid assessment, which may have resulted in selection bias. For example,
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47 268 some older people with low education levels or serious chronic diseases may not be included in the
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49 269 survey, and more comprehensive investigations are needed. Secondly, this study relied on cross-
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51 270 sectional survey data to examine the relationships. Therefore, the results of the analyses should be
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53 271 interpreted with care because causal relationships between variables may exist. Thirdly, the survey was
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55 272 completed in the relatively short-time period so the results may not reflect the long-term practice of
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57 273 preventive measures after the survey. Fourthly, although self-report measures are very convenient and
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59 274 common in some fields of media research^[41], the measurement accuracy heavily depends on
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275 respondents' ability or willingness to recall their behaviors, which may be underreported or

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3 276 overreported. Fifthly, although our findings indicated the potential way of referring to the TPB theory
4 277 to explore influencing factors of uptake of preventive behavior in the early stage of COVID-19, the
5 278 theoretical application is insufficient, which needs the further research with the modeling approach in
6 279 the future study. Finally, our survey was based on social-media, which may skew younger, educated,
7 280 and urban people, in turn may affect the generalizability.

11 281 **Conclusion**

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13
14 282 Despite the cited limitations, our results are helpful for developing education and interventions to
15 283 support health behaviors and enhance outcomes in the public during a pandemic emergency. Attitude
16 284 towards the behavior, subjective norms, and perceived behavioral control have significant positive
17 285 influences on the uptake of preventive behavior during a pandemic, with perceived behavioral control
18 286 (self-efficacy) playing the most important role. Therefore, developing education programs focused on
19 287 improving awareness of SIP and attention to the pandemic are helpful in promoting high uptake of
20 288 preventive behavior during pandemics.

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30 290 **Declarations**

31 32 33 291 **Funding**

34
35 292 This work was supported by the National Natural Science Foundation of China [71573047].

36 37 38 293 **Conflict of interest**

39
40 294 There are no any conflicts.

41 42 43 295 **Ethics approval and consent to participate**

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45 296 The Institutional Review Board of Fudan University, School of Public Health (IRB#2020-01-0800),
46 297 approved the study protocol.

47 48 49 298 **Availability of data and materials**

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51 299 The data that support the findings of this study are available from school of public health, Fudan
52 300 University but restrictions apply to the availability of these data, which were used under license for the
53 301 current study, and so are not publicly available. Data are however available from the authors upon
54 302 reasonable request and with permission of school of public health, Fudan University.

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3 303 **Code availability**
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6 304 SPSS version 22.0 (SPSS, Chicago, IL, USA);
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9 305 **Authors' contributions**

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11 306 Pinpin Zheng, Junling Gao, Junming Dai, Yingnan Jia and Hua Fu designed the study and obtained the
12
13 307 data. Junling Gao and Junming Dai organized. Yimeng Mao, Yi Wang, Suhong Chen and Hao Chen
14
15 308 performed the survey. Yimeng Mao and Qianyi Xiao undertook the data analysis and interpretation
16
17 309 supervised by Pinpin Zheng. Qianyi Xiao and Yimeng Mao wrote the manuscript. Pinpin Zheng reviewed
18
19 310 and commented on the manuscript. All authors read the final manuscript and agree with the text.

20
21 311 **Acknowledgements:**

22 312 We gratefully thank all participants for their cooperation.
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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.	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
		(2) Since the outbreak of COVID-19, I have washed my hands more frequently and thoroughly with soap and water.			
		(3) Since the outbreak of COVID-19, I have avoided nonessential conversation and personal contact with others.			
		(4) Since the outbreak of COVID-19, I have avoided nonessential excursions and public transportation.			
Attitude towards the behavior	Attitude towards preventive behavior	(1) The virus mainly infects the elderly, and young people need not be concerned about it.	Obtain binary categorical classification of attitude: completely positive attitude or partially positive attitude. A completely positive attitude was indicated by agree answers to all 4 items.	0.87±0.334	1-2
		(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.			

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

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

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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	<i>p</i>
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				12.387	<0.001
Poor	254(11.9)	208(8.7)	462(10.2)		
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
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
Risk perception of COVID-19							
Low					1.000		
High	0.547	0.067	66.614	<0.001	1.729	1.516	1.972
Attitude towards the Perceived risk of self-infection behavior							
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
Other people wearing marks in public places								
Subjective norms	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
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		

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	<i>p</i>
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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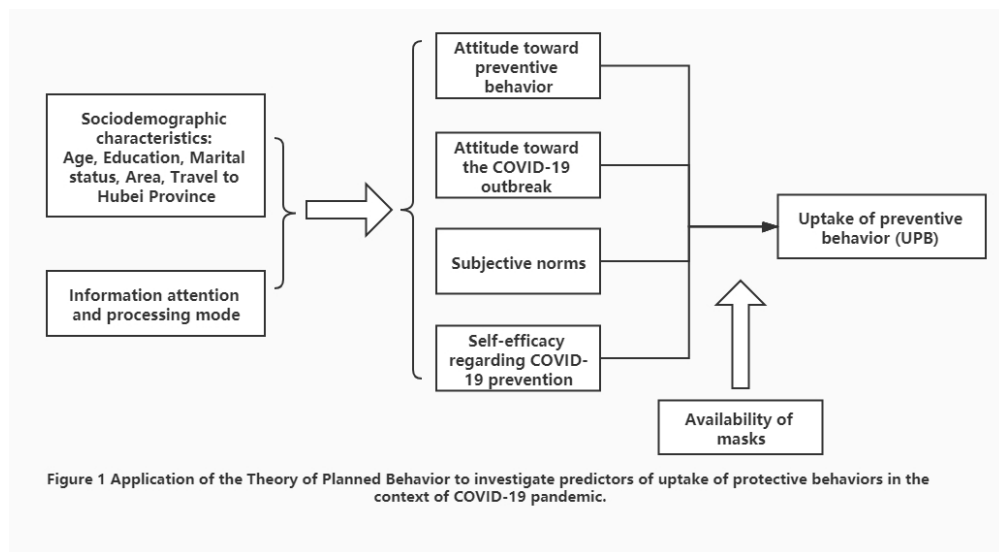


Figure 1. Application of the Theory of Planned Behavior to investigate predictors of uptake of protective behaviors in the context of COVID-19 pandemic

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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	
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
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.